98th NARST International Conference | Digital Program

March 23 - 26, 2025

In Praise of Science Teachers:

Essential Partners in Researching, Reframing, and Reforming Science Learning

Washington, DC

THANK YOU TO OUR EXHIBITORS

IDEALIZED SCIENCE INSTITUTE

Springer

THANK YOU TO OUR SPONSOR

WILEY

98th NARST International Conference

Please note that this program is subject to change.

Check the addendum posted at the meeting and **here** for updates.

Table of Contents

98th NARST International Conference

General Information

Information about NARST

NARST is a global organization for improving science teaching and learning through research. Since its inception in 1928, NARST has promoted research in science education and the communication of knowledge generated by the research. The ultimate goal of NARST is to help all learners achieve science literacy.

The Association is incorporated as a non-profit corporation in the State of Minnesota. The official publication is the *Journal of Research in Science Teaching (JRST)*. NARST encourages presentations of a wide variety of investigations in all aspects of science education, including action, historical, philosophical, ethnographic, experimental, and evaluative research studies. Reports of empirical research, critical reviews, and theoretical works are encouraged. In October 2010, to reflect the Association's growing international focus and membership, the Board approved referring to the Association by its acronym only. At the April 2011 Board Meeting, the tagline for the Association was approved by the Board. Thus, the Association's name and tagline is:

> ***NARST— A global organization for improving science education through research.***

Research areas of interest to NARST members include curriculum development and organization, assessment and evaluation, learning theory, teacher education, programs for exceptional students (special needs and talents), equity studies, policy, and methods of teaching.

NARST Mission Statement

NARST is a global organization of professionals committed to the improvement of science teaching and learning through research. Since its inception in 1928, NARST has promoted research in science education and the communication of knowledge generated by the research.

The ultimate goal of NARST is to help all learners achieve science literacy. NARST promotes this goal by: **1)** encouraging and supporting the application of diverse research methods and theoretical perspectives from multiple disciplines to the investigation of teaching and learning in science; **2)** communicating science education research findings to researchers, practitioners, and policy makers; and **3)** cooperating with other educational and scientific societies to influence educational policies.

Member Benefits

- Ten issues per year of the Journal of Research in Science Teaching (electronic version), with access to **JRST online** through Wiley InterScience.
- Access to the **NARST Member Forum**. Stay connected and informed of NARST activities, position openings, committee and Research Interest Group events, graduate student events, and more.
- Discounted registration rate for the NARST Annual International Conference.
- Opportunities to apply for **scholarships and travel support**.
- Access to **NARST Virtual Events** throughout the year. We encourage members to propose webinars, workshops, and other virtual events that align with NARST's mission. Committees, RIGs, strands, and NARST leadership offer events for members free of charge.
- Opportunities to volunteer for **committees** and **leadership positions**.
- Opportunities to serve as a mentor for new members and early career scholars: **Sandra K. Abell Institute**, **Mentor/Mentee Nexus**, and more.

NARST
A global organization for improving science education through research

NARST Programs and Events Code of Conduct Policy

NARST is committed to providing a safe, productive, and welcoming environment for all meeting participants and NARST staff. All participants, including, but not limited to, attendees, speakers, volunteers, exhibitors, sponsors, staff members, and all others are expected to abide by this Programs Code of Conduct. This Policy applies to all NARST meeting-related events, including those sponsored by organizations other than NARST but held in conjunction with NARST events, on public or private platforms.

Unacceptable Behavior is defined as:

- Harassment, intimidation, or discrimination in any form.
- Verbal abuse of any attendee, speaker, volunteer, exhibitor, sponsor, NARST staff member, other meeting guest or venue staff member.
- Examples of verbal abuse include, but are not limited to, verbal comments related to gender, sexual orientation, disability, physical appearance, body size, race, religion, national origin, inappropriate use of nudity and/or sexual images in public spaces or in presentations, or threatening or stalking any attendee, speaker, volunteer, exhibitor, NARST staff member, service provider, other meeting guest, or venue staff member.
- Disruption of presentations during sessions, in the exhibit hall, or at other events organized by NARST throughout the meeting.
- Participants should not copy or take screen shots of Q&A or any chat room activity that takes place in the virtual space.

NARST reserves the right to take any action deemed necessary and appropriate, including immediate removal from the meeting without warning or refund, in response to any incident of unacceptable behavior, and NARST reserves the right to prohibit attendance at any future meeting, virtually or in person.

If you experience harassment or hear of any incidents of unacceptable behavior, NARST asks that you inform either NARST Executive Director, Mackenzie Kelley, **ExecutiveDirector@narst.org** or NARST Events Manager, Amy Sellheim **Amy.Sellheim@management-hq.com** so that we can take the appropriate action.

Code of Ethical Conduct

The purpose of the National Association of Research in Science Teaching (NARST) Code of Ethical Conduct is to articulate a set of aspirational principles to guide and support members as they engage in professional activities—research, teaching, and service. NARST members are science education professionals who include researchers, practitioners, and graduate students from various cultures worldwide. These aspirational principles align with and support the mission of the organization to help all members achieve, develop, and contribute meaningfully to the improvement of science teaching and learning through research. NARST expects its members to adhere to the highest ethical standards. The Code of Ethical Conduct serves as a guide to the everyday professional conduct of science educators.

Unfamiliarity with NARST's Code of Ethical Conduct is not a valid defense for engaging in or failing to challenge observed unethical behavior. We accomplish this through our Code of Ethical Conduct where there is:

A. Professional Competence

Science education professionals strive to maintain the highest levels of competence in their work; they recognize the limitations of their expertise; and they undertake only those tasks for which they are qualified by education, training, or experience. They recognize the need for ongoing education in order to remain professionally competent; and they utilize the appropriate scientific, scholarly, professional, technical, and administrative resources needed to ensure honesty and integrity. Science education professionals conduct research, teach, practice, and provide service only within the boundaries of their competence, based on their education, training, supervised experience, or appropriate professional experience. They consult with other professionals when necessary for the benefit of their students, research participants, and clients. They maintain awareness of current scientific, scholarly, and professional information in their fields of activity and undertake continuing efforts to maintain competence in the skills they use. Importantly, professional competence must also include a willingness to accept and integrate new information and experiences, regardless of the effect that process has on research outcomes.

B. Integrity

It is the social responsibility of science education professionals to maintain integrity in all conduct, publications, and forums, and give due credit to the contributions of others. Adhering to this standard means science education professionals do not fabricate, falsify, or plagiarize. Public comments on matters of importance that are relevant to science education must be made with care and accuracy. Adhering to this standard means science education professionals do not use deficit language, deceptive statements concerning research data, or otherwise knowingly make false, misleading or deceptive statements in practicing and presenting research. Comment and debate within the bounds of collegiality and professionalism that keep the organization moving forward and current with emergent issues and perspectives are encouraged. Adhering to this standard means science education professionals do not use dismissive remarks or gestures, restrict multiple voices, or use derogatory language. In short, science education professionals conduct their professional activities in ways that engender trust and confidence.

C. Professional and Scholarly Responsibility in Science Teaching, Learning, and Research

Science education professionals have a responsibility to use research practice and policy to advance NARST members' understanding of the teaching and learning of science in all learning contexts—formal, informal, local, and global—through research, practice, and policy. They adhere to the highest scholarly and professional standards within their field of expertise and accept responsibility for adherence to those standards. Science education professionals should regard the tutelage of graduate students and early career faculty as a trust conferred by the organization for which they work, as well as NARST, for the promotion of these individuals' learning and professional development.

Science education professionals understand that they form a community and show respect for other science education professionals even when they disagree on theoretical, methodological, or personal approaches to professional activities. In activities involving marginalized populations, it is essential that responsible science education professionals seek out the voices and experiences of members of these groups and treat them as critical to their scholarship. While always endeavoring to be collegial, science education professionals must never let the desire to be collegial outweigh their shared responsibility for ethical behavior. When appropriate, they consult with colleagues, NARST's Equity and Ethics Committee, or organizational entities such as their institutional review board in order to prevent, avoid, or challenge unethical conduct.

D. Respect for People's Rights, Dignity, and Diversity

Science education professionals respect the rights, dignity, and worth of all people in their professional activities. They treat other professionals, students, research participants, and members of the organization fairly, respectfully, and without exploitation or harassment. Science education professionals acknowledge the rights of others to hold values, attitudes, and opinions that differ from their own and take reasonable steps to avoid harm to others in the conduct of their work. They learn with others, share ideas honestly, give credit for others' contributions, and encourage others to contribute their unique skills, knowledge, and interests in professional environments. Science education professionals are sensitive to cultural, individual, and role differences in teaching, studying, and providing service to groups of people with distinctive characteristics, as well as the power differential that might result from such differences.

Science education professionals carefully avoid discrimination and bias toward individuals and groups based on race, gender, age, religion, ethnicity, nationality, sexual orientation, gender expression, gender identity, presence of disabilities, educational background, socioeconomic status, or other personal attributes. They refrain from making biased assumptions about others and perpetuating demeaning attitudes and stereotypes. Science education professionals do not accept any forms of discrimination and actively challenge implicit and explicit forms of discrimination.

E. Social Responsibility

Science education professionals are aware of their scientific and professional responsibility to the communities and societies in which they live. This awareness extends to their involvement and service to an increasingly diverse and international NARST community. NARST members are guided by the values and standards that reflect the professional literature. They strive to promote equity and the public good by advancing scientific and scholarly knowledge. Science education professionals are aware of the differences in society and culture that impact scholarly knowledge and academic work. They value and embrace the public trust in research and teaching and are concerned about their ethical behavior and the behavior of other science education professionals that might compromise that trust. Science education professionals should reasonably expect of themselves and others to be guided by a code of ethics that supports efforts to resolve ethical dilemmas.

References

AERA Council. (2011). Code of ethics: American Educational Research Association. Educational Researcher, 40(3), 145-146.

American Sociological Association. (1999). Code of ethics and policies and procedures of the ASA committee on professional ethics. Retrieved from: **http://www.asanet.org/membership/code-ethics**

American Psychological Association. (2017). Ethical principles of psychologists and code of conduct. Retrieved from: **https://www.apa.org/ethics/code/**

Research Interest Groups (RIGs) Information

Continental and Diasporic Africa in Science Education RIG (CADASE)

The purpose of CADASE RIG is to **(a)** encourage science educators to engage in research aimed at meeting the needs of people of African descent; and **(b)** provide intellectual, professional, and personal space for science educators engaged in such research. This RIG will provide opportunities for science education researchers to integrate the study of culture, ethnicity, gender, race, and social class as lenses for performing critical analyses and evaluations of prevailing theory and practice of science education on the lives of people of African descent. A variety of theoretical and methodological frameworks will be used to address issues in science curriculum, learning, teaching, assessment and evaluation, and policy issues in both K-14 formal and informal venues in different contexts.

Chair: **Rona Robinson-Hill**
rmrobinsonhi@bsu.edu

Secretary: **Romola Bernard**
romola.bernard@ung.edu

Treasurer: **Stanton Bedford**
sbelfor2@utsouthern.edu

LATINO/A RIG (LARIG)

The Latino/a RIG supports social networks that further research agendas regarding Latino/a science learners. LARIG also serves as a support and mentoring alcoba (space) for Latin@s/Latino science educators and others interested in Latin@ science education.

Chair: **Angela Chapman**
Angela.chapman@utrgv.edu

Contemporary Methods for Science Education Research

The broad purpose of this RIG is to advance the mission of NARST by maintaining the rigor of science education studies, as well as promoting more standardized research practices across the organization such that we are better able to learn from and synthesize each other's work. The intent is that these outcomes will, in turn, allow us to keep advancing the field and maintain the relevance of our research to improving science teaching and learning.

Chair: **Robert Talbot**
robert.talbot@ucdenver.edu

Co-Chair: **Bina Vanmali**
bina@asu.edu

Engineering Education RIG (ENE-RIG)

The purpose of the RIG in Engineering Education is to synergize research in science and engineering education, promote rigorous research in engineering education, and provide a collaboration and discussion space supporting intellectual and professional exchange and networking.

Chair: **Monica Cardella**
mcardell@fiu.edu

Indigenous Science Knowledge Research Interest Group (ISK-RIG)

The ISK-RIG was set up to showcase and provide support to current and future research works of a growing number of Indigenous Knowledge Systems (IKS) researchers working within indigenous communities throughout the world who are members of NARST. This group includes active members from Africa and the African Diaspora, Alaska, Australia, Canada, Indigenous populations of the Americas, Asia and the Pacific, the Middle East, Thailand, Nordic Regions, New Zealand, Scandinavia, the West and East Indies, etc. The goal is to increase awareness of what indigenous knowledge systems can contribute to research.

Chair: **Sharon Nelson-Barber**
snelson@wested.org
Co-Chair: **Bhaskar Upadhyay**
bhaskar@umn.edu
Secretary: **Rouhollah Aghasaleh**
ra292@humboldt.edu
Treasurer: **Julie Robinson**
julie.robinson@und.edu

Research in Artificial Intelligence-Involved Science Education (RAISE)

This RAISE RIG aims at employing AI to extend the landscape of science education, increase the capacity of all participants in the venture to face worldwide challenges, and significantly address the equity and ethical problems in the world broadly. This RIG will **(a)** support cutting-edge innovations using AI to address learning, teaching, assessment, equity and policy issues in science education; **(b)** communicate the cutting-edge research involving AI to all researchers, practitioners, and policymakers; and **(c)** encourage junior scholars in the field to pursue AI innovations within science education research as it is broadly practiced.

Chair: **Xiaoming Zhai**
Xiaoming.zhai@uga.edu
Co-Chair: **Kent J. Crippen**
kcrippen@coe.ufl.edu

Asian and Pacific Islander Science Education Research (APISER)

The APRSER RIG will promote diversity, equity, and inclusion in science education research using the lenses relevant to Asian and pacific islander cultures, ethnicities, gender, and class, as well as the intersections of these markers. It will also serve as an intellectual network to support and mentor current and future Asian and Pacific Islander scholars within and outside of the United States, including NARST members interested in API related research endeavors.

Dr. Hosun Kang
hosunk@uci.edu
Dr. Edna Tan
etan@uncg.edu

Lesbian, Gay, Bisexual, Transgender, Queer, Plus Science Education Research Group (LGBTQ +)

This RIG provides opportunities for science education researchers to explore and discuss issues relevant to the LGBTQ+ community related to a wide range of topics including science curriculum, learning, teaching, assessment or evaluation, and policy issues in both K-16 formal and informal educational contexts. RIG members promote diversity, equity, and inclusion in science education and science education research. The LGBTQ+ RIG serves as a peer support, mentoring, and inclusive space for folks who identity as LGBTQ+. The LGBTQ+ RIG provides a formalized space inclusive of queer folk and queer research.

Dr. Sara Porter
scheredi@uncg.edu
Dr. Colby Toefel-Grehl
colby.tg@usu.edu

2024–2025 NARST Leadership Team

Officers and Board of Directors:

President
Jerome Shaw (2026)
University of California, Santa Cruz

President-Elect
Jennifer D. Adams (2027)
University of Calgary

Immediate Past President
Jomo Mutegi (2025)
Old Dominion University

Secretary-Treasurer
Brooke Whitworth (2026)
Clemson University

Executive Director
Mackenzie Kelley

Executive Board Members:

Heba EL-Deghaidy (2027)
American University in Cairo

Patrick Enderle (2026)
Georgia State University

Amelia Wenk Gotwals (2025)
Michigan State University

Kristin Gunckel (2027)
University of Arizona

S. Selcen Guzey (2026)
Purdue University

Shiang-Yao Liu (2026)
National Taiwan Normal University

Sharon Nelson-Barber (2025)
WestEd

Meredith Park Rogers (2027)
Indiana University

International Coordinator

Mercy Ogunsola-Bandele (2025)
National Open University of Nigeria

Graduate Student Coordinator

Jennifer Bateman (2025)
Clemson University

NARST Liaison to NSTA

Carla Zembal-Saul (2027)
Penn State University

JRST Editors

Felicia Mensah (2025)
Teachers College, Columbia University

Troy Sadler (2025)
UNC Chapel Hill

Matthew Kloser (2030)
University of Notre Dame

Edna Tan (2030)
University of North Carolina-Greensboro

Dana Vedder-Weiss (2030)
Ben-Gurion University of the Negev

Strand Key

Strand 1:	**Science Learning: Development of Student Understanding**
Strand 2:	**Science Learning: Contexts, Characteristics, and Interactions**
Strand 3:	**Science Teaching—Primary School: Characteristics and Strategies** (Grades PreK-6)
Strand 4:	**Science Teaching—Middle and High School: Characteristics and Strategies** (Grades 5-12)
Strand 5:	**College Science Teaching and Learning** (Grades 13-20)
Strand 6:	**Science Learning in Informal Contexts**
Strand 7:	**Pre-service Science Teacher Education**
Strand 8:	**In-service Science Teacher Education**
Strand 9:	**Discontinued**
Strand 10:	**Curriculum, Evaluation, and Assessment**
Strand 11:	**Cultural, Social, and Gender Issues**
Strand 12:	**Technology for Teaching, Learning, and Research**
Strand 13:	**History, Philosophy, Sociology, and Nature of Science**
Strand 14:	**Environmental Education and Sustainability**
Strand 15:	**Policy, Reform and Program Evaluation**

2023-2025 Strand Coordinators

Strand 1: Science Learning—Development of Student Understanding

Daniela Fiedler (2025)
University of Copenhagen

Stefanie L. Marshall (2026)
Michigan State University

Strand 2: Science Learning—Contexts, Characteristics and Interactions

Anne Emerson Leak (2025)
High Point University

Rachel van Aswegen (2026)
University of Virginia

Strand 3: Science Teaching—Primary School (Grades preK-6)

Jing Lin (2025)
Beijing Normal University

Moyu (Molly) Zhang (2026)
New York University

Strand 4: Science Teaching—Middle and High School (Grades 5-12)

Emily Adah Miller (2025)
University of Georgia

Robbie. L. Higdon (2026)
James Madison University

Strand 5: College Science Teaching and Learning (Grades 13-20)

Tara Nkrumah (2025)
Arizona State University

Anita Schuchardt (2026)
University of Minnesota

Strand 6: Science Learning in Informal Contexts

Rebecca Swanson (2025)
University of Nebraska-Lincoln

Kelli Paul (2026)
Indiana University

Strand 7: Pre-service Science Teacher Education

Preethi Titu (2025)
Kennesaw State University

Selina Lynn Bartels (2026)
Valparaiso University

Strand 8: In-service Science Teacher Education

Quentin Biddy (2025)
University of Colorado

Julie C. Brown (2026)
Univeristy of Florida

Strand 10: Curriculum and Assessment

Peng He (2025)
Michigan State University

Jill Wertheim (2026)
WestEd

Strand 11: Cultural, Social, and Gender Issues

Sophia Jeong (2025)
University of Georgia

Quentin Sedlacek (2026)
Southern Methodist University

Strand 12: Technology for Teaching, Learning, and Research

Yang Yang (2025)
Qingdao University

TingTing Li (2026)
Michigan State University

Strand 13: History, Philosophy, Sociology, and Nature of Science

Allison Antink-Meyer (2025)
Illinois State University

Mila Rosa Librea Carden (2026)
University of North Texas

Strand 14: Environmental Education and Sustainability

Narendra Dadarao Deshmukh (2025)
Homi Bhabha Centre for Science Education

Rouhollah Aghasaleh (2026)
California State Polytechnic University, Humboldt

Strand 15: Policy, Reform, and Program Evaluation

Jamie Mikeska (2025)
Educational Testing Research

Sanlyn Buxner (2026)
University of Arizona

Program Proposal Reviewers

Cory A. Buxton
Olasunkanmi A Gbeleyi
Muhammad Abd Hadi Bunyamin
Alli Abdurrazaq
Emine Adadan
Emily Adah Miller
Umar Adam
Adrian Adams
Matt Adams
Yetunde Adaramola
Ibukunolu Ademola
Michael Adewusi
Nazanin Adhami
Isabell Adler
Gili Ad-Marbach
Renee Affolter
Claudia Aguirre Mendez
Amdad Ahmed Awsaf
Raju Ahmmed
Wanjoo Ahn
Rahmi Aini
Ozlem Akcil Okan
Sule Aksoy
Büşra Aksöz
Maram Al Aqra
Sahar Alameh
Piata Allen
Winter Allen
Oshra Aloni
R Ambrose
Noah Amir
Neha Anand
Justin Andersson
Allison Antink-Meyer
Tasneem Anwar
Olukayode Apata
Xornam Apedoe
Helena Aptyka
Anna Arias
Gur Arie Livni Alcasid
Stephanie Arthur
Franklin Aucapina
Luiz Augusto Rezende Filho
Shirly Avargil
Lucy Avraamidou
Elizabeth Ayano
Mehmet Aydeniz
Zeynep Aydin
Kate Ayers
Rana Baddour
Clare Baek
Meena Balgopal
Tanvi Banerjee
Ayelet Baram-Tsabari
Jonathan Barcelo
Cansu Başak Uygun
Alicia Batailles
Kathryn Bateman
Maíra Batistoni e Silva
Jess Bautista
Nazan Bautista
Christina Baze
Orit Ben Zvi Assaraf
Amanda Benedict-Chambers
Adam Bennion
Brooke Bentley
Lillian Bentley
Gregor Benz
Rachel Benzoni
Romola Bernard
Tess Bernhard
Richard Bex
Julie Bianchini
Daniella Biffi
Kader Bilican
Patricia Bills
Stephanie Bismuth

Program Proposal Reviewers

Alex Bittel
Meredith Bittel
Charlie Blake
Margaret Blanchard
Matthew Blank
Estelle Blanquet
Jana-Sabrin Blome
Ron Blonder
Yurdagul Bogar
Franz Bogner
Claus Bolte
Diana Bonilla
Lisa Borgerding
Andreas Borowski
Nikhil Borse
G. Michael Bowen
Jonathan Bowers
Evelyn Boyd
Sharon Bramwell-Lalor
Ava Breitbeck
Linsey Brennan
Bill Bridges
Sinead Brien
Joe Brobst
Julie Brown
Michelle Brown
Ryan Brown
Lauren Browning
Till Bruckermann
Jeanne Brunner
Jason Buell
Engin Bumbacher
Jan-Philipp Burde
Terrance Burgess
Stephen Burgin
Lydia Burke
Eric Burkholder
Rebecca Bushway
Tiffany Butler
Mustafa CAKIR
Brendan Callahan
Aylin çam
Tajma Cameron
Vandeen Campbell
Catalina Canete Llanos
Brandi Cannon
Zhao Cao Kan
Heidi Carlone
Janet Carlson
Sarah Carrier
Carmen Carrion
Grace Carroll
Michael Cassidy
Claudia Castillo-Lavergne
Sheila Castro
Anne Catena
Andy Cavagnetto
Veronica Cavera
Logan CC
Devasmita Chakraverty
Laura Chalfant
Yu-Hui Chang
Shaghig Chaparian
Ravishankar Chatta Subramaniam
Eirini Chatzara
Yen-Yuan Chen
Jiaxin CHEN
Pai-rou Chen
Ying-Chih Chen
Jacquelyn Chini
Edwin Chng
Hye-eun Chu
Heidi Cian
L. Clara Mabour
Darcy Clark
Michael Clough
Hernan Cofre
Scott Cohen
Ryan Coker
Brandin Conrath
Hannah Cooke
Elysa Corin
Peter Cormas
Steven Courchesne
Beth Covitt
Eugene Cox
Lenora Crabtree
Kent Crippen
Hayden Criswell
Hong Cui
Keren Dagan
Zoubeida Dagher
Amanda Dahl
Felisha Dake
Keren Dalyot
Yaa Dankwa
Anupama Das
Bradley Davey
Shannon Davidson
Elizabeth Davis
Elizabeth de los Santos
Elizabeth Deimeke
Isabel Delgado-Quinones
Joe DeLuca
Maggie Demarse
Hasan Deniz
Narendra Deshmukh Desi
Michael Dias
Rifati Dina Handayani
Ly Do
KT Doerr
Jennifer Doherty
Remy Dou
Sara Dozier
Ravit Duncan
Mandy Dunphy
Monica E. Cardella
Kaya Easley
Hadeel Edrees Dabbah
Ruth Edri
Emil Eidin
Sarah El Halwany
Andrew Elby
Heba EL-Deghaidy
J. Elisabeth Mesiner
Kate Elizabeth Miller
Aya Elkholy
Kathryn Eller
Markus Emden
Uchenna Emenaha
Patrick Enderle
Jale Ercan Dursun
Sibel Erduran
Greta Etherton
Spencer Eusden
Gülüzar Eymur
Ayça Fackler
Lillyanna Faimon
Nannan Fan
Sarah Fankhauser
Amy Farris
christelle fayad
Chou Fen-May
Karine Fernandes
Carmen Fernandez
Pinar Fettahlioglu
Pınar Fettahlioglu
Daniela Fiedler
Carla Finkelstein
Solaire Finkenstaedt-Quinn
Elizabeth Finlayson Harris
Steven Fletcher
David Fortus
Jared Fox
Alyssa Freeman
Naz Fulya Cibik
Kristin Gagnier
Dennys Gahrmann
Uma Ganesan
Yizhu Gao
Grant Gardner
Kat Gardner-Vandy
Amanda Garner
Eleni Georgakopoulou
Frikkie George
Martha Georgiou
Ihsan Ghazal
Michael Giamellaro
Robert Gieske
Andrew Gilbert
Donna Giles
Tamar Ginzburg
Luciane Goes
María González-Howard
Amelia Gotwals
Julia Gouvea
Ellen Granger
Nicole Graulich
Meagan Graves
Ron Gray
Karlis Greitans

Program Proposal Reviewers

Muriel Grenon
Chris Griesemer
Julia Grimes
Anna Grinath
Rike Große-Heilmann
Cristina Guarrella
Brenda Guerrero
Kristin Gunckel
Preeti Gupta
Selcen Guzey
Yovita Gwekwerere
Daisy Haas
Robert Hagen
Rita Hagevik
Sarah Haines
Sarah Hajama
Amanda Hall
Jonathan Hall
Emily Haluschak
Razan Hamed
Rebecca Hammack
Karen Hammerness
Melike Hanedar
Frank Hannich
Ute Harms
Tyler Harper-Gampp
Emily Harris
Elizabeth Hasseler
Christa Haverly
Savannah Hayes
Cheng-Wen He
Weiwei He
Xinyu He
Gabriela Heck
Lúcia Helena Sasseron
Ben Herman
Imogen Herrick
Cari Herrmann Abell
Benedikt Heuckmann
Siti Hidayana Binti Nassiri
Robbie Higdon
Priya Hinton
Christine Hirst Bernhardt
Rebecca Hite
Noluthando Hlazo
Nga Hoang
Julia Holzer
Martin Hopf
Tiantian Hou
Hanna Howell
Sherry Hsi
Chih Hsuan Lin
Yuxi Huang
Lynn Huff
Jiaojiao Hui
Ally Hunter
Paul Hutchison
Tra Huynh
Soo Hyun Yang
Amal Ibourk
Mohammed Ibrahim
Robert Idsardi
Chinyere Ikpah
Veronica Ilari
Assad Iqbal
Tobias Irish
Christopher Irwin
Sharfun Islam Nancy
Fredyrose Ivan Pinar
Benjamin Janney
Hannah Jardine
Leonie Jasper
Shiva Javanmardi
Sophia Jeong
Chaochao Jia
Qingna Jin
Thuthukile Jita
Shuochian Joe Shiu
Marie Johanna Univer
Joseph Johnson
Devan Jones
Eric Jones
M. Gail Jones
Eugene Judson
Yehudit Judy Dori
Min Jung Lee
Gabriela Kaiana Ferreira
Ugur Kale
Kostas Kampourakis
Hosun Kang
Dilara Kara Zorluoglu
Srijana Katuwal
Nurcan Keles
Eleanor Kenimer
Meena Kharatmal
Rola Khishfe
Ritesh Khunyakari
Anum Khushal
Meredith Kier
Gamze Kılıç
Selçuk Kılınç
Heather Killen
Anna Kim
Kathryn Kirchgasler
Eric Kirk
James Kisiel
Vance Kite
DeNae Kizys
Jasmin Kneuper
Karel Kok
Niki Koukoulidis
Rebecca Krall
Scott Kreher
Moritz Krell
Kerstin Kremer
Dirk Krueger
Jule Krüger
Jerrid Kruse
Marcus Kubsch
Eric Kuo
Sophie Kurschildgen
Jee Kyung Suh
Emily L
Richard Lamb
Summer Landreth
Elon Langbeheim
Kim Lange-Schubert
Kathryn Lanouette
Kaylee Laub
James Laverty
Michael Lawson
Paul Le
Anne Leak
Felicia Leammukda
Soon Lee
YewJin Lee
Pit Lepage
Amnon Levin
Olivia Levrini
Elizabeth Lewis
Min Li
Tingting Li
Ling Liang
Peter Licona
Rasheda Likely
Cynthia Lima
Huann-shyang Lin
Jing Lin
Ming-Yeng Lin
Qiuyu Lin
Tzung-Jin Lin
Kristen Lindahl
Karen Lionberger
Matthew Lira
Anna Liskes
Shiang-Yao Liu
Melissa Livingston
Silvia Lizette Ramos
Peter Locher
Daniela Lopes Scarpa
Sarah Losoya
Christine Lotter
Pamela Lottero-Perdue
Vanessa Louis
Shanshan Lu
Deana Lucas
Krista Lucas
April Luehmann
Lisa Lundgren
S M Mushfiquer Rahman Ashique
Jennifer M. Bateman
Aihanh Maasen
Yetunde Mabadeje
Nessrine Machaka
Anna MacPherson
Lauren Madden
Seungho Maeng
Nicolette Maggiore
Bridget Maher
Anina Mahmud
Hamza Malik
Lisa Marco-Bujosa
Letícia Marinho
Mayra Marquez-Mendez

Program Proposal Reviewers

Stefanie Marshall
Teresa Massey
Leah Master
Becky Mathers
Clausell Mathis
Daniel Matthew Levin
Alexis Mayfield
Carla McAuliffe
Jonathan McCausland
Katie McCorrison
Sarah McDowell
Justin McFadden
Thomas McKenna
Amber Meeks
Kim Megyesi-Brem
Insa Melle
Ren Mendoza
David Menendez
Adjoa Mensah
Alison Mercier
Joi Merritt
Allison Metcalf
André Meyer
Shuaishuai Mi
Rhea Miles
Jadda Miller
Maizie Miller
Anica Miller Rushing
Catherine Milne
James Minogue
Taya Misheva
Richie Moalosi
Olayinka Mohorn
Robert Monahan
Austin Moore
Sierra Morandi
Nancy Moreno
Maria Moreno Vera
Adi Moskovits
Fatemeh Mozaffari
Ebru Muğaloğlu
Ali Muller
Michelle Müller
Bridget Mulvey
Frackson Mumba
Danusa Munford
Jaclyn Murray
Jomo Mutegi
Vivien Mweene Chabalengula
Shahriar Nafees Chowdhury Raaz
Slki Narae Lim
Josie Nardo
Shannon Navy
Ross Nehm
Andreas Nehring
Eva Nelson
Alana Newell
UrLeaka Newsome
Ayşe Nihan Şatgeldi
Argyris Nipyrakis
Ryan Nixon
Felicia Nkrumah
Tara Nkrumah
Eric Nolan
Lucky Nonyelum
Jessica Norberto Rocha
Sevde Nur Yerisenoglu
Maggie O'Brien
Curtis O'Dwyer
Yinka Ogunlade
John Ojeogwu
Peter Okebukola
Agyemang Okyere Darko
Adekunle Oladejo
Daniel Oleynik
Stacy Olitsky
Deborah Oluwatosin Agbanimu
Ray Opoku
Rena Orofino
Jonathan Osborne
Peter Oyewole
Ferah Özer
Nilay OZTURK
Elif Ozulku
Laura Pannullo
Priyanka Parekh
Jongchan Park
Soonhye Park
Wonyong Park
Carolyn Parker
Shira Passentin
Suzanne Patzelt
Alexander Paulchell
Chris Pavlovich
Felix Pawlak
Melissa Pearcy
Marisa Peczuh
Rafael Pelletti
Gonzalo Peñaloza
Hongyu Peng
Robyn Pennella
Carlos Perez
Veronica Pérez Serrano Flores
David Perl-Nussbaum
Asghar Pervaiz Gill
Esther Peter
Andrea Phillips
Éric Picholle
Pieranna Pieroni
Takeshia Pierre
Kimberly Pigford
Daniel Pimentel
Jacob Pleasants
Katarzyna Pomian Bogdanov
Sarah Poor
Cheri Porter
Wardell Powell
Rani Prasad
Adepeju Prince
Rajashri Priyadarshini
Muhammad Purwanto
Senay Purzer
Anjar Putro Utomo
Asnat R. Zohar
Benjamin R.Lowell
Arif Rachmatullah
Jeffrey Radloff
Jennifer Radoff
Toma Radu Bogdan
Natalie Rae
Jrène Rahm
Kellyann Ramdath
Kay Ramey
Miia Rannikmäe
Shelley Rap
Guy Raviv
Rebecca Rawson
Jessica Reaves
Carina Rebello
Michael Reiss
Danielle Rhemer
Zuway R-Hong
Greer Richardson
Alvin Riffel
Alexis Riley
Devon Riter
Jonathan Rivera
Javier Robalino
Nicolas Robin
de Robles
Shahaf Rocker Yoel
Marc Rodemer
Hanna Røkenes
William Romine
Mathias Ropohl
Yuval Rosenberg
Linda Rost
Rob Rouse
Alexis Rutt
Maryam Saberi
Dana Sachayni
Nobomita Saha
Burak Sahin
Emine Sahin
Demet Şahin Kalyon
Merav Saini
Toluwalase Salako
Soykan Sandikcioglu
N. Sanjay Rebello
Richard Sannert
Alejandra Santely
Esra Sarıcı
Sara Satanassi
Sean Savage
Alyssa Sayavedra
George Schafer
Anita Schuchardt
Heather Schurman
Renee Schwartz
Meredith Schwendemann

Program Proposal Reviewers

Martinique Sealy
Wisam Sedawi
Quentin Sedlacek
Natasha Segal
Ozden Sengul
Daniel Serrano
Keiphe Setlhatlhanyo
Elsun Seung
Neta Shaby
Kazi Shahidullah
Brian Shambare
Daniel Sharkey
Manav Sharma
Meenakshi sharma
Katherine Sharp
Or Shav-Artza
Carrie-Anne Sherwood
Yann Shiou Ong
Mary Short
Chuhui Si
Bernadette Sibuma
Tiffany-Rose Sikorski
Elena Silverman
Jennifer Simons
Michelle Sinapuelas
Corinne Singleton
Anna Skorupa
Dimitri Smirnoff
Bethany Smith
Cody Smith
Julie Smith
Patrick Smith
Rebecca Smith
Theila Smith
Zacharoula Smyrnaiou
Danielle Sodani
Jorge Solis
Olutosin Solomon Akinyemi
Isaac Sonful
Regina Soobard
Stefan Sorge
Sherry Southerland
Ronja Sowinski
Simge Söylemez
Ornit Spektor-Levy
Kristine Squillace Stenlund
Alex St. Louis
Tina Stamper
Sabrina Stanley
Elizabeth Stansberry
Gal Stern
Lisa Stinken-Rösner
Annabel Stoler
Tuba Stouthart
Kate Strangfeld
Rachel Stronach
Shannon Stubbs
Henry Suárez
Karthigeyan Subramaniam
ChiJung Sui
Ryan Summers
Hye Sun You
Nivedha Sundar
Rebecca Swanson
Janari T
Tali Tal
Emily Tancredi-Brice Agbenyega
Arzu Tanisozcelik
Kristina Tank
Dan Tao
Yang Tao
Giulia Tasquier
Sebastian Tassoti
Lezly Taylor
Sureka Taylor
Gerald Tembrevilla
Başak Tepedelen
Oliver Tepner
Italo Testa
Andrew Tetteh
Sandhya Thakur
D Thom
Ashley Thomas
Preethi Titu
Ana-Maria Topliceanu
Hong Tran
Khanh Tran
Trang Tran
Florian Trauten
Maiza Trigo
Jennifer Tripp
Graciela Trujillo Hernandez
Kathy Trundle
Yu-Jan Tseng
Hsiao-Lin Tuan
Grace Tukurah
Heidi Turcotte
Refika Turgut
Franklin U. Onowugbeda
Bhaskar Upadhyay
Annette Upmeier zu Belzen
Maya Usher
Muhammad Usman Ijaz
Faezeh Vahdat Nia
Angie Valbuena Rojas
Rachel van Aswegen
Malka van Dijk
Helena van Vorst
Max Vazquez Dominguez
Dana Vedder-Weiss
Katherine Vela
Sotheara Veng
Birgit Viru
Irit Vivante
Tina Vo
Andreas Vorholzer
Rejoice Vorsah
Katie Wade-Jaimes
Aditi Wagh
Lauren Wagner
Steffen Wagner
Noemi Waight
Joi Walker
Jamie Wallace
Megan Walser
Crystal Wang
Jianlan Wang
Lu Wang
Mengqian Wang
Song Wang
Yangchunxiao Wang
Carol Waters
Pirchi Waxman
David Weiler
Matthew Weinstein
Kristen Wendell
Julianne Wenner
Laura Wheeler
Lindsay Wheeler
Jeanna Wieselmann
Hopegay Williams
Michele Williams
Sara Wilmes
Matthew Wilsey
Kerri Wingert
Kevin Winn
Stephen Witzig
Nicole Wong
Karen Woodruff
Salome Wörner
Ti'Era Worsley
Jingyun Wu
Meng-Yang Wu
Christine Wusylko
Xin Xia
Ping Xiao
Yong Xie
Shiyu Xu
Mingfeng Xue
Elad Yacobson
Haoxuan Yang
Hui Yang
Tingting Yang
Cathery Yeh
Sevda Yerdelen Damar
Ella Yonai
SaeYeol Yoon
Tugba Yuksel
Anıl Yurdakul
Jannis Zeller
Molly Zhang
Yingzhi Zhang
Jinzhi Zhou
Heather Zimmerman
Michal Zion
Lynne Zummo
Melissa Zwick

NARST Presidents

1928 **W. L. Eikenberry**
1929 **W. L. Eikenberry**
1930 **W. L. Eikenberry**
1931 **Elliot R. Downing**
1932 **Elliot R. Downing**
1933 **Francis D. Curtis**
1934 **Ralph K. Watkins**
1935 **Archer W. Hurd**
1936 **Gerald S. Craig**
1937 **Walter G. Whitman**
1938 **Hanor A. Webb**
1939 **John M. Mason**
1940 **Otis W. Caldwell**
1941 **Harry A. Carpenter**
1942 **G. P. Cahoon**
1943 **Florence G. Billig**
1944 **Florence G. Billig**
1945 **Florence G. Billig**
1946 **C. L. Thield**
1947 **Earl R. Glenn**
1948 **Ira C. Davis**
1949 **Joe Young West**
1950 **N. Eldred Bingham**
1951 **Betty Lockwood**
1952 **Betty Lockwood**
1953 **J. Darrell Barnard**
1954 **George G. Mallinson**
1955 **Kenneth E. Anderson**
1956 **W. C. Van Deventer**
1957 **Waldo W. Blanchet**
1958 **Nathan S. Washton**
1959 **Thomas P. Fraser**
1960 **Vaden W. Miles**
1961 **Clarence H. Boeck**
1962 **Herbert A. Smith**
1963 **Ellsworth S. Obourn**
1964 **Cyrus W. Barnes**
1965 **Frederic B. Dutton**
1966 **Milton P. Pella**
1967 **H. Craig Sipe**
1968 **John M. Mason**
1969 **Joseph D. Novak**
1970 **Willard D. Jacobson**
1971 **Paul D. Hurd**
1972 **Frank X. Sutman**
1973 **J. David Lockard**
1974 **Wayne W. Welch**
1975 **Robert E. Yager**
1976 **Ronald D. Anderson**
1977 **O. Roger Anderson**
1978 **Roger G. Olstad**
1979 **James R. Okey**
1980 **John W. Renner**
1981 **Stanley L. Helgeson**
1982 **Stanley L. Helgeson**
1983 **Carl F. Berger**
1984 **Ann C. Howe**
1985 **Ertle Thompson**
1986 **David P. Butts**
1987 **James P. Barufaldi**
1988 **Linda DeTure**
1989 **Patricia Blosser**
1990 **William G. Holliday**
1991 **Jane Butler Kahle**
1992 **Russell H. Yeany**
1993 **Emmett L. Wright**
1994 **Kenneth G. Tobin**
1995 **Dorothy L. Gabel**
1996 **Barry J. Fraser**
1997 **Thomas R. Koballa, Jr.**
1998 **Audrey B. Champagne**
1999 **Joseph S. Krajcik**
2000 **David F. Treagust**
2001 **Sandra K. Abell**
2002 **Norman G. Lederman**
2003 **Cheryl L. Mason**
2004 **Charles W. (Andy) Anderson**
2005 **John R. Staver**
2006 **James A. Shymanksy**
2007 **Jonathan F. Osborne**
2008 **Penny J. Gilmer**
2009 **Charlene M. Czerniak**
2010 **Richard A. Duschl**
2011 **Dana L. Zeidler**
2012 **J. Randy McGinnis**
2013 **Sharon J. Lynch**
2014 **Lynn A. Bryan**
2015 **Valarie L. Akerson**
2016 **Mary M. Atwater**
2017 **Mei-Hung Chiu**
2018 **Barbara Crawford**
2019 **Gail Richmond**
2020 **Tali Tal**
2021 **Eileen R. C. Parsons**
2022 **Renée Schwartz**
2023 **Gillian Roehrig**
2024 **Jomo Mutegi**
2025 **Jerome Shaw**

NARST Executive Directors

(NARST created the position of Executive Secretary in 1975; the title was changed to Executive Director in 2003)

1975–1980 **Paul Joslin**
1980–1985 **Bill Holliday**
1985–1990 **Glenn Markle**
1990–1995 **John Staver**
1995–2000 **Art White**
2000–2002 **David Haury**
2002–2007 **John Tillotson**
2007–2017 **Bill Kyle**
2018–2021 **Helen Schneider Lemay**
2021–2024 **Lisa Martin-Hansen**
2024–Present **Mackenzie Kelley**

JRST Editors

1963–1966 **J. Stanley Marshall**
1966–1968 **H. Craig Sipe**
1969 **James T. Robinson**
1970–1974 **O. Roger Anderson**
1975–1979 **David P. Butts**
1980–1984 **James A. Shymansky**
1985–1989 **Russell H. Yeany, Jr.**
1990–1993 **Ronald G. Good**
1994–1999 **William C. Kyle, Jr.**
1999–2001 **Charles W. (Andy) Anderson**
James J. Gallagher
August
2002–2005 **Dale R. Baker**
Michael D. Piburn
2006–2010 **J. Randy McGinnis**
Angelo Collins
2011–2015 **Joseph S. Krajcik**
Angela Calabrese Barton
2016–2020 **Fouad Abd-El-Khalick**
Dana L. Zeidler
2021–2025 **Felicia Moore Mensah**
Troy Dow Sadler
2026–2030 **Matthew Kloser**
Edna Tan
Dana Vedder-Weiss

Emeritus Members

Michael Agin
Hans Andersen
Charles Anderson
Ronald Anderson
Carl Angell
Hanna Arzi
Doris Ash
Mary Atwater
Dale Baker
Nitza Barnea
Marianne Barnes
Guilford Bartlett
John Bencze
Glenn Berkheimer
Lowell Bethel
George Bodner
Lynn Bryan
Mei-Hung Chiu
John Christopher
Julia Clark
Barbara Crawford
David Crowther
Helmut Dahncke
George De Boer
Onno De Jong
Robert Dehaan
Rodney Doran
Dewey Dykstra
Larry Enochs
Elsa Feher
Allan Feldman
Patricia Friedrichsen
Uri Ganiel
George Glasson
Richard Haney
David Haury
Stanley Helgeson
Peter Hewson
Todd Hill
Avi Hofstein
Jack Holbrook
William Holliday
William Jaffarian
Joseph Jesunathadas
Paul Joslin
Jane Kahle
David Kennedy
Aviva Klieger
Gerald Krockover
William Kyle
Judith Lederman
Jay Lemke
Huann-shyang Lin
Ivo Lindauer
Vincent Lunetta
Jacqueline Mallinson
Glenn Markle
Robert Mayes
Mary McCarthy Hintz
Alan McCormack
Charles McFadden
Gottfried Merzyn
Michael Michie
Jim Minstrell
Mansoor Niaz
Obed Norman
Albert Nous
Joseph Novak
Peter Okebukola
Roger Olstad
Jonathan Osborne
Ann Osman
Isaac Otoo
Michael Padilla
Sung Jae Pak
Eileen Parsons
Gian Pedemonte
Linda Phillips
Michael Piburn
Robert Poel
James Poth
J. Prather
Altaf Qadeer
Leonie Rennie
Donald Riechard
Ryda Rose
Jo Ellen Roseman
Kathryn Scantlebury
Donald Schmidt
Manuel Sequeira
Robert Sherwood
James Shymansky
Ellen Simmons
Doris Simonis
Edward Smith
Elke Sumfleth
Dennis Sunal
J. Swift
Marlene Thier
Herbert Thier
Andree Tiberghien
Sue Tunnicliffe
Ed Van Den Berg
Richard Walding
Wayne Welch
Robert Williams
Mark Windschitl
Larry Yore
Uri Zoller

NARST Award Recipients

Distinguished Contributions to Science Education through Research Award

This award is presented at the Annual International Conference but is bestowed only when an outstanding candidate, or candidates, has been identified. It is given to recognize individuals who, through research over an extended period of time, have made outstanding and continuing contributions, provided notable leadership, and made a substantial impact in the area of science education.

Year	Awardee(s)
1986	Anton E. Lawson
1987	Paul DeHart Hurd
1988	John W. Renner
1989	Willard Jacobson
1990	Joseph D. Novak
1991	Robert L. Shrigley
1992	Pinchas Tamir
1993	Jack Easley, Jr.
1994	Marcia C. Linn
1995	Wayne W. Welch
1996	Carl F. Berger
1997	Rosalind Driver
1998	James J. Gallagher
1999	Peter J. Fensham
2000	Jane Butler Kahle
2001	John K. Gilbert
2002	Audrey B. Champagne
2003	Barry J. Fraser
2004	Robert E. Yager Paul Black
2005	John C. Clement
2006	David Treagust
2007	Kenneth Tobin
2008	Dorothy Gabel
2009	Peter W. Hewson Leonie Jean Rennie Wolff-Michael Roth
2010	Reinders Duit Joseph Krajcik
2011	Norman Lederman
2012	Charles W. (Andy) Anderson Larry Yore
2013	Dale R. Baker
2014	Glen Alkenhead Richard Gunstone Frances Lawrenz
2015	Richard A. Duschl Meshach Mobolaji Ogunniyi
2016	Lynn D. Dierking John N. Falk Dana L. Zeidler
2017	Avi Hofstein
2018	Marissa Rollnick Jonathan Osborne
2019	Mary M. Atwater Maria Pilar Jiménez-Aleixandre
2020	Judy Dori Saouma Bou Jaoude
2021	Valarie Akerson Greg Kelly
2022	Fouad Abd-El-Khalick Gail Jones
2023	Franz X. Bogner Okhee Lee
2024	Angela Calabrese Barton Julie Luft
2025	Sherry Southerland

NARST Award Recipients

Outstanding Doctoral Research Award (Sponsored by Wiley)

This award is given annually for the Doctoral Research judged to have the greatest significance in the field of science education from among all theses and dissertations nominated this year for the award.

Year	Awardee(s)	Advisor(s)
1992	Rene Stofflett	Dale R. Baker
1993	Julie Gess-Newsome	Norman G. Lederman
1994	Carolyn W. Keys	Burton E. Voss
1995	Jerome M. Shaw	Edward Haertel
1996	Christine M. Cunningham	William L. Carlsen
1997	Jane O. Larson	Ronald D. Anderson
1998	Kathleen Hogan	Bonnie K. Nastasi
1999	Fouad Abd-El-Khalick	Norman G. Lederman
2000	Danielle Joan Ford	Annemarie S. Palinscar
2001	Iris Tabak	Brian Reiser
2002	Mark Girod	David Wong
2003	Hsin-Kai Wu	Joseph Krajcik
2004	David L. Fortus	Ronald Marx Joseph Krajcik
2005	Thomas Tretter	Gail M. Jones
2006	Stacy Olitsky	Kenneth Tobin
2007	Julia Plummer	Joseph S. Krajcik
2008	Victor Sampson	Douglas Clark
2009	Lei Liu	Cindy E. Hmelo-Silver
2010	Heather Toomey	Phillip Bell Zimmerman
2011	Jeffrey J. Rozelle	Suzanne M. Wilson
2011	Catherine Eberbach	Kevin Crowley
2012	Melissa Braaten	Mark Windschitl
2013	Lori Fulton	Jian Wang
2014	Daniel Birmingham	Angela Calabrese Barton Anne-Lise Halvorsen
2015	Allison Godwin	Geoffrey Potvin
2016	Anna MacPherson	Jonathan Osborne
2017	Anita Schuchardt	Christian Schunn
2018	Katherine Wade-Jaimes	Renée Schwartz
2019	Anita S. Tseng	Jonathan F. Osborne
2020	Netta Shaby	Orit Ben Zvi-Assaraf
2021	Eben Witherspoon	Christian D. Schunn
2022	Won Jung Kim	Angela Calabrese Barton Alicia Alonzo
2023	Gary William Wright III	Cesar Delgado
2024	Grace P. Carroll K. "Ren" Rende Mendoza	Soonhye Park Carla Johnson
2025	Sam Lee Daniel R. Pimentel	Katherine L. McNeill Janet Carlson and Bryan Brown

NARST Award Recipients

Early Career Research Award

The Early Career Research Award is given annually to the early researcher who demonstrates the greatest potential to make outstanding and continuing contributions to research in science education. The recipient will have received his/her Doctoral degree within five years of receiving the award.

Year	Awardee(s)
1993	Wolff-Michael Roth
1994	Deborah J. Tippins
1995	Nancy B. Songer
1996	Mary B. Nakhleh
1997	Peter C. Taylor
1998	J. Randy McGinnis
1999	Craig W. Bowen Gregory J. Kelly
2000	Angela Calabrese Barton
2001	Julie A. Bianchini
2002	Alan G. Harrison
2003	Fouad Abd-El-Khalick
2004	Grady J. Venville
2005	Randy L. Bell
2006	Heidi Carlone
2007	Bryan A. Brown
2008	Hsin-Kai Wu
2009	Troy D. Sadler
2010	Thomas Tretter
2011	Katherine L. McNeill
2012	Victor Sampson
2013	Alandeom W. Oliveira
2014	Cory Forbes
2015	Benjamin C. Herman
2016	Richard L. Lamb
2017	Ying-Chih Chen David Stroupe
2018	Doug Lombardi
2019	Hosun Kang Eve Manz
2020	Brian Donovan Dana Vedder Weiss
2021	Lama Jaber
2022	Maria González-Howard Laura Zangori
2023	Natalie S. King Christina Krist
2024	K.C. Busch Terrell R. Morton
2025	Marcus Kubsch

NARST Fellows Award

The NARST Fellow Program is an award program that honors and recognize excellence in science education research and service. This program promotes and advances the NARST mission in science education, and the role of science education in the local and global community, by designating NARST members as Fellows.

Year	Awardee(s)
2021	Bryan A. Brown
2021	Richard A Duschl
2021	Gillian Roehrig
2022	Peter A. Okebukola
2023	Julie Bianchini
2023	Ron Blonder
2023	Patricia Friedrichsen
2024	Elizabeth Mavhunga
2024	Carla Zembal-Saul
2024	Renee' Schwartz
2024	Christina Schwarz
2024	Lynn Bryan
2025	Janet Carlson
2025	M. Gail Jones
2025	Hosun Kang
2025	Katherine L. McNeill
2025	Felicia Moore Mensah
2025	Eileen Parsons
2025	Bhaskar Upadhyay

Excellence in Mentoring Award

Year	Awardee(s)
2024	Janet Carlson
2025	Ron Blonder

Future NARST Meeting Dates

2026 April 18 - 21 | Seattle, WA

2027 March 14 - 17 | Boston, MA

NARST Award Recipients

The *Journal of Research in Science Teaching (JRST)* Award

The *JRST* Award was awarded annually to the author or authors of the *Journal of Research in Science Teaching* article judged to be the most significant publication for the Volume year. It was awarded annually between 1974 and 2015.

Year	Awardee(s)
1974	Donald E. Riechard Robert C. Olson
1975	Mary Budd Rowe
1976	Marcia C. Linn Herbert C. Thier
1977	Anton E. Lawson Warren T. Wollman
1978	Dorothy L. Gabel J. Dudley Herron
1979	Janice K. Johnson Ann C. Howe
1980	John R. Staver* Dorothy L. Gabel* Linda R. DeTure
1981	William C. Kyle, Jr.
1982	Robert G. Good* Harold J. Fletcher* F. David Boulanger
1983	Jack A. Easley, Jr.
1984	Marcia C. Linn Cathy Clement Stephen Pulos
1985	Julie P. Sanford
1986	Anton E. Lawson
1987	Russell H. Yeany Kueh Chin Yap Michael J. Padilla
1988	Kenneth G. Tobin James J. Gallagher
1988	Robert D. Sherwood* Charles K. Kinzer* John D. Bransford* Jeffrey J. Franks* Anton E. Lawson*
1989	Glen S. Aikenhead
1990	Richard A. Duschl Emmett L. Wright
1991	E. P. Hart I. M. Robottom
1992	John R. Baird Peter J. Fensham Richard E. Gunstone Richard T. White
1993	Nancy R. Romance Michael R. Vitale
1994	E. David Wong
1995	Stephen P. Norris Linda M. Phillips
1996	David F. Jackson, Elizabeth C. Doster Lee Meadows Teresa Wood
1997	C. W. J. M. Klassen P. L. Linjse
1998	Julie Bianchini
1999	Phillip M. Sadler
2000	Allan G. Harrison J. Grayson David F. Treagust
2001	Fouad Abd-El-Khalick Norman G. Lederman
2002	Andrew Gibert Randy Yerrick
2003	Sofia Kesidou Jo Ellen Roseman
2004	Jonathan Osborne Sue Collins Mary Ratcliffe Robin Millar Richard Duschl
2005	Jonathan Osborne Sibel Erduran Shirley Simon
2006	Troy D. Sadler Dana L. Zeidler
2007	Jerome Pine Pamela Aschbacher Ellen Roth Melanie Jones Cameron McPhee Catherine Martin Scott Phelps Tara Kyle Brian Foley
2008	Christine Chin
2009	Kihyun Ryoo Bryan Brown
2010	Helen Patrick Panayota Mantzicopoulos Ala Samarapungavan
2011	Daphne Minner Jeanne Century Abigail Jurist Levy
2012	Julie A. Luft Jonah B. Firestone Sissy S. Wong Irasema Ortega Krista Adams Eun Jin Bang
2013	Edys S. Quellmalz Michael J. Timms Matt D. Silberglitt Barbara C. Buckley
2014	Joseph Taylor Susan Kowalski Christopher Wilson Stephen Getty Janet Carlson
2015	Matthew Kloser

*Tie

NARST Award Recipients

The NARST Outstanding Paper Award

The NARST Outstanding Paper Award was awarded annually for the paper or research report presented at the NARST Annual International Conference that was judged to have the greatest significance and potential in the field of science education. It was awarded annually between 1975 and 2015.

Year	Awardee(s)
1975	John J. Koran
1976	Anton E. Lawson
1977	*NO AWARD*
1978	Rita Peterson
1979	Linda R. DeTure
1980	M. James Kozlow Arthur L. White
1981	William Capie Kenneth G. Tobin Margaret Boswell
1982	F. Gerald Dillashaw James R. Okey
1983	William C. Kyle, Jr. James A. Shymansky Jennifer Alport
1984	Darrell L. Fisher Barry J. Fraser
1985	Hanna J. Arzi* Ruth Ben-Zvi* Uri Ganiel* Russell H. Yeany Kueh Chin Yap Michael J. Padilla
1986	Barry J. Fraser* Herbert J. Walberg* Wayne W. Welch*
1987	Robert D. Sherwood
1988	Barry J. Fraser Kenneth G. Tobin
1989	James J. Gallagher Armando Contreras
1990	Patricia L. Hauslein Ronald G. Good Catherine Cummins
1991	Nancy R. Romance Michael Vitale
1992	Patricia Heller Ronald Keith Scott Anderson
1993	Wolff-Michael Roth
1994	Wolff-Michael Roth Michael Bowen
1995	Wolff-Michael Roth
1996	Nancy J. Allen
1997	*NO AWARD*
1998	Wolff-Michael Roth Reinders Duit Michael Komorek Jens Wilbers
1999	Lynn A. Bryan
2000	Joseph L. Hoffman Joseph S. Krajcik
2001	Allan G. Harrison
2002	Carolyn Wallace Keys Eun-Mi Yang Brian Hand Liesl Hohenshell
2003	Wolff-Michael Roth
2004	Joanne K. Olson* Sharon J. Lynch* Joel Kuipers Curtis Pyke Michael Szesze
2005	Chi-Yan Tsui David Treagust
2006	Leema Kuhn Brian Reiser
2007	Eugene L. Chiappetta Tirupalavanam G. Ganesh Young H. Lee Marianne C. Phillips
2008	Guy Ashkenazi Lana Tockus-Rappoport
2009	Jrene Rahm
2010	Mark W. Winslow John R. Staver Lawrence C. Sharmann
2011	Matthew Kloser
2012	Shelly R. Rodriguez Julie Gess-Newsome
2013	Edward G. Lyon
2014	Ying-Chih Chen Soonhye Park Brian Hand
2015	Lori M. Ihrig Michael P. Clough Joanne K. Olson

*Tie

NARST Award Recipients

Outstanding Masters Thesis Award

This award was established in 1995 to be given annually for the Master's Thesis judged to have the greatest significance in the field of science education. It was last awarded in 2002.

Year	Awardee	Major Professor	Advisor
1995	Moreen K. Travis	Carol L. Stuessy	
1996	Lawrence T. Escalada	Dean A. Zollman	
1997	C. Theresa Forsythe	Jeffrey W. Bloom	
1998	Renee D. Boyce		Glenn Clark
1999	Andrew Gilbert		Randy K. Yerrick
2000	Rola Fouad Khishfe		Fouad Abd-El-Khalick
2002	Laura Elizabeth Slocum		Marcy Hamby Towns

Classroom Applications Award

The Classroom Applications Award was established in 1979. The award was given annually to authors whose papers were presented at the previous NARST Annual International Conference and judged to be outstanding in terms of emphasizing classroom application of research in science education. The award was last presented in 1991.

Year	Awardee(s)
1980 *Five Equal Awards*	Livingston S. Schneider John W. Renner
	Heidi Kass Allan Griffiths
	Ramona Saunders Russell H. Yeany
	Joe Long James R. Okey Russell H. Yeany
	M. James Kozlow Arthur L. White
1981 *Four Equal Awards*	Dorothy L. Gabel Robert D. Sherwood Larry G. Enochs
	Wayne Welch Ronald D. Anderson Harold Pratt
	Mary Ellen Quinn Carolyn Kessler
	P. Ann Miller Russell H. Yeany
1982 *Four Equal Awards*	Louise L. Gann Seymour Fowler
	Dorothy L. Gabel Robert D. Sherwood
	Thomas L. Russell
	Joseph C. Cotham
1983	Robert D. Sherwood Larry G. Enochs Dorothy L. Gabel
1984 *Three Equal Awards*	Mary Westerback Clemencia Gonzales Louis H. Primavera
	Kenneth G. Tobin Hanna J. Arzi Ruth Ben-Zvi Uri Ganiel
	Charles Porter Russell H. Yeany
1985 *Three Equal Awards*	Dan L. McKenzie Michael J. Padilla
	Margaret Walkosz Russell H. Yeany
	Kevin C. Wise James R. Okey
1986 *Four Equal Awards*	Sarath Chandran David F. Treagust Kenneth G. Tobin
	Darrell L. Fisher Barry J. Fraser
	Dorothy L. Gabel Stanley L. Helgeson Joseph D. Novak John Butzow V. K. Samuel
	Linda Cronin Meghan Tweist Michael J. Padilla
1987	Dorothy L. Gabel V. K. Samuel Stanley L. Helgeson Saundra McGuire Joseph D. Novak John Butzow
1988	Uri Zoller Ben Chaim
1989	James D. Ellis Paul J. Kuerbis
1990	Dale R. Baker Michael D. Piburn Dale S. Niederhauser
1991	David F. Jackson Billie Jean Edwards Carl F. Berger

NARST Standing Committees

Awards Committee	
Final Year	**Board Liaison**
2025	**Amelia Wenk Gotwals** Michigan State University

Outstanding Doctoral Research Award	
Final Year	**Committee Leadership**
2025	**David C. Owens** (Chair) University of Montana
2026	**Dina Tsybulsky** (Co-Chair) Technion, Israel
	Members
2025	**Eunjin Bahng** Iowa State University
2025	**Maia Elkana** Washington University in St. Louis
2025	**Guopeng Fu** East China Normal University
2025	**Nilay Ozturk** Kirsehir Ahi Evran University, Turkey
2026	**Mindy Chappell** Portland State University
2026	**Colby Tofel-Grehl** Utah State University
2026	**Annabel Stoler** Boston University
2026	**David Stroupe** Michigan State University
2026	**Noemi Waight** University at Buffalo
2026	**Stephanie Batres Spezza** Univeristy of Illinois - Chicago
2027	**Mary Short** George Washington University
2027	**Julianne Wenner** Clemson University

Early Career Research Award	
Final Year	**Committee Leadership**
2025	**Bridget Miller** (Chair) University of South Carolina
	Members
2025	**Eleanor Abrahms** University of Massachusetts Lowell
2025	**Ben Herman** Texas A&M University
2026	**Katherine Doerr** Mount Aloysius College
2026	**Katherine Doerr** Malmo University, Sweden
2026	**Uchenna Emenaha** The University of Texas at San Antonio
2026	**Laura Zangori** University of Missouri
2027	**Meg Blanchard** North Carolina State University
2027	**Hyesun You** University of Iowa
2027	**Gary William Wright** University of Missouri
2027	**Elizabeth (Betsy) Davis** University of Michigan

NARST Standing Committees

Awards Committee (cont.)

Distinguished Contributions to Science Education Through Research

Final Year	Committee Leadership
2025	**Mei-Hung Chiu** (Chair) National Taiwan University
2026	**Saouma BouJaoude** (Co-Chair) American University of Beirut, Lebanon
	Members
2025	**Justin Dillon** Exeter University, UK
2025	**Kathy Trundle** Utah State University
2026	**Carla Johnson** NC State University
2026	**Gail Jones** NC State University
2027	**Okhee Lee** New York University
2027	**Fouad Abd-El-Khalick** University of North Carolina-Chapel Hill
2027	**Greg Kelly** Pennsylvania State University

NARST Fellow Award

Final Year	Committee Leadership
2025	**Enrique (Henry) Suarez** (Chair) University of Massachusetts, Amherst
2025	**Lezly Taylor** (Co-Chair) Virginia Polytechnic Institute and State University
	Members
2026	**Helena Aptyka** University of Cologne, Germany
2026	**Flavia Kigozi** University of Witwatersrand, South Africa
2026	**Laura B. Schneider** St. Mary's College of Maryland, OpenSciEd
2027	**Ron E. Gray** Northern Arizona University
2027	**Peter Okebukola** Lagos State University

Elections Committee

Final Year	Committee Leadership
2026	**Nazan U. Bautista** (Chair) Miami University
2027	**Muhammad Abd Hadi Bunyamin** (Incoming Chair) Universiti Teknologi Malaysia
2025	**David Crowther** (Outgoing Chair) University of Nevada, Reno
	Members
2025	**Holly Kennedy Amerman** University of Georgia
2025	**Carina Rebello** Purdue University-Main Campus
2026	**Angela Chapman** University of Texas Rio Grande Valley
2026	**Susie M. Cohen** Trinity International University
2026	**Tim Klavon** Black Hills State University
	Board Member Liaison
2027	**Heba EL-Deghaidy** American University in Cairo

NARST Standing Committees

Equity and Ethics Committee	
Final Year	**Committee Leadership**
2026	**Regina McCurdy** (Chair) Georgia Southern University
2025	**Justice T. Walker** (Outgoing Chair) University of Texas at El Paso
2027	**Iliana Esther De La Cruz** (Incoming Chair) Texas A&M University
	Members
2025	**Marsha E Simon** University of West Georgia
2026	**Laura Peña-Telfer** Georgia State University
2027	**Devasmita (Deva) Chakraverty** Indian Institute of Management Ahmedabad
2027	**Dominick Fantacone** SUNY Cortland Director of Research and Sponsored Programs
2027	**Maria R. Maulucci** Barnard College
2027	**Khanh Q. Tran** Purdue University
	Board Member Liaison
2025	**Sharon Nelson-Barber** WestEd

External Policy and Relations Committee	
Final Year	**Committee Leadership**
2025	**Ellen Granger** (Chair) Florida State University
2026	**Mark Meszaros** (Co-Chair) Carolina Biological Supply Company
	Members
2026	**Christina Baze** The University of Texas at Austin
2026	**Allison Esparza** Texas A&M University

External Policy and Relations Committee (cont.)	
2026	**Brittany Gavrin Hudson** University of Mary Washington
2027	**Julie Bianchini** University of California, Santa Barbara
2027	**Zoubeida R. Dagher** University of Delaware
	Board Liaison
2027	**Kristin Gunckel** University of Arizona

Membership Committee	
Final Year	**Committee Leadership**
2025	**Melanie Kinskey** (Chair) Texas A&M University
2026	**Joi Merritt** (Co-Chair) James Madison University
	Members
2025	**Harini Krishnan** University of Utah
2025	**Mihwa Park** Texas Tech University
2025	**Harleen Singh** University of Georgia
2026	**Jonathan Bowers** Michigan State University
2026	**Alyssa Freeman** Middle Tennessee State University
2026	**Grant Gardner** Middle Tennessee State University
2027	**Ilayda Kilic** Kocaeli University, Turkey
2027	**Theila Smith** Brooklyn College
	Board Liaison
2026	**S. Selcen Guzey** Purdue University

NARST Standing Committees

Graduate Student Committee

The Graduate Student Committee is composed of graduate student members appointed by the President-elect. The committee is chaired by the Graduate Student Representative, a non-voting (ex-officio) liaison to the NARST Board. A Board Director is appointed to serve as an ex officio advisor to the committee.

Final Year	Graduate Student Coordinator
2025	**Jennifer Bateman** (Chair) University of Georgia
	Committee Leadership
2025	**Savannah Hayes** (Co-Chair) Space Center Houston
2026	**Alexander Eden** (Co-Chair) Florida International University
	Members
2025	**Deborah Cotta** Universidad Federal de Minas Gerais, Brasil
2025	**Beyza Okan** Bogazici University
2025	**Amy Padolf** Florida International University
2025	**Mutiara Syifa** Illinois State University
2025	**Johan Tabora** Northwestern University
2026	**Brandin Conrath** Virginia Commonwealth University
2026	**Austin R. Jenkins** Purdue University
2026	**Muhammad Guntur Purwanto (Guntur)** University of Minnesota
2026	**Andrea Reeder** Middle Tennessee State University
2026	**Kristal Louise Turner** University of Calgary, Canada
2026	**Lauren E. Wagner** University of North Alabama

International Committee

Final Year	International Coordinator
2025	**Mercy Ogunsola-Bandele** (Chair) National Open University of Nigeria
	Committee Leadership
2025	**Ranu Roy** (Co-Chair) Amity University Kolkata, India
2026	**Arif Rachmatullah** (Co-Chair) SRI International
	Members
2025	**Nuri Balta** Suleyman Demirel University
2025	**Aerin W. Benavides** University of North Carolina Greensboro
2025	**Imran Tufail** University of Waikato
2026	**Estelle Blanquet** University of Bordeaux - France
2026	**Christelle Fayad** Texas Christian University
2026	**Jose Pavez** University of Georgia
2027	**Sahar Alameh** University of Kentucky
2027	**Shirly Avargil** Technion Junior Faculty, Israel
2027	**Keren Dalyot** Weizmann Institute of Science, Israel
2027	**Argyris Nipyrakis** University of Chicago
2027	**Giulia Tasquier** University of Bologna, Italy

NARST Standing Committees

Program Committee	
Final Year	**Committee Leadership**
2025	**Jerome Shaw** (Chair) University of California, Santa Cruz
2026	**Jennifer D. Adams** (Co-Chair) University of Calgary, Canada
	Members
2025	**Quentin Biddy** University of Colorado, Boulder
2025	**Narendra Dadarao Deshmukh** Homi Bhabha Centre for Science Education
2025	**Daniela Fiedler** University of Copenhagen
2025	**Peng He** Michigan State University
2025	**Sophia Jeong** University of Georgia
2025	**Anne Emerson Leak** High Point University
2025	**Jing Lin** Beijing Normal University
2025	**Allison Antink-Meyer** Illinois State University
2025	**Jamie N. Mikeska** ETS
2025	**Emily Adah Miller** University of Georgia
2025	**Tara Nkrumah** Arizona State University
2025	**Rebecca Swanson** University of Nebraska-Lincoln
2025	**Preethi Titu** Kennesaw State University
2025	**Yang Yang** Qingdao University
2026	**Rouhollah Aghasaleh** California State Polytechnic University, Humboldt
2026	**Rachel van Aswegen** University of Virginia
2026	**Selina Lynn Bartels** Valparaiso University
2026	**Julie C. Brown** Univeristy of Florida
2026	**Sanlyn Buxner** University of Arizona
2026	**Mila Rosa Librea Carden** University of North Texas
2026	**Robbie. L. Higdon** James Madison University
2026	**TingTing Li** Michigan State University
2026	**Stefanie L. Marshall** Michigan State University
2026	**Kelli Paul** Indiana University
2026	**Anita Schuchardt** University of Minnesota
2026	**Quentin Sedlacek** Southern Methodist University
2026	**Jill Wertheim** WestEd
2026	**Moyu (Molly) Zhang** New York University

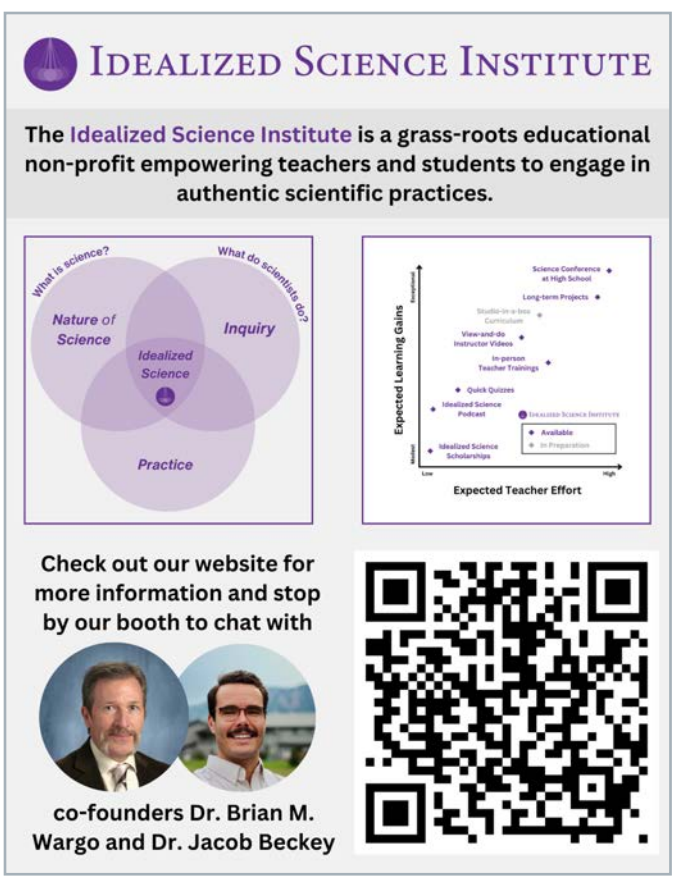
NARST Standing Committees

Publications Advisory Committee	
	Committee Leadership
2025	**Tina Vo** (Chair) University of Nevada, Las Vegas
2027	**Marcus Kubsch** (Co-Chair) Freie University-Berlin
	Members
2025	**Cesar Delgado** North Carolina State University
2025	**Li Ke** University of North Carolina Chapel Hill
2025	**Linda Morell** UC Berkeley
2026	**Eli Tucker-Raymond** Boston University
2027	**Justin McFadden** University of Louisville
2027	**Melissa Mendenhall** Utah State Board of Education
2027	**James Minogue** North Carolina State University
2027	**Samuel Severance** Northern Arizona University
2027	**Sissy Wong** University of Houston
2027	**Yewon Lee** University of Maryland at College Park
2027	**Danielle Malone** Purdue University
	Board Liaison
2026	**Shiang-Yao Liu** National Taiwan Normal University

Research Committee	
Final Year	**Committee Leadership**
2026	**Bryan H. Nichols** (Chair) Florida Atlantic University
2027	**Colby Tofel-Grehl** Utah State University
	Members
2025	**Liam Guilfoyle** University of Oxford
2025	**James Nyachwaya** North Dakota State University
2025	**Mina Sedaghatjou** Rowan University
2025	**Karen Woodruff** Kean University
2025	**Ezgi Yesilyurt** Weber State University
2026	**Alexander Bohn** Northern Virginia Community College
2026	**Saramma Chandy** Mumbai University
2026	**Michael Giamellaro** Oregon State University
2026	**Carrie-Anne Sherwood** Southern Connecticut State University
2027	**Franz X. Bogner** University of Bayreuth (Germany)
2027	**Beth A. Covitt** Univeristy of Montana
2027	**Dr. Patrice Juliet Pinder** Independent STEM Education Researcher
2028	**Stephen B. Witzig** University of Massachusetts Dartmouth
	Board Liaison
2027	**Meredith Park Rogers** Indiana University

NARST Standing Committees

Social Media, Website and Communications Committee	
Final Year	**Committee Leadership**
2026	**Gary Weiser** (Chair) Bill and Melinda Gates Foundation
2025	**Ryan Cain** (Outgoing Chair) Weber State University
2027	**Stephanie Teeter** (Co-Chair) North Carolina State University
	Members
2025	**Anna Maria Arias** Kennesaw State University
2025	**Stanton Belford** University of Tennessee Southern
2025	**Won Jung Kim** Santa Clara University
2026	**Linsey Brennan** Michigan State University
2026	**Marti Canipe** Northern Arizona University
2026	**Suzanne Poole Patzelt** Touro University
2027	**Katerina Pia Gunter** San Francisco State University
2027	**Olayinka Mohorn** University of Memphis
2027	**Christina Schwarz** Michigan State University
	Board Liaison
2026	**Patrick Enderle** Georgia State University



Support NARST

NARST is able to continue its mission because of your support and generosity. By contributing, you'll help ensure that our work continues. We welcome donations of all sizes and payment plans – whether it's a one-time gift, a monthly contribution or part of a matching gifts program.

https://members.narst.org/donations/

SPRINGER NATURE | Springer Open | palgrave macmillan

ADVANCING DISCOVERY

OA books at Springer Nature

Springer Nature publishes open access (OA) books and chapters under its SpringerOpen and Palgrave Macmillan imprints. We helped to pioneer OA book publishing, first piloting OA publication for books in 2011. We publish OA books across a wide range of areas in:

SCIENCE | TECHNOLOGY | MEDICINE | HUMANITIES & SOCIAL SCIENCES

550+ books

280+ chapters

200+ funding partners

Including:

European Commission, European Research Council, FWF, IEA, IMISCOE, Simula, The Wellcome Trust.

1,200+
leading authors and editors

across **60+** countries

Downloads

30+ million chapter downloads since 2013

Average chapter downloads per open access book: **58.7K**

Readers are in **150+** countries

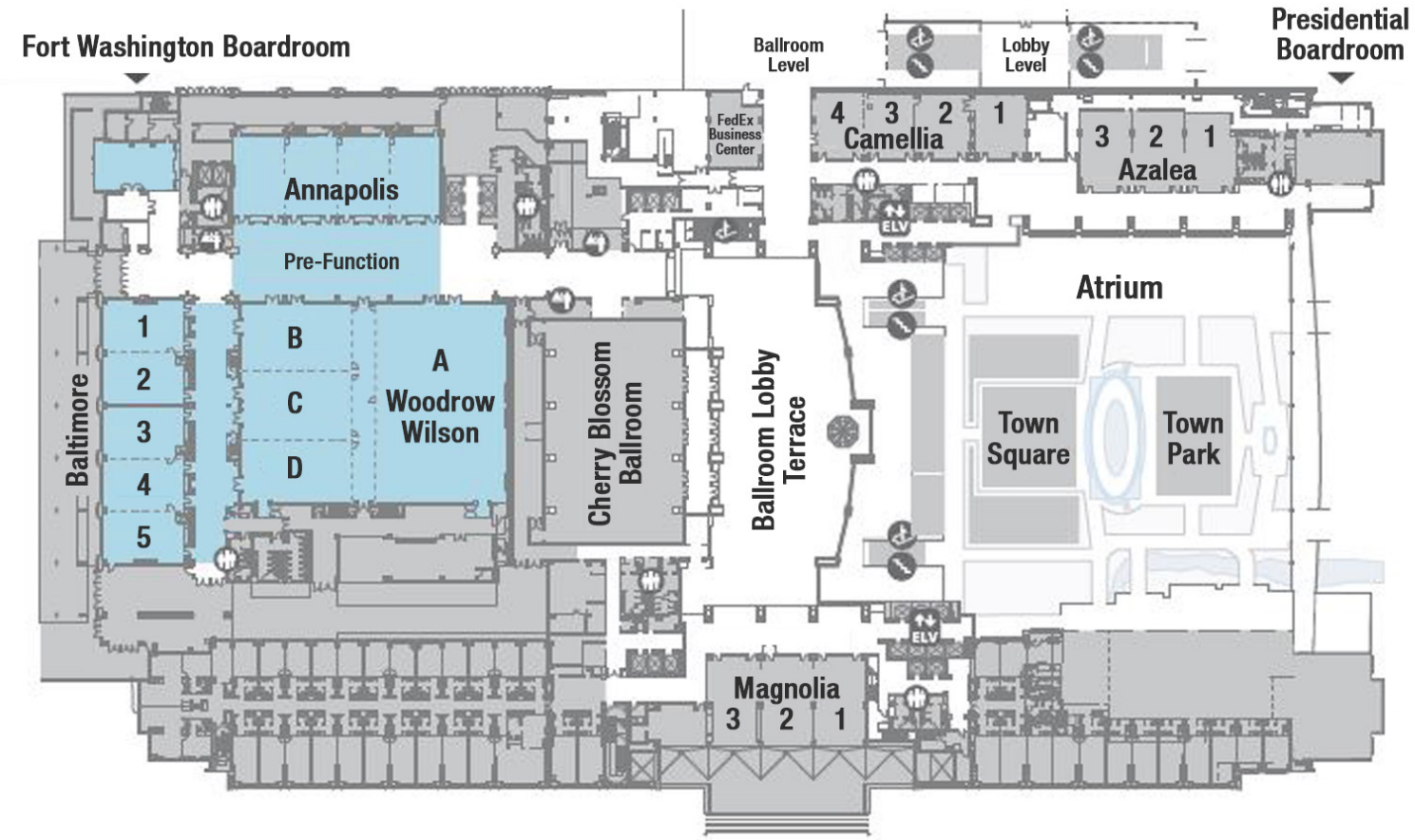
Benefits of publishing an OA book with Springer Nature

- Increased visibility
- Maximised discoverability
- Global readership
- CC BY 4.0 licence for maximum reuse
- Author retains copyright
- Rigorous peer review
- Access to Bookmetrix
- Free for readers (PDF, ePub, HTML, MOBI)
- Various formats accepted: monographs, edited volumes/collections, proceedings, protocols, short-form books (SpringerBriefs, Palgrave Pivots), chapters.

Contact Claudia Acuna
Editor, Science Education

claudia.acuna@springer.com

GAYLORD HOTEL MAP



NARST 2026 Conference Theme

Prepared by Jennifer D. Adams, NARST President-Elect

Joyful Transgressions and Radical Imagination in Science Education

> ***The classroom, with all its limitations, remains a location of possibility. In that field of possibility, we have the opportunity to labor for freedom to demand of ourselves and our comrades an openness of mind and heart that allows us to face reality even as we collectively imagine ways to move beyond boundaries, to transgress.***
>
> ***- Bell Hooks***

What could science teaching, learning and research look like in our wildest dreams? What could science teachers, learners, communities, and researchers be saying, thinking, doing, and feeling? What could be the priorities of science education?

Urgent times calls for radical actions and opportunities to collectively imagine different worlds and plot futures where we all can flourish. Uncertainty and global transitions create openings for radical world-building—moving beyond what is given, including the imaginations imposed by those in power. Could we dare to envision a world where everyone can thrive, where the flourishing of all humans and more-than-humans is the status quo? As such, it is imperative that we locate and create spaces of hope, imagination, and joy in science education—spaces where we re-envision how we can live well together on this pale blue dot that we call home.

The NARST 2026 Annual Meeting invites us to collectively imagine and build a world where scientific knowledge making is connected to lived experience and recorded through, as Sylvia Wynter suggests, "representational and biological feelings," and the creation of spaces where "there is unlimited access to the pleasure and power of knowing," as Bell Hooks advocates. This challenges us to re-engage with the fully human aspects of science learning considering some of the following provocations: What would happen if we considered play in science learning across contexts and lifespan? What joyful methodologies could we employ to research science learning? How could we enact care alongside students, teachers, communities, and peers in our work? What would happen if we started our projects from a place of trust and relationship-building? Given that NARST's ultimate goal is to help all learners achieve science literacy, how might we reimagine science literacy with social, environmental, and epistemological justice at its core?

This conference theme invites us to share the ways that we can transgress canonical boundaries in science education and expand dialogues on strategies for disrupting structures that sustain inequities, and in the spirit of Bell Hooks, "*[envision] new, alternative, oppositional aesthetic acts that both challenge and transcend [given] frameworks and limitations*." This conference is a step toward forging deeper connections between science and social life across formal, informal, and lived contexts—unpacking histories, reimagining relationships with science, and ultimately working toward a scientific endeavor of joyful transgressions and world-building. Together, we will envision and enact future-oriented approaches that cultivate a radical reimagining of what science education—and the world—can be.

NARST

A global organization for improving science education through research

99th NARST International Conference

Seattle | April 19-22, 2026

Joyful Transgressions and Radical Imagination in Science Education

Virtual Conference Day

13 March 2025

Opening and Welcome

9:30 AM-10:00 AM
Location: Zoom A

Presidential Welcome

Multi-Strand Stand-Alone Paper Set 1

Strand 2: Science Learning: Contexts, Characteristics and Interactions
13-Mar-25, 10:00 AM-11:30 AM
Location: Zoom A

Stand-Alone Paper

Research on social regulation learning in collaborative socioscientific issues argumentation

Yong Xie*, Beijing Normal University, China
Yangchunxiao Wang, Beijing Normal University, China
Xingda Li*, Beijing Normal University, China
Shuhao Yang*, Beijing Normal University, China
Yonghe Zheng*, Beijing Normal University, China

ABSTRACT

Collaborative socioscientific issues argumentation (CSSIA) plays an important role in improving students' scientific literacy, but students often fail to achieve good outcome in CSSIA. In this study, two students with opposite positions on socioscientific issues were asked to conduct collaborative argumentation. The process of CSSIA was analyzed from the perspective of social regulation learning, and the differences between the high quality group and the low quality group in collaborative social science issues argumentation were compared. The findings suggest that high quantity groups in CSSIA tend to be more rational in evaluating evidence and reasoning from diverse perspectives and can maintain a constructive argumentative atmosphere with peers holding different viewpoints. These insights offer practical guidance for researchers in designing effective scaffolding for CSSIA

Stand-Alone Paper

Supporting the Development of Scientific Arguments about Ecosystems Responses to Disturbances

Kaya Easley*, Northern Illinois University, USA
Steven McGee*, The Learning Partnership, USA
M. Britt, Northern Illinois University, USA

Amanda Durik, Northern Illinois University, USA
Randi McGee-Tekula,The Learning Partnership, USA

ABSTRACT

Understanding the dynamics of complex systems is essential for scientific decision making, yet complex systems is not generally taught in school. In addition, it is challenging for students to develop scientific arguments. The level of challenge significantly increases when students develop scientific arguments about complex systems. This 3-year research study focuses on the development of two curriculum units on disturbance ecology and the extent to which the units support the development of scientific arguments about the impact of disturbances on ecosystems. The units were implemented in 6th, 7th, and 8th grade. An assessment based on a learning progression of interdependent relationships in ecosystems was administered as a pretest and posttest. Final essays were collected and scored using a scientific argumentation learning progression. The results showed that students significantly increased performance on the assessment from pretest to posttest. The analysis of the final scientific argument showed that most students can develop a valid claim but struggled to provide both necessary and sufficient evidence. The quality of the final scientific argument correlated with posttest performance, after controlling for pretest performance. These results suggest there is a link between the practice of scientific argumentation and the development of system thinking.

Stand-Alone Paper

Exploring Metaphorical Differences and Language Switching in Multilingual Students' Translanguaging: A Study on Heat Transfer

Rajashri Priyadarshini*, Indian Institute of Technology Bombay, India
Chandan Dasgupta, University of Twente, Netherlands
Sahana Murthy, Indian Institute of Technology Bombay, India

ABSTRACT

This study explores how multilingual students use metaphorical language and translanguaging to conceptualize abstract scientific concepts, particularly in the context of heat transfer. Drawing on Conceptual Metaphor Theory (CMT) by Lakoff and Johnson, the research examines the role of metaphors rooted in concrete experiences in shaping students' scientific reasoning. While previous research highlights the importance of conceptual metaphors (CMs) in science education, this study addresses the need to understand how metaphorical variations across languages impact students' learning. The findings reveal that students' use of metaphors in Marathi, Hindi, and English reflects diverse cultural understandings of scientific ideas. Additionally, the study showed how translanguaging using three languages allowed students to draw on a richer set of linguistic resources, previously studied with largely bilingual students. These insights suggest that encouraging culturally relevant metaphors and supporting translanguaging practices can lead to more inclusive and effective science education in multilingual contexts. The study reiterates the importance of developing educational strategies that recognize linguistic and cultural diversity, ultimately improving communication and understanding of complex scientific concepts.

Stand-Alone Paper

Enhancing students' achievement in software development cycle through a cultural, technological and contextual pedagogy

Henry Okorie*, Lagos State University, Nigeria
Uchenna Ugwuoke*, Lagos State University, Nigeria
Peter Okebukola, Lagos State University, Nigeria
Rasheed Sanni, Lagos State University, Nigeria
Abdurrazaq Olawale, Lagos State University, Nigeria

ABSTRACT

As the global emphasis on software development increases, the need for innovative educational methods to address persistent learning challenges become urgent. In Nigeria, many ICT students struggle with the software development cycle, partly due to outdated teaching strategies. Students' diverse cultural backgrounds, technological access and contextual needs are not accounted for when educators use traditional methods, leading to suboptimal learning outcomes. This study investigates the effectiveness of a cultural, technological and contextual pedagogy in improving students' achievement in software development cycle. A quasi-experimental design was adopted for the study, 126 senior secondary 2 ICT students drawn from intact classes of two senior secondary schools in Lagos State, Nigeria. The experimental group engaged with the Culturo-Techno-Contextual Approach (CTCA), while the control group experienced traditional lectures. Both groups took a pretest before treatment and posttest at the end of the treatment phase. The ANCOVA output demonstrated a statistically significant difference in the achievement [F (1,126) = 172.13; p .05]. The results underscore the effectiveness of a culturally and contextually responsive teaching methods in boosting achievement. The research concluded in alliance with numerous previous studies that having cultural integration learning approach proved more productive than those without culture factors taken into cognizance.

Stand-Alone Paper

Efficacy of Learning Management Systems in Cybersecurity Education in an ODeL Environment in Ghana

Felicia Nkrumah*, Lagos State University, Nigeria
Peter Okebukola, Lagos State University, Nigeria
Oluwatoyin Enikuomehin, Lagos State University, Nigeria
Emmanuel Ekwam, Lagos State University, Nigeria
Adekunle Oladejo, Lagos State University, Nigeria

ABSTRACT

In the context of cybersecurity education, the integration of Learning Management System (LMS) and virtual labs allow students to gain hands-on experience which is crucial for skill acquisition. Despite this benefit, implementing Open Distance and e-Learning (ODeL) in the Global South faces challenges, which tends to impact the effectiveness of such Systems. This study explores the impact of an Author App Learning Management System (LMS) on student' achievements in and attitudes towards cybersecurity risk management in an ODeL

environment. The study compared the pretest and posttest performance and attitudes of students in an experimental group using the LMS and a control group receiving traditional lecture-based instruction. Utilizing a sample of undergraduate students enrolled in a cybersecurity risk management course, the study employed quantitative methods to analyze the differences in outcomes between the two groups. The findings revealed a statistically significant improvement in the achievement of students taught using the Author App platform compared to those in the lecture group (F (1, 64) = 13.57; p 0.001). Additionally, there was a significant positive shift in the attitudes of students towards learning when using the LMS compared to the traditional method (F (1, 63) = 4.19; p 0.045).

Stand-Alone Paper

Middle school students' climate literacy and climate change awareness: Validation of two instruments

Nilay Ozturk*, Bahcesehir University, Turkey
Osman Aksit, Bogazici University, Turkey
Nazmiye Ertugrul, Bogazici University, Turkey
Ayse Gul Celenk, Bahcesehir University, Turkey
Naz Fulya Cibik,Mugla Sitki Kocman University, Turkey
Zeynep Aydin, Bogazici University, Turkey
Yasemin Ozdem-Yilmaz, Mugla Sitki Kocman University, Turkey
Gaye Ceyhan, Bogazici University, Turkey

ABSTRACT

This study aims to validate two climate change instruments in the Turkish context and examine the profile of a large group of middle school students' climate change awareness and climate literacy. A pilot study with 215 students and a main study with 1516 students enrolled in 19 middle schools were conducted. Winsteps 5.7.3 and SPSS 25 were used for data analysis. Climate Literacy Survey (CLS), which was first developed and validated by Quarderer and Fulmer (2019) and used in a larger group of students by Quarderer et al. (2021). Climate Change Awareness Questionnaire (CCAQ) was developed by Kuthe et al. (2019) and used for 13-16 year-old students in German and Austrian contexts. Rasch analysis showed that the translated version of the CLS and the revised version of CCAQ are valid and reliable for measuring middle school students' climate literacy and climate change awareness. Descriptive results showed that students' both climate literacy and climate change awareness were on a moderate level, which is far from a robust and informed level of overall literacy, understanding, and awareness. Students' scores on the awareness subscales were also moderate, with a comparably larger mean score for personal concern and a smaller mean score for action.

Stand-Alone Paper

Collaborative Creation of Culture-Infused Chemistry Card Game for an Under-resourced College Students

Hai Vo*, University of Science, Vietnam
Le Duong*, University of Science, Vietnam
Trinh Nguyen*, University of Science, Vietnam

Anh Mai Nguyen, University of Science, Vietnam
Thuy Nguyen,University of Science, Vietnam
Hanh Dinh, Vermont State University, USA

ABSTRACT
In developing countries, the provision of robust tertiary chemical education is pivotal for enhancing living standards and economic growth. However, under-resourced educational systems often grapple with challenges like overcrowded classrooms, limited individual study time, and poorly designed teaching materials. Addressing these challenges, this study explores gamification's potential in chemistry education through the collaborative creation of a culturally-infused chemistry card game, "Mono-Poly." This game aims to enhance students' understanding of polymers by integrating local cultural elements in the students' home country, bridging the gap between abstract concepts and real-world applications. The research employed a design-based approach, involving practitioners in developing the game to ensure it reflected students' backgrounds. The study involved video recordings, questionnaires, and interviews with students and teachers to evaluate the game's educational value. Results revealed that "Mono-Poly" significantly increased student engagement and motivation, with 92.3% of participants finding the game engaging and effective for learning. The study emphasizes the importance of incorporating local culture into educational materials such as recycling and environmental protection, fostering inclusivity and relatability for students. By bridging language barriers through a bilingual English-Viet format, the game offers a model for creating high-quality educational resources and empowering students in developing regions through meaningful learning experiences.

Multi-Strand Stand-Alone Paper Set 2
Strand 11: Cultural, Social, and Gender Issues
13-Mar-25, 10:00 AM-11:30 AM
Location: Zoom B

Stand-Alone Paper
Colonial influence in shaping the science education discourse in Bangladesh
Shamnaz Arifin Mim*, McGill University, Canada

ABSTRACT
This review paper explores the impact of colonialism on science education discourse in Bangladesh, with a focus on science teaching. It analyzes how colonial interests shaped the types of sciences valued in the region and influenced who had access to scientific pursuits. The colonial portrayal of science as the domain of white men perpetuated discriminatory practices, hindering the development of an inclusive scientific community and perpetuating inequalities, especially for women in science careers. In addition, the Eurocentric perspective overshadowed local practices and indigenous scientific achievements in science curriculum, limiting the understanding of science. By examining these influences, the paper sheds light on the complexities of identity construction among science teachers in Bangladesh and

emphasizes the need to acknowledge and confront colonial legacies embedded in science teaching. This analysis sets a foundation for further inquiry into the experiences of women science teachers and the structural forces of colonialism shaping their identity work in Bangladesh.

Stand-Alone Paper

Exploring the Challenges of Implementing Experiential Learning in the Secondary Level Science Curriculum: Teachers Perspective

Anika Arpa*, University of Dhaka, Bangladesh
Umme Tithi, University of Dhaka, Bangladesh
MD Baktiar Bulbul, University of Dhaka, Bangladesh

ABSTRACT

Experiential learning (ExL), defined as the process by which learners build knowledge, skills, and values through direct experience (Jacobs, 1999). This study explores the challenges of implementing ExL in the secondary science curriculum in Bangladesh, focusing on the experiences and perspectives of science teachers. Through a multiple case study approach, the research examines teachers views on ExL, its application in the classroom, and the obstacles they face. Data were gathered from semi-structured interviews with eight teachers, classroom observations, and field notes from four diverse schools across Bangladesh. The findings indicate that while teachers recognize the benefits of ExL for enhancing student engagement and understanding, there is a substantial gap between their theoretical understanding and practical application. Major challenges identified include high teacher-student ratios, inadequate infrastructure, flawed evaluation methods, insufficient teacher training, and limited resources. The study emphasizes the necessity for systemic changes, such as improved evaluation systems, better resource allocation, expanded professional development, and increased collaboration within the education community. Addressing these challenges could lead to more effective ExL practices, ultimately enhancing science education and fostering a more innovative and skilled future workforce. Future research should consider scaling ExL globally, evaluating long-term impacts, and improving teacher training and policy support.

Stand-Alone Paper

Physics Teaching using technology at secondary level: A TPACK perspectives of teachers views and practice

MD Baktiar Bulbul*, University of Dhaka, Bangladesh
S M Rahman, University of Dhaka, Bangladesh
Anika Arpa, University of Dhaka, Bangladesh
Md Shahadat Khan, Islamic University of Technology, Bangladesh
Shariar Nafees Raaz,University of Dhaka, Bangladesh
Mehedi Anik, University of Dhaka, Bangladesh

ABSTRACT

Technological Pedagogical Content Knowledge (TPACK) represents the intersection of pedagogical knowledge (PK), content knowledge (CK), and technology knowledge (TK),

framework for integrating technology into classroom teaching. The effectiveness of TPACK in enhancing instructional practices depends on teachers' ability to blend these knowledge domains. However, previous research has indicated that secondary teachers often struggle to incorporate TPACK into their daily teaching routines. This study explored how secondary physics teachers apply TPACK in their teaching practices, with a particular focus on their views and practical implementation in the classroom. Using a mixed-methods parallel convergent design, the study collected quantitative data from 100 secondary physics teachers through structured questionnaires. In qualitative part, four teachers were selected for observation, interviews, and focus group discussions (FGDs) with students were conducted for triangulation the. A significant gap between teachers' perceived TPACK and its actual application were found, because of insufficient tech-infrastructure, inadequate training, and poor coordination. Notable differences found based on gender, professional qualifications, and teaching experience. These findings highlight the need for targeted interventions, including enhanced teacher training, improved technological infrastructure, and better leadership to support TPACK integration. Further research could expand on these findings by exploring STEM education and cross-cultural contexts to deepen understanding.

Stand-Alone Paper

Harnessing the Power of Culturo-Techno-Contextual Approach plus to Transform Students' Perspectives on Food, Nutrition, Metabolism

Agyemang Okyere Darko*, Lagos State University, Nigeria
Peter Okebukola, Lagos State University, Nigeria
Franklin Onowugbeda, Lagos State University, Nigeria

ABSTRACT

This study investigates the effectiveness of the Culturo-Techno-Contextual Approach Plus (CTCA Plus) in enhancing students' attitudes towards key biological concepts, specifically food, nutrition, and metabolism. Despite efforts to improve science education, students' engagement in biology especially at the senior high school level, remains challenging due to a lack of interest. CTCA Plus addresses this by integrating cultural relevance, technological tools, contextual learning, and motivational rewards to create a more engaging learning environment for students. The research used a mixed-method design, involving 91 students from two public senior high schools in Accra, Ghana. The students were divided into experimental and control groups, with the experimental group receiving CTCA Plus instruction and the control group taught through traditional lectures. Data was collected using the Food, Nutrition, and Metabolism Attitude Questionnaire (FNMAQ) and student perception interviews. The results showed a statistically significant improvement in the attitudes of students taught with CTCA Plus compared to the traditional method [F (1, 88) = 185.50; p = .000]. The experimental group developed more favorable attitudes, confirming the effectiveness of CTCA Plus in promoting a positive and culturally resonant learning environment.

Stand-Alone Paper

Secondary Level Physics Teachers' Collaborative Practices and Challenges to Promote Scientific Literacy

Shahriar Nafees Chowdhury Raaz, University of Dhaka, Bangladesh
S M Hafizur Rahman*, University of Dhaka, Bangladesh
Mehedi Hasan Anik, Côte de Azur University, France
Md Baktiar Alam Bulbul, Green University of Bangladesh, Bangladesh

ABSTRACT
Scientific literacy enables individuals to make informed decisions by applying scientific knowledge to their daily lives. However, the promotion of scientific literacy by secondary science teachers is not up to the mark. This study therefore aims to investigate the secondary-level physics teachers' collaborative practices and challenges to promote scientific literacy. Two questions are selected according to the purpose of the study where the focuses of the research questions are engagement and challenges faced by the participants. The study uses a qualitative basic interpretative design where 10 secondary physics teachers are selected as the sample and both purposive and convenience sampling techniques are used. The data have been collected through semi-structured interviews where thematic analysis techniques have been followed. The study findings reflect that secondary physics teachers can enhance scientific literacy promotion through collaboration, despite challenges like time constraints, hesitancy, and a lack of trust in engaging in collaborative practices. The study's implications extend to secondary-level physics teachers as the primary audience, while also benefiting primary, secondary, and higher-level teachers, school authorities, and policymakers.Keywords: Professional Learning Community, Collaborative Practices, Scientific Literacy, Professional Knowledge, Professional Attributes, Secondary Education

---

Interrogating Context in the Study of Affect and Emotion for Dignity and Justice

Strand 11: Cultural, Social, and Gender Issues
13-Mar-25, 10:00 AM-11:30 AM
Location: Zoom C

Related Paper Set
Pedagogies of Joy ;)

D Keifert*, University of North Texas, USA
Day Greenberg*, Indiana University, USA
Déana Scipio*, IslandWood, USA
Sarah Lee, University of Washington, USA

ABSTRACT
Joy is a core human experience. We conceptualize Pedagogies of Joy (POY, rhymes with joy)—an approach to learning, design, and implementation that creates opportunities for transformative, dignity-affirming learning (Espinoza et al., 2020). Our exemplar case comes from PROJECT, a critical ethnography within a participatory design-based (Bang Vossoughi, 2016) justice-centered afterschool STEM program for youth in a Midwestern low-income, predominantly Black community. We collectively analyzed a video clip through interaction analysis (Jordan Henderson, 1995) video watching, highlighting design and implementation

choices, and then collaboratively (re)writing our analysis together. We share an exemplar of POYful learning affirming a young person's dignity from PROJECT as final preparations were underway for an Open House. We examine the return of an on-again/off-again member of PROJECT, his enthusiastic making, the ready support of peers, and the ways he was centered to share what he loved about PROJECT in the Open House. We use this case to highlight features of POYful design including making space for representation, disruption of hierarchical relations, youth leadership, and co-construction of makerspace culture with facilitators and youth. By disrupting unjust hierarchies, creating spaces for relations of caring, and affirming all learners' dignity, POY highlight transformative possibilities in STEM learning.

Related Paper Set

Exposing and Challenging "Grit" in Physics Education

Amy Robertson*, Seattle Pacific University, USA
Verónica Vélez, Western Washington University, USA
Trà Huynh, Western Washington University, USA
W. Hairston, Equitable Development LLC, USA

ABSTRACT

In STEM education, grit is increasingly the focus of research, with scholars and educators seeking to develop and test interventions that would enhance persistence. In this paper, we use interviews with twelve white physics faculty to show that physics culture has also taken up the narrative that grit is key to success in the discipline. Using affective technology (Zembylas Leonardo, 2013), habitus (Bourdieu, 1972/1977) and emotional habitus (Gould et. al, 2019) as theoretical anchors, our analysis revealed that grit, as described by faculty participants, is part-and-parcel of a white physics habitus.In other words, gritacts to reproduce systems of dominance through the internalization of a set of structures, symbols, and worldviews that produce embodied, affective responses, drawing dominant actors toward particular embodiments of hard work and away from others. Thus, we argue that power in physics is mediated through affect and embodiment. Employing qualitative case study methods, we theorize how whiteness, in part,is reproduced in the discipline. We end by joining with existing calls to refuse grit, building from the work of STEM Scholars of Color who have called attention to the sufferingthat is endemic to notions of schooling and school science.

Related Paper Set

Raciolinguistic Hierarchies of Feeling in U.S. Science Education

Kathryn Kirchgasler*, University of Wisconsin–Madison, USA

ABSTRACT

Attending to the affect of racially and linguistically minoritized students now appears crucial to promoting equitable science education; crucially, however, this aim has a history predating equity reforms. This paper examines how U.S. science classrooms became sites of affective intervention aimed especially at Black, Puerto Rican, Mexican American, and Indigenous students. The study asks: How did U.S. science education project affective distinctions onto racially and linguistically marked science learners in the decades between

desegregation rulings and the field's first equity report (1946–1989)? As a raciolinguistic genealogy, the study employed archival and literature analysis to trace how U.S. science education research and curricular reforms mapped affective differences onto racial and linguistic categories of science learners. Analysis outlines how desegregation-era science education reforms created raciolinguistic hierarchies of feeling in three ways. First, by contrasting idealized personality traits of elite scientists (e.g., competitive individualism) with values ascribed to minoritized communities. Second, by attributing science career disparities to individuals' acquisition of this 'rational,' 'apolitical' attitude. And third, by reauthorizing separate instructional tiers to elevate target groups' dignity by helping learners culturally and linguistically approximate that depoliticized scientific self. This analysis extends work toward unsettling disciplinary molds for feeling that inadvertently reinscribe raciolinguistic hierarchies.

Related Paper Set

'Everyone's Struggling:'' Coping with Institutionalized Hierarchies of Competence Through Emotional Resonance

Muxin Zhang*, University of Illinois Urbana-Champaign, USA
Eric Kuo, University of Illinois Urbana-Champaign, USA

ABSTRACT

This paper presents a case study of how four university engineering students in an introductory physics course addressed the emotional discomfort that arose when a hierarchy of competence emerged among group members, to demonstrate two points. First, students can cope with the discomfort of local hierarchical positioning by sharing and relating to each other's negative emotional experiences as engineering majors. This "emotional resonance" can be a resource for helping students locally reposition to find common ground. Second, the local construction of hierarchical positioning among students, and the resulting emotional discomfort, can be supported by larger institutional structures and hierarchies within STEM culture. Although emotional resonance can locally alleviate discomfort and help students avoid hierarchical positionings, the legitimacy of positioning some students as "smarter" than others based on institutional labels and other markers of success can be left unchallenged. Therefore, efforts to support student emotions in STEM education should look beyond local interventions and critically examine pathways through which institutional structures and STEM culture can create hierarchical and competitive relations between students, generate feelings of not being "smart" enough, and increase the socio-emotional risks of learning.

Related Paper Set

Affective Contradictions in Future-Oriented Science and Sustainability Education

Hanna Røkenes*, University of Oslo, Norway
Alfredo Jornet Gil*, University of Girona, Spain

ABSTRACT

Transformation towards sustainability entails the building of collaboration across disciplines and sectors capable of informed, large-scale action. In projects of local and global relevance

educational innovations can foster future-oriented learning through collaborations between schools, scientists, and out-of-school actors. In this regard, structural/systemic transformations to traditional schooling are necessary. This paper explores the challenges and opportunities emerging when students and teachers participate in a research program aimed at developing a science education unit on climate action through open schooling science education. By taking a critical cultural-historical perspective, we empirically examine discourses and narratives of change, and how these include affective contradictions connected to sociopolitical realities of designing a lesson with the aim of making visible structural/systemic challenges. The study draws from data collected through a European research project aimed at designing and implementing open schooling innovations for action and engagement towards sustainability and future thinking. The study contributes ways to address the recognized contradictions and develop the disciplinary discourses that better include the perspective of the students' futures when teachers and out of school actors co-design lesson plans in open schooling science education, thus strengthening learning as a collective achievement.

Roundtable Discussions
13-Mar-25, 12:00 PM-1:30 PM
Location: Zoom A

Strand 14: Environmental Education and Sustainability
WIP Roundtable
Examining Ontarios Pre- and In-service Elementary Teachers Knowledge and Beliefs about Climate Change
Shiva Javanmardi*, The University of Western Ontario, Canada
Anton Puvirajah, The University of Western Ontario, Canada

ABSTRACT
Climate change presents an urgent global crisis, necessitating effective education strategies to address its complexities and mitigate its impacts. Old teaching methods often struggle to adequately engage with the multifaceted nature and root causes of climate change are not effective anymore, highlighting the need for innovative, participatory approaches. The purpose of this study is to examine pre- and in-service teachers' beliefs, and attitudes about climate change and the factors that influence these beliefs and attitudes. Additionally, the research seeks to identify potential gaps in both pre-service and in-service teachers professional training programs and their knowledge level that may contribute to difficulties faced by educators when integrating climate change topics into their classroom instruction. This is an ongoing research project that has recently received approval for its initial stages, including the proposal and ethical protocol, and is now in the process of beginning. In this research, to gather data, both quantitative and qualitative approaches are utilized. Hence, the research method in this study is mixed method. The first phase of the research involves a survey method using an online questionnaire, while the second phase consists of semi-structured interviews with a number of participants.

Strand 10: Curriculum and Assessment
WIP Roundtable

From written to enacted curriculum: what topics do elementary teachers choose to teach and why?

Mariana Luzuriaga*, Universidad de San Andres, Argentina
Agustina Ollivier, Universidad de San Andres, Argentina
Melina Furman, Universidad de San Andres, Argentina

ABSTRACT

In this study, we examined the curricular content taught by 4th-grade science teachers in elementary schools in Argentina and the criteria they use for content selection, aiming to characterize the "pedagogical flow"—the transformations and mediation mechanisms between the written and enacted curriculum. We conducted a multiple case study involving 42 teachers from 35 public elementary schools. Through thematic content analysis and triangulation of curriculum documents with students' science notebooks, we identified prescribed science content items and measured content coverage throughout the school year. Additionally, we interviewed 35 school principals and 42 teachers to explore their perceptions and decision-making processes regarding curriculum and content selection. Our findings reveal low overall curricular coverage (average 24.44%) and unbalanced curriculum coverage, with a predominant focus on Living Beings. Testimonies from principals and teachers suggest a perceived curriculum overload and indicate that students' interests and textbooks are major factors influencing content selection. These findings have implications for curriculum policy and suggest a need for enhanced support for teachers in lesson planning to improve science education outcomes.

Strand 11: Cultural, Social, and Gender Issues
WIP Roundtable

A Systematic Review of Translanguaging Practices in K-12 Science Education

Zixin Zeng*, The University of Hong Kong, China

ABSTRACT

As science classrooms become increasingly linguistically and culturally diverse, there is a growing body of research on translanguaging in science education contexts. This systematic review analyzes the methodological development, theoretical foundations, and research themes of 43 empirical studies on translanguaging in K-12 science education. Five key themes are identified: translanguaging pedagogy in science education, related ideologies, impact on academic performance, newcomer's translanguaging practices, and translanguaging in assessment and online learning. Initial findings suggest the need for more empirical studies on the effects of translanguaging practices on science learning outcomes and their potential role in online learning and academic assessment. Furthermore, more research is needed to find effective solutions to challenges such as differences between discursive and national languages, and the potential misuse and overuse of home languages in multilingual classrooms where the teacher and students do not share the same mother

tongue. The implications of the findings for methodology, research directions, and pedagogy are discussed.

Strand 7: Pre-service Science Teacher Education
Roundtable

Utilizing Phenomenon-based Science Instruction to Enhance Preservice Teachers' Skills in Generating Hypothetico-Predictive Reasoning

Noushin Nouri*, University of Texas Rio Grande Valley, USA
Leslie Garrido, University of Texas Rio Grande Valley, USA
Saberi Maryam, Ministry of Education, Iran, Islamic Republic of
Morteza Karimi Aghbolagh, University of Texas Rio Grande Valley, USA

ABSTRACT

This case study examines the impact of a 27-hour phenomenon-based learning (PhBL) workshop on enhancing preservice elementary teachers' skills in generating hypothetico-predictive reasoning consisting of hypotheses, planned tests, predictions, observed results, and conclusions. Five preservice teachers participated in workshops focused on the phenomenon of diffusion. Thes phenomenon was explored through multiple models by the participants, allowing them to test various hypotheses and refine their scientific understanding. Through these hands-on activities, participants constructed, evaluated, and revised various forms of hypothetico-predictive. Data collected fromclassroom observations,worksheets, video recordings, and post-workshop interviews showed significant improvements in their ability to generate all five elements of hypothetico-predictive reasoning. The findings underscore the effectiveness of PhBL as a potential context for deepening scientific inquiry skills.

Strand 13: History, Philosophy, Sociology, and Nature of Science
Roundtable

Bridging the Gap: How Designed Purposes Facilitate Authentic Scientific Purposes in Citizen Science Project

Haya Ben Simon*, Technion, Israel
Dina Tsybulsky, Technion, Israel

ABSTRACT

Three cultural worlds intersect in learning: the authentic culture of the studied discipline, the "intended" culture designed by the educators, and the actual culture of the students. While the purposes of each culture have been widely studied, gaps and methods to bridge them remain underexplored. In scientific disciplines, comprehending authentic scientific purposes is one of the cognitive-epistemic aspects of understanding the Nature of Science. This study aimed to enhance students' understanding of authentic scientific purposes in citizen science projects. We examined how designed purposes embedded in learning activities could mediate the teaching of authentic scientific purposes through an instrumental case study. Initially, students referred to familiar but scientifically inauthentic purposes, like cause-and-effect mechanisms. Over time, they began to adopt the designed purposes and eventually formulated scientifically authentic purposes, such as describing phenomena. This

progression indicates that designed purposes can facilitate students' understanding of authentic scientific purposes.

Strand 15: Policy, Reform, and Program Evaluation
WIP Roundtable

Implementing New Science Course Pathways in Urban High School District

Claudia Castillo-Lavergne*, Rutgers University, USA
Meril Antony, Rutgers University, USA
Vandeeen Campbell, Rutgers University, USA

ABSTRACT

The purpose of this study is to understand how science course-taking policies that advance college enrollment and STEM careers are implemented by an urban school district at the school level. Recent research on high school science course enrollment trends in NJ using publicly available school-level data showed that schools having majority students of color and economically disadvantaged students - i.e., segregated - have different science enrollment patterns than integrated or majority White schools (Author, 2022). This study builds on the body of research studying the effects of secondary-level science course-taking on postsecondary outcomes. Using a high-need urban school district as a case study, this exploratory qualitative study consists of four 60-minute interviews with district and school leadership and lead teachers involved with science curriculum policies. The study's purpose is to understand how lead science teachers and administrators made sense of a new science sequence implementation and subsequently its effect on implementation at the school level. Findings reveal that lead science teachers and administrators employed situated sensemaking, which we define as a deep-rooted teacher noticing of the local realities and histories of teaching in an urban school district to make sense of the implementation of a new science-course taking policy.

Strand 3: Science Teaching — Primary School (Grades preK-6): Characteristics and Strategies
WIP Roundtable

Unpacking Teacher Understanding of the Next Generation Science Standards through a Vignette

Min Jung Lee*, University of North Dakota, USA
Martha Inouye, University of Wyoming, USA
Meghan Macias, Wested, USA
Tugba Boz, Purdue University, USA

ABSTRACT

Though it has been nearly ten years since theFramework(NRC, 2013) and NGSS have been released, there remains a persistent need for effective professional learning (PL) that supports teachers' knowledge of the NGSS and their science and engineering content knowledge. Grades 3-5 rural teachers across four states participated in a week-long PL with ongoing supports. We asked to what extent the intervention enhanced teachers' knowledge of NGSS-aligned teaching strategies and science and engineering content knowledge. We

developed a vignette that embedded practical planning and teaching experiences that align with the NGSS vision. More specifically, the vignette focused on planning and classroom instruction with both hypothetical and realistic situations that were brief and incomplete and had open questions that targeted their own perspective. A purposefully selected subgroup of teachers (n=33) representing a range of grades and the four states were asked to complete the vignette in Spring 2024. We are following the six-step thematic analysis process (Braun Clark, 2012). Findings indicate teachers needed more support with the following themes: what the three dimensions are, how the three dimensions should be integrated, how phenomena should be implemented, and how to align the lesson with the standard.

Strand 4: Science Teaching — Middle and High School (Grades 5-12): Characteristics and Strategies
Roundtable

Science Teachers' learning from what matters students for transformative practice: A Change Laboratory study

Isaac Coffie*, University of Technology Sydney, Australia

ABSTRACT

Teachers are key actors in curriculum change, and their professional learning is crucial Opportunities for teacher professional learning to bring about more fundamental changes in teaching practice during curriculum reforms cannot be underestimated. However, this critical aspect is often neglected in curriculum reforms, especially in Africa.This study explores science teacher professional learning at a crucial time of curriculum reform in Ghana using interventional approach called Change Laboratory.The study design was a qualitative formative intervention grounded within the theoretical framework of Cultural-Historical Activity Theory (CHAT). Six Change Laboratory sessions were conducted with six junior high school science teachers in the Sefwi Wiawso Municipality of Ghana.The six Change Laboratory sessions were complemented by two interviews with each teacher, six focus group with students, and 18 lesson observations over three months. The analysis of the data showed that three themes emerged as what matters to students:support and attention, engagement and interestedness, applicability and connectedness.These ideas that matters to students became a resource for teacher professional learning and practice leading to four key changes in teachers' practice.The practices focused on the use of questioning, assessment, teaching beyond the classroom, and designing a range of activities.

Virtual Poster Session
13-Mar-25, 12:00 PM-1:30 PM
Location: Zoom B

Strand 3: Science Teaching — Primary School (Grades preK-6): Characteristics and Strategies
Poster

A Bibliometric and Content Analysis of Research in Elementary Science Education

Shuhao Yang*, Beijing normal university, China
Yang Tao, Beijing normal university, China
Dan Tao, Beijing normal university, China

ABSTRACT
The study aims to reveal the research trends in elementary science education over the past 30 years using bibliometric and content analysis methods on 398 articles from the Web of Science. The research examines the distribution of annual publication volumes, the countries involved, and the trends of different research themes. The bibliometric mapping indicates a consistent increase in research output, with significant contributions from the United States, the United Kingdom, and Australia. In addition, the top keywords are "Education," "Science Education," "knowledge," "students,""inquiry," and "teacher professional development" . The content analysis reveals that existing research predominantly focuses on "Student Science Learning," "Science Teacher Education," "belief," and "Science Teaching." Besides, research themes such as "Curriculum and Assessment," "Science Education in Informal Contexts," and "Educational Policy and Administration" are less frequently explored, suggesting gaps in existing research. These results provide an overview of the global research landscape of elementary science education and shed light on potential themes for future investigation.

Strand 3: Science Teaching — Primary School (Grades preK-6): Characteristics and Strategies
Poster

An Exploratory Study Assessing the Instructional Quality of Preservice Teachers' Engineering Tasks

Danielle Rhemer*, Old Dominion University, USA
Keri Parker*, Old Dominion University, USA
Samantha Myers, Old Dominion University, USA
Kristie Gutierrez, Old Dominion University, USA
Jennifer Kidd,Old Dominion University, USA

ABSTRACT
One significant change to national and statewide K-12 science education standards is the emphasis on incorporating engineering content and practices. Though these changes were made more than ten years ago, engineering is not typically a part of K-12 science education or teacher preparation. Thus, teachers need support designing cognitively demanding engineering tasks integrating math and/or science content with engineering practices.This article aims to advance the Tasks Analysis Guide in Engineering (TAGE) framework, which analyzes engineering tasks based on 1) cognitive demand and 2) the integration of math and/or science content and engineering practices. Guided by this framework, we analyzed 18 engineering tasks designed by elementary preservice teachers as a part of a science methods course. Thirteen of the tasks integrated math and/or science content and engineering practices and required a moderate or high level of demand on student thinking. Building on our analysis, we suggest how tasks might be improved and provide implications for teachers and teacher educators regarding how to support the design of engineering instruction that engages students in similar intellectual work to engineers.

Strand 12: Technology for Teaching, Learning, and Research
Poster

Identifying Learners' Cognitive-Affective Profiles in Virtual Scientific Inquiry Practices

Shuo Feng*, Shanghai Jiao Tong University, China
Maohua Wang, Shanghai Municipal Education Commission, China
Ke Li, Shanghai Jiao Tong University, China
Shuai Wang, Shanghai Jiao Tong University, China

ABSTRACT

In recent years, with the continuous upgrading and transformation of the global technology industry, international competition has intensified. As a result, cultivating high-quality talent has become a critical objective in building a strong nation in education, science, and human resources in the new era. Scientific inquiry practices are regarded as the core of science education reform(Schwartz et al., 2021), aiming to engage students in scientific practices akin to those of scientists, such as identifying problems, conducting investigations, collecting data, evaluating data, and generating explanations, thereby fostering a deep understanding of knowledge and a positive scientific perception(Chen Terada, 2021; Papalazarou et al., 2024). Researchers have designed a series of open-ended virtual science inquiry environments to facilitate students' engagement in scientific inquiry activities. Our study aims to identify cognitive-affective profiles to understand learners in this context. After analyzing 552 learners' data, we found that two profiles formed and behavioral and background characteristics can predict them.

Strand 6: Science Learning in Informal Contexts
Poster

Embracing a Pluriversal Approach in Science Education: Racialized Multilingual Youth as Epistemic Contributors and Sensemakers

Akira Harper*, University of Massachusetts Dartmouth, USA
Shakhnoza Kayumova, University of Massachusetts Dartmouth, USA
Fernanda Minghetti Weisheimer, University of Massachusetts Dartmouth, USA
Jared Fredette, University of Massachusetts Dartmouth, USA

ABSTRACT

Efforts towards more equitable or dignity-oriented outcomes in science education, emphasize the importance of providing all youth with expansive opportunities to participate in science sensemaking or inquiry processes. This is particularly critical for racialized multilingual youth, from non-dominant communities, whose ways of knowing-in-being as well as sensemaking repertoires continue to be devalued due to deficit-thinking and raciolinguistic ideologies. Thus, we situate this study in the context of longitudinal design-based STEAM Research Academy and draw on decolonial theories and a pluriversal praxis approach to examine what sensemaking practices emerge from a representative case of middle-school racialized multilingual youth who are positioned as legitimate epistemic agents, as they participate within science and engineering activities.We collected video or

dialogue-based interviews, classroom data, and student artifacts. Interactional analysis revealed the opportunities racialized youth were provided, to enact their ways of knowing-in-being or sensemaking and participate in their science learning in robust, dignity-conferring, and expansive ways. Critical discourse analysis provided a lens to juxtapose the micro-level analysis, with teacher video-elicited interviews. This research contributes to broader societal goals within scientific research and education of embracing more expansive views of and dignified approaches to knowing-in-being in science.

Strand 8: In-service Science Teacher Education
Poster

Science Teachers Visual Representations of Nature of Science through Online Reflective Collaborative Professional Development Program

Büşra Aksöz*, Bogazici University, Turkey
Ebru Kaya, Bogazici University, Turkey

ABSTRACT

This study is a part of a teacher professional development project which is based on Erduran and Dagher's (2014) Family Resemblance Approach (FRA) to Nature of Science (NOS), which has later been termed as RFN (Reconceptualized FRA-to-NOS) by Authors (2016). The RFN framework encompasses cognitive, epistemic, and social-institutional aspects of science. It offers pedagogical strategies and practical applications for science education settings. One critical issue is that NOS involves meta-concepts demanding higher-order cognitive skills. Visualization can be a strategy to aid comprehension to enhance teachers learning and to assess understanding. Although both NOS and visualization have been extensively researched independently, their intersection remains limited (Authors, 2018). This paper aims to investigate the effect of an online reflective collaborative professional development (PD) program on science teachers visual representations of NOS. The PD was organized for 9 weeks including pre and post data collection. Six science teachers participated to study. Teachers drew their representations for each RFN category and explained their drawings before and after the PD program. Qualitative analysis of visual representations and written data indicates that science teachers have more sophisticated understanding about RFN categories after PD program, highlighting implications for future research on visualizing NOS.

Multi-Strand Stand-Alone Paper Set 3
Strand 2: Science Learning: Contexts, Characteristics and Interactions
13-Mar-25, 2:00 PM-3:30 PM
Location: Zoom A

Stand-Alone Paper

Broadening Participation in STEM by Engaging Students in Data Science in Puerto Rico

Steven McGee*, The Learning Partnership, USA

Willow Kelleigh, The Learning Partnership, USA

ABSTRACT

This study explores the relationship between students' perceptions of a data science initiative and their expectancy-value beliefs in science. The initiative involved middle and high school students analyzing ecological data from Puerto Rico's El Yunque rainforest using the Common Online Data Analysis Platform (CODAP). The research is based on Eccles' Expectancy-Value, which found that expectations of success and the value they place on the field of science is correlated with their future career choices about science. The research analyzed data from 461 students and 20 teachers to examine the relationship between the perceived difficulty of the tasks and teachers' engagement of scientific inquiry with students' perceptions of expectancy-value. Results showed that higher student perceptions of task easiness and teachers' use of inquiry methods positively influenced students' post-initiative expectancy and value scores. These findings suggest that appropriately challenging scientific inquiry experiences can enhance students' beliefs in their ability to succeed in science and the value they place on the field, potentially promoting long-term participation in STEM fields. The study highlights the initiative's potential to broaden participation in science among underrepresented Hispanic students in Puerto Rico, aligning with broader efforts to address STEM disparities.

Strand 7: Pre-service Science Teacher Education
Stand-Alone Paper

Integrating Historical Empathy into History of Science: Promoting Socio-Emotional Competence in Pre-Service Science Teacher.

María Paz Beltrán*, Universidad del Desarrollo, Chile
Francesca Grez, Universidad del Desarrollo, Chile

ABSTRACT

In recent years, there has been growing interest in the development of social-emotional competencies (SEC) in education. However, various studies have revealed a worrying lack in the integration of these competencies in teacher training programs. This lack of attention highlights the need to address SEC alongside the academic aspects of the science curriculum. This research aims to reduce the gap by exploring how Historical Empathy (HE) can promote Socio-Emotional Learning (SEL) in teaching the History of Science (HOS). Within the framework of a pedagogical training program for secondary school teachers at a private university in Chile, we propose the following research question: How does the use of HE contribute to the didactic approach to the HOS and the development of social emotional learning of the pre-service teacher? The goal is to evaluate the impact of implementing a didactic proposal that incorporates HE and HOS. This research follows a qualitative paradigm, through action research and focus groups. The results reveal epistemological reflections related to the Nature of Science (NOS), epistemic affect, and socio-emotional development. Ultimately, this study underscores the transformative potential of HE in enriching science education and advancing comprehensive teacher training programs.

Stand-Alone Paper

Noticings by Principals and Their Responses to Elementary Science Lessons

Melissa Pearcy*, Washington State University, USA
Meagan Graves, Washington State University, USA
Patrick Ochieng, Washington State University, USA

ABSTRACT

This study examines elementary principals' noticings (attending, interpreting, and responding to) of a second-grade science lesson on sound. While some research focuses on principal noticings in science and teacher candidate noticings for equitable sense-making practices, this research is at the intersection of principals' responses and coaching toward equitable sense-making practices. Thirteen elementary principals participated in a semi-structured interview where they viewed three three-minute video clips. Principals shared events they attended to, interpreted, and responded to involving opportunities they saw or would have liked to see. This resulted in four emerging themes; principals noticed opportunities where the teacher could build on the students' funds of knowledge, check for students' understanding, build space for students to talk with one another, and explicitly include times to increase student agency by having students reflect on their behaviors and content knowledge. This study's insight offers valuable implications for teacher educators, in-service teachers, administrators, and science education researchers, as it can help inform what principals may be looking and coaching for in observed lessons and promote equitable sensemaking practices.

Stand-Alone Paper

Early Childhood Teachers' Perspectives on Integrated STEM Education

Lu Wang*, Indiana University Kokomo, USA
Alina Mihai, Indiana University Kokomo, USA

ABSTRACT

Young children are natural scientists and engage in exploring the world around them since infancy. Although early childhood classrooms abound in integrated STEM opportunities, early educators need to be intentional in fostering children's development of STEM knowledge and skills. As such, it is important to understand teachers' perspectives toward their everyday STEM instruction practices. This study, guided by the integrative STEM framework, examines the STEM teaching practices of 8 preschool teachers through in-depth interviews. We present themes related to teachers' STEM instructional approaches, their observations of student learning outcomes, strategies for providing equitable and inclusive STEM experiences, and their confidence and attitudes toward teaching STEM. This research contributes to the understanding of integrated STEM teaching in preschool settings and offers insights for supporting teachers in STEM instruction.Keywords: Integrated STEM, early childhood, teacher, preschool, perspectives, classroom practice.

Stand-Alone Paper

Effects of lab sequence and student preferences, combining virtual and physical labs in middle school

Amnon Levin*, Ben-Gurion University, Israel
Elon Langbeheim, Ben-Gurion University, Israel

ABSTRACT

This study investigates the impact of combining virtual laboratories (VLs) and physical laboratories (PLs) on 8th-grade students' understanding of electric circuits. We examine how the sequence of VL and PL experiences affects conceptual learning and explore the relationship between students' attitudes towards laboratory work and their learning outcomes. Fifty-two students were divided into three groups: VL followed by PL, PL followed by VL, and PL only (control). Conceptual understanding was assessed through pre- and post-tests, while attitudes were measured using Likert-scale surveys. Results indicate that combining VLs and PLs leads to greater conceptual gains compared to PLs alone, with the VL-first sequence showing the highest improvement. Students' self-determination towards experiments increased slightly across all groups. A negative correlation was found between preference for direct instruction and post-test scores. These findings suggest that integrating VLs before PLs may optimize students' understanding of electric circuits in middle school science education.

Stand-Alone Paper Set 4

Strand 5: College Science Teaching and Learning (Grades 13-20)
13-Mar-25, 2:00 PM-3:30 PM
Location: Zoom B

Stand-Alone Paper

AI in STEAM Education: case study of visual literacy in biology and visual art drawing

Michael Ahove*, Lagos State University, Nigeria
Benjamin Onuorah*, Lagos State University, Nigeria
Peter Okebukola, Lagos State University, Nigeria
Sanni Rasheed, Lagos State University, Nigeria
Juma Shabani,University of Burundi, Burundi

ABSTRACT

In the fast-changing field of education, Artificial Intelligence (AI) has become a powerful tool that can significantly change how we teach and learn. Science, Technology, Engineering, Arts, and Mathematics (STEAM) education is an interdisciplinary approach that fosters creativity, critical thinking, and problem-solving skills. This study investigated the effectiveness of the Technology-Education-Art (TEA) artificial intelligence model on attitude of student in biological and visual art drawing. The study group comprised of two categories

of students (visual art and biology students) and used the Questionnaire on Student's Attitudes to Visual Art Drawing (QSABD), Questionnaire on Student's Attitudes to Biological Drawing (QSABD) for quantitative data collection and Interview guide for qualitative data. The quantitative data gathered was analysed using ANCOVA. The results showed that there is no statistically difference in the attitude of students taught biological drawing using the two methods. While for the visual art category the results showed that there is a statistically significant difference in the attitude of students towards visual art drawing using the two methods (TEA and traditional method). From the interview responses, students in both categories are positive about using AI technology for learning drawing skill.

Stand-Alone Paper

Improving African Students Learning Outcomes in Cybersecurity, the Culturo-Techno-Contextual Approach and Afrocyberlibrary to the Rescue.

Michael Armah), Lagos State University, Nigeria
Peter Okebukola, Lagos State University, Nigeria
Moses Akanbi, Lagos State University, Nigeria
Rasheed Saani, Lagos State University, Nigeria
Andrew Tetteh, Lagos State University, Nigeria

ABSTRACT

This study aims to evaluate the efficacy of the Culturo-Techno-Contextual Approach (CTCA), an instructional framework that integrates indigenous knowledge, and the Afrocyberlibrary, a repository of indigenous cybersecurity information that caters to various socio-economic backgrounds and learning preferences. This research used a quasi-experimental approach. The Analysis of Covariance (ANCOVA) demonstrated that both the CTCA and Afrocyberlibrary app had a positive impact on students' learning outcomes, irrespective of their socio-economic status [F (1, 52) = 2.54; p.05] and learning styles [F (1, 52) = .49; p.05]. This study recommends using the CTCA and Afrocyberlibrary in cybersecurity courses to enhance students' understanding.

Stand-Alone Paper

Improving Students Interests in Cybersecurity: Will the CTCA and Afrocyberlibrary Help?

Andrew Tetteh, Lagos State University, Nigeria
Michael Armah, Lagos State University, Nigeria
Peter Okebukola, Lagos State University, Nigeria
Moses Akanbi, Lagos State University, Nigeria
Rasheed Saani, Lagos State University, Nigeria

ABSTRACT

This study seeks to assess the effectiveness of the Culturo-Techno-Contextual Approach (CTCA). This instructional framework combines indigenous knowledge with the Afrocyberlibrary, a collection of indigenous knowledge relative to cybersecurity. This study employed a quasi-experimental technique, with 36 students in the control group and 35

students in the experimental group. The Analysis of Covariance (ANCOVA) indicated that both the CTCA and Afrocyberlibrary app had a favourable influence on students' interests [F (1, 66) = 56.84; p.05], regardless of their gender [F (1, 66) = 3.29; p.05]. Based on these preliminary findings, we cautiously advocate the usage of the CTCA and Afrocyberlibrary in cybersecurity courses to boost students' interests.

Stand-Alone Paper

Phenomenographic Analysis to Students' Problem Solving in Introductory Physics

Ozden Sengul*, Bogazici University, Turkey
Sevde Yerisenoglu, Bogazici University, Turkey

ABSTRACT

This paper aims to describe student approaches to introductory physics problems. This empirical study had a phenomenographic approach to examine college students' responses on open-ended problems. Participants were 173 college science students from physics, physics education, and engineering departments. Students were selected among sophomore, junior, and senior students, who could pass the freshman physics courses. Data was collected from volunteer students by visiting their classrooms. Data analysis was conducted through constant comparative method. The results showed hierarchical categories of students' problem-solving approaches for knowledge level and skill type. The research has implications for further studies in the context of introductory physics.

Stand-Alone Paper

2-Year College Biology Instructor Perceptions on Mathematics in Biology Instruction

Kristine Squillace Stenlund*, University of Minnesota, USA
Anita Schuchardt, University of Minnesota, USA

ABSTRACT

Understanding mathematics in the context of biology is an important competency for STEM professionals. Two-year colleges provide foundational science education to a large proportion of these developing professionals in the US and is an important arena for educational reform. In this study, a convenience survey was designed to explore 2-year college biology instructor perceptions and use of mathematics in the biology context. Respondents were asked a series of 6-point Likert questions surrounding efficacy, algorithmics, mathematical sensemaking, biological sensemaking, fixed mindset, and perceived difficulty in mathematical concepts pertaining to biological phenomena. Responses indicate instructors are confident with their mathematical abilities but do not feel the same confidence in their students. Data reveals that instructors do use mathematics in their biology classrooms and value the connection between content in their class learning objectives. Instructors report listing mathematical connections to biological phenomena as top learning objectives in their introductory biology classes. However, instructors also indicate they do not use classroom activities in line with these learning objectives. Overall, this study suggests 2-year college instructors may benefit from workshop opportunities focused on ways to allow students to build connections between mathematics and biology. Results from this study will be used to design such workshops.

Principles for Designing Science Methods Courses Toward Humanizing Science Teaching and Learning

Strand 7: Pre-service Science Teacher Education
13-Mar-25, 4:00 PM-5:30 PM
Location: Zoom A

Symposium

Principles for Designing Science Methods Courses Toward Humanizing Science Teaching and Learning

D Keifert*, University of North Texas, USA
Bethany Daniel*, Vanderbilt University, USA
Heather Johnson, Vanderbilt University, USA
Déana Scipio*, IslandWood, USA
Yaa Dankwa*, The Ohio State University, USA
Sophia Jeong, The Ohio State University, USA
Alejandra Santely, The Ohio State University, USA
Khadija Zogheib*, Florida State University, USA
Enrique Suárez, University of Massachusetts Amherst, USA
Myeongji Kim, The Ohio State University, USA

ABSTRACT

Supporting transformative science teaching and learning necessitates adopting humanizing approaches centered in collective learning (Andrews et al., 2019; Mensah, 2009). Central to this work is developing critical consciousness, or "learning to perceive social, political, and economic contradictions, and to take action against the oppressive elements of reality" (Freire, 1970, p. 17). Critical consciousness serves as a foundation for a professional vision (Goodwin, 1994) that is "grounded in theoretical traditions dealing with cultural, social, and political issues that are interconnected with classroom dynamics" (Beyer, 2001, p. 152). Salazar's (2013) principles and practices of humanizing pedagogy identify the kinds of interconnections that teachers need to be prepared to address. Our symposium includes five papers that take up different principles/practices from Salazar to explore teacher candidates' experiences in science methods courses. Collectively, we explore relationships between designed elements of methods courses and teacher candidates' humanizing experiences for themselves and their future students. These design/experience relations shed light on successes and challenges in humanizing science teacher candidate learning to inform future work by teacher educators.

Multi-Strand Stand-Alone Paper Set 5
Strand 6: Science Learning in Informal Contexts
13-Mar-25, 4:00 PM-5:30 PM
Location: Zoom B

Stand-Alone Paper
People who have more science education rely less on misinformation when making science-related decisions
Yael Rozenblum*, Technion – Israel Institute of Technology, Israel
Keren Dalyot, Weizmann Institute of Science, Israel
Ayelet Baram- Tsabari, Technion – Israel Institute of Technology, Israel

ABSTRACT
Recent research has underscored the importance of science education in mitigating beliefs in science-related misinformation and its beneficial impact on decision-making and behavior. This study employed the Elaboration Likelihood Model to assess how individuals' abilities and motivation affect their processing of scientific information through peripheral versus central persuasion routes.A representative sample of 500 adults completed an online questionnaire during the second wave of COVID-19 (Nov. 2020), focusing on two social distancing dilemmas. Motivation was measured as personal relevance, and abilities, measured by science education level, science knowledge, and misinformation identification strategies.We found that relying on misinformation was associated with the intention to reject social distancing recommendations and with the use of simple arguments. In addition, personal relevance was associated with the intention to reject the recommendations but also with more complex arguments, suggesting that people did not intend to reject scientific knowledge but rather tended to contextualize it. Science education was also positively associated with argument complexity but not with respondents' stances. Finally, respondents with higher levels of science education and motivation relied less on misinformation. This implies that science education and the issue's relevance to one's life contribute to people's inclination to engage with information critically.

Stand-Alone Paper
Effect of Technology-Education-Art (TEA) Artificial Intelligence Model on Students' Attitude towards Biological Drawing
Benjamin Onuorah*, Lagos State University, Nigeria
Peter Okebukola*, Lagos State University, Nigeria
Michael Ahove, Lagos State University, Nigeria
Sanni Rasheed, Lagos State University, Nigeria
Juma Shabani, University of Burundi, Burundi
Franklin Onowugbeda, Lagos State University, Nigeria

ABSTRACT
Biology is one of the most visually intensive STEM subjects; studies have shown that students are having challenges with biological drawing in Nigeria. This study looks at the effectiveness of the Technology-Education-Art (TEA) artificial intelligence model on attitude of student

towards biological drawing with gender as moderator variable. The study used a mixed research method for a more effective data gathering. The sample comprised 85 students from two higher institutions. Two instruments were used to collect quantitative and qualitative data. The experimental group was exposed to the TEA application while the control group use normal lecture method. The quantitative data gathered were analysed using ANCOVA. The results showed that there is no statistically difference in the attitude of students taught biological drawing using the two methods. Output of the qualitative data however showed that the students perceived TEA as viable tool for learning biological drawing. Based on the findings of this study and within its limitations, it was recommended that visual literacy skill for science students should be given more attention and AI should not be seen as a threat to learning but as an important tool to support learning.

Stand-Alone Paper

The Impact of Teaching Based on HOS on Students' Understanding of the Nature of Science

Kadriye İnci*, METU, Turkey
Semra Sungur, METU, Turkey
Özgül Yılmaz-Tüzün, METU, Turkey

ABSTRACT

This study examines the impact of history of science (HOS)-based instruction on sixth-grade students' understanding of the Nature of Science (NOS) using the Reconceptualized Family Resemblance Approach to NOS (RFN). The study focuses on five RFN categories: aims and values, scientific practices, method and methodological rules, scientific knowledge, and social-institutional system. A quasi-experimental design was implemented, with two classes randomly assigned as experimental groups and two as control groups, involving 101 sixth-grade students from a public school in Ankara (45 boys, 56 girls). Quantitative data were collected using the RFN Student Questionnaire as pre- and post-tests. Multivariate Analysis of Variance (MANOVA) on pre-test scores showed no significant differences between the experimental and control groups across all RFN categories. However, post-test results revealed that the experimental groups had significantly higher NOS levels in the categories of aims and values, scientific knowledge, and social-institutional system. Although no significant differences were found in the other two categories, the experimental groups had higher mean scores. The findings suggest that HOS-based instruction is more effective than curriculum-based teaching in enhancing students' NOS understanding as measured by the RFN framework.

Stand-Alone Paper

Pre-service Science Teachers' Place-Based Learning Experience: A Bioblitz Activity in Ihlara Valley

Nurcan Tekin, Aksaray University, Turkey
Başak Tepedelenlioğlu*, Aksaray University, Turkey

ABSTRACT

The aim of the study is to examine pre-service science teachers' (PSTs) experiences in terms of the species recorded and their views during the bioblitz process. A qualitative case study design was used. 49 PSTs voluntarily participated in the study using convenient sampling method. The data were collected through photos or sounds recorded by the PSTs in the "Ihlara Valley Bioblitz" project in the iNaturalist application and the Views on the Bioblitz Process Form. The process included a short-term bioblitz implementation and continued for seven weeks. Descriptive analysis was used in the evaluation of the recorded species, and PSTs' views were analyzed through content analysis to reach their experiences. The results revealed that during the bioblitz event, PSTs made 3180 observations in Ihlara Valley, and these observations included 1015 species. These species mostly comprised of plants, insects and fungi. The participants were highly satisfied with the bioblitz activity and stated that they would like to do this activity again in environments such as forest, mountain and lake ecosystems. PSTs stated that the bioblitz activity positively affected their perceptions of biodiversity, out-of-school learning and the process of working like scientists. Detailed information on the research results is discussed.

Stand-Alone Paper

Relating Professional Action Competence in ESD to Sustainability Teaching Outcome Expectancy, ESD Value, Teacher Self-Regulation

Zeynep Aydin*, Bogazici University, Turkey
Sevda Yerdelen-Damar, Bogazici University, Turkey

ABSTRACT

The study aimed to explore in-service teachers' professional action competence in education for sustainable development (PACesd) across primary, middle, and high school levels, and how factors like sustainability teaching outcome expectancy, education for sustainable development (ESD) value, and teacher self-regulation predict this competence. A total of 475 teachers participated, with data collected through several scales, including the PACesd and Teacher Self-Regulation Scales.Results showed that there were statistically significant differences in PACesd scores amongin-service teachers teaching at different levels of education (i.e., primary, middle, high school).The model incorporating ESD value, sustainability teaching outcome expectancy, and teacher self-regulation explained a significant portion of the variance in PACesdafter controlling forthe influence of education level in which in-service teachers teach. Also, the model containing ESD value, sustainability teaching outcome expectancy and teacher self-regulation was tested at eacheducation leveland it was found that the highest variance in PACesd was explained at primary school level, and it was followed by middle and then high school.Notably, while all factors significantly predicted PACesd in primary and middle school teachers, ESD value did not have a significant unique contribution for high school teachers.

Stand-Alone Paper

Bridging Roles: Educators and High School Graduates' Sense of Climate Change.

Shaima Alokbe*, Ben-Gurion University of the Negev, Israel
Areej Nbari*, Ben-Gurion University of the Negev, Israel
Wisam Sedawi*, University of Michigan, USA

Orit Ben Zvi Assaraf, Ben-Gurion University of the Negev, Israel

ABSTRACT

This study explores the connection between climate literacy and sense of place among Bedouin teachers and high school graduates in Israel's Negev Desert, focusing on how these factors influence climate education within the community. The literature suggests that the role of educators in fostering informed climate-related decisions is crucial yet challenging, particularly in communities with a strong sense of place, which may be more likely to engage in environmental practices. Using a phenomenological approach, this study investigates the perceptions of ten science teachers and twenty recent graduates regarding climate change, their lived experiences, and their insights into existing climate education. Interviews reveal a strong connection to their natural rural environment and the immediacy of their lived experiences with climate change, underscoring the importance of sense of place in shaping perspectives and informing educational practices. Furthermore, both groups emphasize the need for place-based learning that aligns with their cultural context, advocating for a curriculum that informs and empowers them to take action, while also revealing concerns about inequality, marginalization, and the risks of discussing sensitive political issues. The findings highlight the potential of culturally responsive, place-based education to promote social justice, enhance climate resilience, and support environmental sustainability in marginalized communities.

Closing remarks

13-Mar-25, 5:30 PM-6:00 PM

Location: Zoom A

In-Person Conference, Day 1

Sunday, 23 March 2025

All times are in US EDT

New Member Welcome

23-Mar-25, 7:00 AM-8:00 AM
Location: Magnolia 3
Social Event

Pre-Conference Workshops

Challenging Academic Hegemony: How Latin@ Rethink Scholarly Conventions in Science Education Research

23-Mar-25, 8:00 AM-11:45 AM
Location: Annapolis 1

Pre-Conference Workshop

Angela Chapman, University of Texas Rio Grande Valley, USA
Alejandro Gallard , Georgia Southern University, USA
Uma Ganesan, University of Texas Rio Grande Valley, USA
S. Lizette Ramos De Robles, Nacional de Ciencia y Tecnología, Mexico
Verónica Serrano Flores, Instituto Superior de Investigación y Docencia para el Magisterio (ISIDM), Mexico
Dulce Gonzalez Ramírez, Instituto Superior de Investigación y Docencia para el Magisterio (ISIDM), Mexico
Liliana Garcia, University of California Santa Barbara, USA
Alexander Eden, Florida International University, USA
Summer Blanco, University of Georgia, USA

ABSTRACT

The purpose of the LARIG-sponsored session is to provide a platform for NARST members to share their perspectives and experiences in science education research involving learners and/or educators who are Latinx. This session will include a diverse group of panelists conducting research in communities, policy, teaching, and learning. The panel discussion will explore tensions and challenges experienced by Latin@ and non-Latin@ researchers not to be “othered” in scholarship by the hegemony of dominant paradigms that maintain the

status quo. Empirical and theoretical modes of research from different perspectives will be unpacked. For example, the perspectives of non-Latin@ science education researchers' understanding of a Latin@ community as juxtaposed to that of a Latin@ science education researcher researching Latin@ learners will be explored. The insider/outsider perspective will be explored. Also, policy implications that affect the teaching and learning of science of Latin@ students will be discussed.

Empowering Innovative Teacher-Researcher Partnerships in Switzerland: A Collaborative Approach to Strengthen the Use of Conceptual & Affective Tests in Classrooms

23-Mar-25, 8:00 AM-11:45 AM
Location: Annapolis 2

Pre-Conference Workshop
Florian Stern, University of Geneva, Switzerland

ABSTRACT
Evidence-based practice in science education needs short, validated tests that assess cognitive, attitudinal, and affective factors, helping teachers to enhance their teaching. Despite the availability of a wide range of such tests - covering areas like conceptual understanding, scientific literacy, interest, or self-concept - they are still little used by teachers in classrooms. Our project aims to promote the use of diagnostic tests tailored for secondary science teaching in Switzerland. The specifity of the project is the close collaboration between teachers and researchers. Teachers identify the most relevant classroom variables, ensure the tests align with current curricula, conduct validations in their own classrooms, and provide feedback for improvement. In turn, researchers provide their expertise in existing tests, theoretical frameworks, and methodologies for test development and validation.

In this workshop, we will showcase examples of teacher & researcher collaborative test development and validation, drawn from both pre-service and in-service teachers In Switzerland. We will outline a roadmap for achieving effective teacher-researcher partnerships under the constraints of practice and research, point out common challenges and limitations, and mention how to integrate these collaborations within teacher program trainings. Participants will be able to share their own experiences related to the use of tests, and suggest initiatives to develop further such teacher/research partnerships.

Another Essential Partner We Need in the Mix: Building Lasting Connections Among Science Teachers, Researchers, and EdTech Innovators

23-Mar-25, 8:00 AM-11:45 AM
Location: Annapolis 3

Pre-Conference Workshop

Megan Conrad, ExploreLearning, USA
Megan Conrad, ExploreLearning, USA
David Kantner, ExploreLearning, USA
William Penuel, University of Colorado Boulder, USA
Stefani Stephenson, Digital Promise, USA

ABSTRACT

There is a large literature on research-practice partnerships (RPPs) and their benefits for improving the relevance of research, addressing inequities in who has a voice in research, and making research findings more actionable. However, industry has historically been absent from these relationships, resulting in a disjointed classroom ecosystem. Industry partners can help to turn theoretical knowledge generated by researchers into solutions that can be delivered at scale, with infrastructure that is equipped to reach millions of learners. They can also support rapid research on student learning with large numbers of teachers and students who represent diverse populations.

This pre-conference workshop will explore how expanding RPPs can enhance the relevance, equity, and impact of technology-based studies on classroom science learning. The session is grounded in the literature on Research-Practice Partnerships (RPPs), Design-Based Implementation Research (DBIR), and Feedback Loops, providing participants with a theoretical foundation and practical tools for building effective collaborations. We will discuss the benefits and challenges of developing and sustaining purposeful, bi-directional, and iterative relationships to advance and scale STEM learning and research in K-12 classrooms, sharing practical strategies learned from recent partnership projects. Participants will engage in hands-on, collaborative activities to reframe research questions through an expanded lens of RPPs. By the end of the workshop, participants will have co-created actionable research plans that change the knowledge, actions, or goals for each engaged party. This workshop is designed for researchers and other practitioners interested in bridging the gap between research, industry, and practice through meaningful, collaborative approaches.

The Pendulum: A Gateway to Authentic Scientific Research in High School Classrooms

23-Mar-25, 8:00 AM-11:45 AM
Location: Annapolis 4

Pre-Conference Workshop

Brian Wargo, Idealized Science, USA
Brian Wargo, Idealized Science, USA
Jacob Beckey, University of Colorado Boulder, USA

ABSTRACT

For decades, educational researchers have been imploring educators to engage students in science authentically. Waves of new techniques and styles influence state- and national-level standards and seem to provide the next promising route to helping students understand what science is and what scientists do. Yet, the research is clear: engaging students in authentic scientific practices in the classroom is a rare occurrence. This, in large part, may be attributed to the limited experience many in-service science teachers have with inquiry, nature of science, and engineering practices. Researchers and reform documents alike have begged for continued professional development to help close these gaps in preparation.

In this workshop, we provide a model for such professional development that targets authentic scientific practices in a simple, inclusive, and cost-effective manner. To lower all barriers to engaging in authentic scientific research, we focus on a simple and cheap physical system: the pendulum. Participants will be taken through an investigation into the period of a simple pendulum, with an emphasis on inquiry, nature of science, and science/engineering practices throughout. This workshop will serve as a model for teacher educators and teachers to engage their students in authentic science research projects which are the epitome of decades of educational reform documents and standards. All participants will be given a copy of Idealized Science: A Framework for Practicing Science Authentically by Brian M. Wargo, Ph.D., which will serve as a step-by-step guide for implementing such an intervention with in-service teachers or students alike.

An Introduction to the VAScoR and Using a Rubric to Qualify Responses to the Views of Nature of Science (VNOS) Questionnaire

23-Mar-25, 8:00 AM-11:45 AM
Location: Baltimore 2

Pre-Conference Workshop

Ryan Summers, University of North Dakota, USA
Ryan Summers, University of North Dakota, USA
Sahar Alameh, University of Kentucky, USA
Jeanne Brunner, University of Massachusetts Amherst, USA
Fouiad Abd-El-Khalick,University of Massachusetts Amherst, USA

ABSTRACT
Systematic approaches to assessing learners' and teachers' NOS understandings are necessary for making meaningful comparisons, and improving consistency is an important step towards large-scale investigations using open-ended measures. Join us for a workshop where you will learn to use the VAScoR to qualify nature of science (NOS) ideas. As part of this workshop you will learn about the coding logic of the VAScoR and how the rubric can be used to analyze qualitative data for elements of 10 target NOS aspects. You will have the opportunity to work collaboratively and practice applying the VAScoR to authentic responses collected using Views of Nature of Science (VNOS) Questionnaire (Version C). Participants will receive relevant readings detailing the development of the VAScoR, access to a curated VNOS data set, copies of worksheets with decision matrices, and resources like a list of frequently asked questions and a user guide. We look forward to a dialogue across positions and frameworks, including diverse perspectives, towards the goal of enhancing the scale and reliability of NOS research.

Equity and Ethics Practices in Science Education: Implications for Teaching and Research

23-Mar-25, 8:00 AM-11:45 AM
Location: Magnolia 3

Pre-Conference Workshop
Maria Rivera Maulucci, Barnard College, Columbia University, USA

ABSTRACT
Equity and ethics are central to advancing science education research and equipping science teachers with the knowledge, understanding, and skills to foster inclusive learning environments that address the diverse needs of all students. This pre-conference explores the intersection of equity and ethics within science education, highlighting the importance of implementing science teaching practices and research methodologies that are fair, just, and culturally responsive. Equity in science education focuses on dismantling barriers such as systemic racism, gender inequality, and socioeconomic disparities that inhibit student participation and success. Ethics in science education involves responsible care for students, teachers, or research participants, equitable access to resources, and mitigating biases in teaching, research design, and analysis. The workshop will engage participants in four experiential and reflective equity and ethics practices that can be used to foster inclusive science teaching and research settings: 1) What's Your Name?; 2) Land Acknowledgments; 3) What's Your Why?: and 4) Teacher Inquiry. By engaging with the dual concerns of equity and ethics, participants will gain tangible ways to contribute to more just and inclusive science teaching and research in their own educational or research contexts.

Ways of Knowing Nature: Exploring Piscataway Park

23-Mar-25, 8:00 AM-11:45 AM
Location: Offsite

Pre-Conference Workshop

Julie Robinson, University of North Dakota, USA
Steph Dean, Clemson University, USA
Julie Robinson, University of North Dakota, USA

ABSTRACT

Indigenizing STEM curriculum implies place-specific, contextualized learning; thus, our workshop focuses upon place-based education as an impactful model for allowing teachers, researchers, and students to develop awareness of how to connect learning experiences meaningfully to the local biocultural community and to address local community interests, which is a tenet of culturally relevant pedagogy (Ladson-Billings, 1995). As is even stated in the Next Generation Science Standards (NGSS Lead States, 2013), "Strategies that involve the community underscore the importance of connecting the school science curriculum to the students' lives and the community in which they live. It is through these connections that students who have traditionally been disenfranchised within Westernized science recognize science as relevant to their lives and future, deepen their understanding of science concepts, develop voice and belonging in science, and consider careers in science." (NGSS Lead States, p. 9 – 10). Our session will bring participants to Piscataway Park to learn about connections between place-based education, Indigenous Science Knowledge, and embedding Indigeneity into STEM education. Session participants will have an opportunity to consider place from various perspectives and have personal experiences exploring the shores of the Potomac River. They will gain background and an opportunity for discourse and exploration around place-based, Indigenized educational and research methods that center culture, community, and epistemological pluralism as essential components.

Graduate Student Luncheon

23-Mar-25, 11:45 AM-12:45 PM
Location: Cherry Blossom Ballroom

Social Event

Presidential Welcome

23-Mar-25, 1:00 PM-1:15 PM
Location: Woodrow Wilson Ballroom

Keynote Panel: What Science Teachers Say to Researchers

23-Mar-25, 1:15 PM-2:15 PM
Location: Woodrow Wilson Ballroom

Keynote Panel

Jerome Shaw, University of California, Santa Cruz, USA
Denise Masayesva, Chasing Butterflies Consulting, USA
Hellin Pietikäinen, Hetta Primary School, Finland
Jonathan Perez, Mervyn Dymally High School, USA
Saeed Maigari,Prime Academy, Nigeria
YiWen Hung, The Affiliated Senior High School of National Taiwan Normal University, Taiwan

ABSTRACT
In keeping with the conference theme "In Praise of Science Teachers," this year's keynote brings together a unique panel of multilingual, multi-disciplinary science teachers from around the globe. With over 100 years teaching experience among them, these esteemed educators will share their perspectives on topics such as: What is their teaching context like? How has research impacted their practice? What advice do they have for STEM education researchers? Come join the conversation as we explore practitioner-based musings on ways that researchers can reframe and reform science teaching and learning to the benefit of all learners!

Bridging Practice and Research: Perspectives on Achieving Stronger Mutual Impacts

23-Mar-25, 2:45 PM-4:15 PM
Location: Annapolis 4

Symposium

Alexander Bohn, Northern Virginia Community College, USA
Karen Woodruff, Kean University, USA
Bryan Nichols, Florida Atlantic University, USA
Carrie-Anne Sherwood, Southern Connecticut State University, USA
Stephen Witzig, University of Massachusetts Dartmouth, USA
Beth Covitt, University of Montana, USA
Liam Guilfoyle, University of Oxford, UK
Mina Sedaghatjou, Rowan Univesity, USA
James Nyachwaya, North Dakota State University, USA
Rich DelVechio, Hackensack Public Schools, USA
Bridget Miller, University of South Carolina, USA
Deb Morrison, University of Washington, USA

ABSTRACT
How can research and practice in science education be more mutually symbiotic? Advancing partnership among practitioners and researchers requires a shared understanding of how - and how successfully - research findings and practitioner insights inform and shape each

other. Achieving that understanding is challenging: those impacts are made in overlapping, evolving systems of dissemination and communication and are driven by the diversity of needs and interests of folks working at all levels to improve science education. The Research Committee sponsors this administrative session to gather, share, and discuss these diverse perspectives. Discussant Ryan Summers (NSTA Research Committee, UND Associate Professor of Science Education) will moderate a discussion between panelists representing a variety of roles that might include researcher, practitioner, publisher, curator, administrator, leader, educator, coordinator, or supervisor, among others. The current state of the twin efficacies of practice-insights-informing-research and research-informing-practice-reforms will be discussed, along with directions of emergent research and ongoing communication and collaboration efforts. After Q&A, the panelists will lead small "breakout-room-style" discussions with attendees for deeper exploration of key topics and collaborative solutions. Given the rapid advances in information technology and communication, complicated by ongoing political challenges about effective science education worldwide, how can teachers, researchers, and everyone in between more effectively impact each other's work in mutually beneficial ways?

Empowering Learners: Emotional Awareness, Self-Evaluation, and Cultural Influences in Education

Strand 1: Science Learning: Development of student understanding
23-Mar-25, 2:45 PM-4:15 PM
Location: Azalea 3

Stand-Alone Paper

Teachers as Sponsors: Empowering Urban Youth for Success through Advanced Placement Enrollment.

Justina Ogodo*, Baylor University, USA

ABSTRACT

Teachers are uniquely positioned to prepare students with the skills and abilities to compete favorably on the global stage. This mixed-method study used urban underrepresented students' perspectives to examine the teachers' role as sponsors in inspiring and empowering them to succeed through advanced placement enrollment despite limiting factors. The findings from surveying about 256 participants followed by focus group interviews are crucial, indicating that students who enroll in advanced placement in the urban high-need school district were inspired by intentional teachers who a) advocated and sponsored them to belong in the AP space and b) created the learning environment for them as agentic beings to thrive and succeed in a context usually less supportive of their kind. The study offers implications for preparing teachers with humanistic characteristics beyond content expertise and pedagogical skills to inspire and empower students with agency, self-efficacy, and determination to overcome their contextual limitations.

Stand-Alone Paper

Engaging Emotions: Fostering Critical Emotional Awareness in Climate Justice Education

Michael Lawson*, Kansas State University, USA
Imogen Herrick*, University of Kansas, USA

ABSTRACT

The increasing concern over climate change necessitates an educational approach that not only imparts knowledge but also fosters critical emotional awareness (CEA). Central to CEA is the validation and verbalization of emotions, challenging pre-existing meta-emotion philosophies, understanding coping strategies, and fostering critical consciousness about emotions. This study examines how learning and emotion are intertwined as high school students complete final projects after engaging in a series of small-scale climate justice-centered conversations. The study context is a physics class in an urban community facing high environmental burdens. Data sources include open responses, final projects, and small group discussions. We coded the pre-and post-responses to identify students' coping strategies and conducted open, in vivo, and axial coding of projects and discussions to further explore the interplay between learning and emotion. Findings indicate that students transitioned from primarily emotion-focused to predominantly meaning-focused coping strategies, reflecting a growth in critical emotional consciousness. Additionally, students found expressed their learning through artistic forms accessible and meaningful, and the verbalization of emotions led to more constructive coping strategies. These insights underscore the importance of educational frameworks that recognize and validate emotions, promoting meaningful student engagement and agency in addressing environmental justice initiatives.

Stand-Alone Paper

Further Reflections on the Influence of Culture on Development of Science Process Skills

Peter Okebukola*, Lagos State University, Nigeria
Moses Emmanuel, Lagos State University, Nigeria
Joshua Akinpelu, Lagos State University, Nigeria
Abdulazeez Balogun, Lagos State University, Nigeria
Atinuke Adekoya, Lagos State University, Nigeria

ABSTRACT

Two questions were of interest in this study: (a) How do Nigerian secondary school students perform in process skills of observing, classifying and predicting? (b) What impact has religion, ethnic affiliation, rural-urban culture and socio-economic status on the development of science process skills of observing, classifying and predicting? Fifty-nine students in junior and senior secondary schools in Lagos, Nigeria aged between 12 and 17 years participated in the study. A practical task was designed to measure observation, classification and predicting. Students performed relatively well on the observation task (mean of 78.4%) and less well on the classification task (63.7%). The least performance was on the prediction task

(45.3%). Ethnicity combined with rural/urban domicile was found to play a role in observation. Religious affiliation exerted noteworthy influence on predicting. The findings of the study draw attention to the need for sensitivity to socio-cultural orientations of learners while designing interventions to bolster process skills. In the quest to reform STEM education, due notice must be paid to the role of culture in impacting how students acquire knowledge, practical skills (including process skills) and scientific attitudes.

Stand-Alone Paper

Investigating cross-age gender differences in accuracy of self-evaluation about introductory astronomy topics

Silvia Galano*, University Federico II, Italy
Italo Testa, University Federico II, Italy

ABSTRACT

Students' assessment of their own ability – so called accuracy of self-evaluation - is at the basis of important cognitive processes, such as decision making, and is positively correlated with academic achievement in science, persistence in science tasks, and motivation towards science. In this cross-sectional study, we investigated how gender differences in accuracy of self-evaluation vary across school grades, from primary to secondary school. We chose introductory astronomy as the subject area because astronomy is taught at all school levels and is often considered a ''gateway science'', as students may be inspired to choose a scientific career after being exposed to astronomy content in different contexts. A total of N=3,287 students (mean age:14.7,SD=2.4 years, girls=50.4%) participated in the study. The research instrument used was a multiple-choice test developed from previous studies. T-tests and factorial ANOVA were used to analyse the collected data. The results show that, on average, boys are more confident than girls on all questions and that the differences increase with school grade. Overall, our results suggest that astronomy education practice in secondary schools should go beyond teaching astronomy as a collection of facts and aim to better calibrate students' assessment of their performance.

Innovative Practices bridging Language, Identity, and Equity in STEM Education

Strand 2: Science Learning: Contexts, Characteristics and Interactions
23-Mar-25, 2:45 PM-4:15 PM
Location: Annapolis 1

Stand-Alone Paper

A Systematic Review of Research on Translanguaging in Science, Technology, Engineering and Mathematics Education

Kason Ka Ching Cheung*, The Education University of Hong Kong, China
Davy Ng Tsz Kit, The Education University of Hong Kong, China

ABSTRACT
Translanguaging has aroused interests of owing to its creation of equitable opportunities for multilingual learners' meaning making of science, technology, engineering and mathematics using different modal and linguistic resources. However, research on translanguaging still focuses on micro-episodes of classroom interaction and fails to bring a disciplinary view on translanguaging. Considering this, we conducted a systematic and critical review of 109 full texts that reveal current trend of research in the field of science, mathematics, engineering and mathematics education. We focused on five aspects of the studies, including (a) overall characteristics; (b)methodologies and methods; (c) types of linguistic and modal resources; (d) disciplinary learning outcomes focused on the studies; (e) position of how different STEM disciplines are integrated. Our findings showed that there is a lack of studies in the field of engineering and technology education. More importantly, there are only a few studies targeting disciplinary practices and disciplinary epistemic outcomes. Some of these studies which use the acronym "STEM" do not address how different disciplines integrate. Based on these findings, we propose future research studies that examine translanguaging in both disciplinary and interdisciplinary manner.

Stand-Alone Paper

I think I'm going to be aningeniero: Translanguaging and engineering identity development

Kathryn Bateman*, Museum of Science, Boston, USA
Gregory Kelly*, University of Massachusetts, Amherst, USA
Peter Licona, Elizabethtown College, USA
Christine Cunningham, Museum of Science, Boston, USA

ABSTRACT
Engineering provides many opportunities for Emergent Multilingual Learners (EMLs) to develop their engineering and language skills. The development of an engineering identity can support EMLs in seeing themselves as members of the learning community, but there has been little research into the resources for doing this work in out-of-school spaces. Here, we use Actor-Network Theory to trace the network of a case study EML engaging in an afterschool STEM club and the influence of the network on his engineering identity work and language development. Participant structures and the materiality of engineering scaffold the work of becoming a skilled ingeniero, sought by peers as an expert in the engineering community. Participant structures included intentional collaborative engineering and opening classroom discourse to translanguaging. The materiality of engineering included the embodiment of designing and the physical resources used to scaffold engineering and language practices. The identity work was grounded not in individual components but in the relationality and interaction of these actors in the network. We call attention to the need to consider the multiplicities of youths' identities and communities in the learning environment to ensure all students can belong in the engineering community.

Stand-Alone Paper

Supporting Emergent Bilingual Students Understanding of Energy Through Equitable Teaching Practices

ANUPAM RAJ*, University of Massachusetts Dartmouth, USA
Shakhnoza Kayumova*, University of Massachusetts Dartmouth, USA

ABSTRACT
This study investigates how equitable teaching practices support emergent bilingual students in understanding energy, a pivotal concept in science education. Energy, as a core idea and crosscutting concept, is central to scientific literacy from elementary through high school. Given its prominence in everyday life and media, it's crucial for educators to build on students' existing knowledge and leverage their diverse linguistic, non-linguistic, and cultural backgrounds. Using asset-oriented theories such as translanguaging and multimodal interaction, this research study reveals how equitable teaching practices can create inclusive learning environments to support emergent bilingual students. Data from a middle school science classroom during a summer STEAM Academy showed that teacher's incorporation and encouragement of translanguaging and multimodal learning, including drawing and non-linguistic semiotics, enhanced students' engagement, comprehension, and expression of different aspects of energy. Findings reveal that these equitable practices allow students to effectively co-create and express knowledge with their peers and teacher, utilizing their full semiotic repertoires. This study also emphasizes the value of embracing diverse linguistic and semiotic resources that emergent bilingual students bring to the classroom. Implications to improve equity and effectiveness in science classrooms, and insights for educators and researchers working in multilingual and multicultural settings are discussed.

Exploring digitization in elementary science education

Strand 3: Science Teaching — Primary School (Grades preK-6): Characteristics and Strategies
23-Mar-25, 2:45 PM-4:15 PM
Location: Camellia 1

Stand-Alone Paper

Unveiling Young Students' Computational Thinking Strategies with Multiple Representations

Kristina Tank, Iowa State University, USA
Tamara Moore*, Purdue University, USA
Anne Ottenbreit-Leftwich, Indiana University, USA
Zarina Wafula, Iowa State University, USA
Sohheon Yang, Indiana University, USA
Lin Chu, Indiana University, USA

ABSTRACT
This study investigates how early elementary students engage with computational thinking (CT) tasks. Given the increasing emphasis on integrating CT into early education, understanding how young children develop CT skills is crucial. This research employed a task-based interview design to examine 12 K-2 students' understanding of sequencing as a

foundational CT skill. The Lesh Translation Model (LTM) framed the analysis, focusing on students' use of multiple representations (concrete, pictorial, and language-based). Results indicate that students effectively utilized various representations to solve CT tasks, with language playing a pivotal role in their problem-solving processes. The study contributes to understanding how to support early CT learning by highlighting the importance of diverse representational approaches in fostering CT competencies for all students.

Stand-Alone Paper

AI Competencies for Elementary Students: A Comprehensive Literature Review and Implications for AI-integrated Science Education

Hui Yang*, SRI International, USA
Arif Rachmatullah*, SRI International, USA
Nonye Alozie, SRI International, USA
Yan-Ming Chiou, SRI International, USA

ABSTRACT

Artificial intelligence (AI) has brought new opportunities to advance pre-college STEM education. Despite numerous efforts that have shown the importance of preparing AI-literate students to succeed in their future education and careers, emerging trends have revealed the need for and promise of AI integration into subject areas including science. Such trends, however, are still under-studied and remain scarcely sparse without much empirical evidence. In this study, we conducted a systematic literature review on AI literacy and education in elementary grades to distill AI literacy components and competencies appropriate for science-AI integration at these grade levels. Subsequently, we provide an example curriculum to illustrate the integration of AI into science classrooms. Our goal is to spark conversations and discussions around effective AI integration into science education in elementary grades to prepare the next generation of AI-literate scientists to excel in scientific inquiries equipped with essential AI literacy.

Stand-Alone Paper

Validating the App-Based Science and Engineering Practices Observation Protocol (SciEPOP) for Play-based Early Learning Environments

Alison Miller*, Bowdoin College, USA
Lauren Saenz, Bowdoin College, USA
Hildah Makori*, Bowdoin College, USA
Sadie Smith, Bowdoin College, USA
Lisa Kenyon, Maine Mathematics and Science Alliance, USA
Rachel Larimore, Samara Early Learning, USA
Maranda Chung, Maine Mathematics and Science Alliance, USA

ABSTRACT

This paper describes the validation of the app-based SciEPOP, an instrument designed to identify and categorize preschool and kindergarten-aged children's play-based engagements with science and engineering practices (SEPs) that support STEM learning. Children are natural scientists and engineers, and while play has long been recognized as

critical to their development, little research has been done to document the ways that children engage in STEM learning through self-directed play. Built on more than 170 hours of video observation data and thorough literature and theoretical analysis, the SciEPOP has been designed in both paper and mobile app formats. The current study establishes that the revised and expanded app-based SciEPOP is a valid and reliable tool to describe and make claims about the integrated relationship among play, STEM, and early childhood environments.

Stand-Alone Paper

Enhancing Early Childhood Science and Engineering Practices through Professional Learning with the SciEPlay SEP Toolbox

Lisa Kenyon, Maine Mathematics and Science Alliance, USA
Rachel Larimore, Samara Early Learning, USA
Maranda Chung, Maine Mathematics and Science Alliance, USA
Hildah Makori*, Bowdoin College, USA
Alison Miller*, Bowdoin College, USA
Lauren Poniatowski, Bowdoin College, USA
Sadie Smith, Bowdoin College, USA

ABSTRACT

Play provides a powerful pathway for early science learning, yet early childhood educators often struggle to integrate science in play-based settings due to low self-efficacy and limited science content knowledge. To address these challenges, we developed the SciEPlay SEP Toolbox, a practical tool designed to support educators in recognizing and fostering children's engagement with Scientific and Engineering Practices (SEPs) during play. This study investigates how the Toolbox, embedded within professional learning, enhances educators' knowledge of SEPs, and their ability to identify and support SEPs during play. The findings reveal that the Toolbox has led to meaningful shifts in teaching approaches, including more intentional observation and strategic questioning. Educators have gained a stronger understanding of how scientific practices naturally emerge in play and have become more skilled at supporting these practices. Classroom evidence indicates that children are increasingly incorporating scientific practices into their activities, guided by the enhanced support of educators. Overall, the Toolbox has reshaped educators' perspectives, fostering a more enriched integration of science into everyday play.

Moving toward more dynamic and holistic approaches to assessing students in science education

Strand 4: Science Teaching — Middle and High School (Grades 5-12): Characteristics and Strategies
23-Mar-25, 2:45 PM-4:15 PM
Location: Baltimore 4

Stand-Alone Paper

Rethinking Assessments in Science: A Teacher's Journey to Expand Accepted Knowledge and Ways of Knowing

Lindsay Wells*, University of Wisconsin - Madison, USA
Aaron Burg, Badger High School, USA
Ryan Stowe, University of Wisconsin - Madison, USA

ABSTRACT

Various scholars have called for science education to 1) better reflect the epistemic heterogeneity required for public engagement in science(Feinstein Baram-Tsabari, 2024)and 2) expand the content and form of science knowledge that is valued to honor the sensemaking of students from nondominant communities(Bang et al., 2012). We contend that these important goals cannot be fully realized without addressing the epistemological messages in summative assessments.In this study we explore a high school chemistry teacher's evolving logic about the kinds of thinking that ought to be valued, and should therefore be the focus of his assessments. In addition, we describe tensions and challenges he grappled with as he worked to translate his epistemic goals for students into practice.

Stand-Alone Paper

Alternative Assessment in High School Chemistry Exploring Teachers' Knowledge and Perceptions

Shirly Avargil*, Technion, Israel
Karen Sokolov, Bar Ilan University, Israel

ABSTRACT

This study investigates the knowledge and perceptions of high school chemistry teachers regarding alternative assessment before and after participating in professional development (PD) programs. Assessment literacy, crucial for effective teaching, encompasses understanding and applying various assessment methods to enhance student learning. The research involved 205 chemistry teachers and employed a mixed methods approach, integrating quantitative data from questionnaires and qualitative data from interviews, observations, and reflective assignments. Findings indicate that prior to PD programs, teachers were primarily at the 'informational' stage of innovation adoption, seeking more knowledge about alternative assessment. Post-PD, teachers demonstrated a deeper understanding and appreciation of alternative assessment, recognizing its role in fostering experiential learning, student engagement, and higher-order thinking skills. Despite challenges such as time constraints and the need for creativity, teachers acknowledged the benefits of alternative assessment in promoting meaningful learning and adapting to diverse

student needs. The study contributes to the development of a conceptual model for mapping alternative assessment literacy, offering insights for teacher training and educational reform in science education.

Stand-Alone Paper

Teacher Use of 3D Assessments to Assess Student Learning and Provide Feedback

Jonathan Bowers*, Michigan State University, USA
Peng He, Washington State University, USA

ABSTRACT

In recent decades, there has been an increasing push towards constructivist pedagogies in science education. In the US, this has culminated in Three-Dimensional (3D) learning where teachers are asked to design activities and assessments that integrate disciplinary core ideas (DCIs), science and engineering practices (SEPs), and cross-cutting concepts (CCCs). Despite this push for 3D learning, studies suggest that in-service teachers need additional support with implementing 3D pedagogies and assessments in their classrooms. As such we set out to evaluate how in-service teachers approached unpacking 3D assessments and providing feedback to student responses. We conducted six semi-structured interviews with five middle school science teachers. Through our interviews we found that these teachers had an easier time identifying relevant DCIs and SEPs than CCCs from these assessments when asked explicitly about assessment goals. However, these teachers took a more holistic approach when providing feedback to student responses that showcased the synergy between all three dimensions in these assessments. As such, this study suggests that well designed 3D assessments can support teachers in providing more holistic feedback to students and support them in shifting towards more constructivist approaches to assessment and teaching.

Undergraduate Research: Challenges, Benefits, and Learning Outcomes

Strand 5: College Science Teaching and Learning (Grades 13-20)
23-Mar-25, 2:45 PM-4:15 PM
Location: Magnolia 3

Stand-Alone Paper

What are the Benefits and Challenges of Undergraduate Research? Perspectives from Undergraduate Students

Hayden Criswell*, University of Oklahoma, USA
Jacob Pleasants, University of Oklahoma, USA

ABSTRACT

Research experiences for undergraduate students have been associated with positive educational outcomes. Many questions remain regarding context and how students react to these outcomes (e.g., type of experience, length of experience). The goal of this research study is to investigate the development and trajectories of students that start their research

experience early in their undergraduate careers versus later. Students participate in an NSF-Funded STEM Program at a small public liberal arts college in the Northeastern US. Some students began participating in undergraduate research during their first semester, while others began at later times. Longitudinal data include interviews conducted with students, interviews conducted with faculty mentors, and survey information from students. We use a case study methodology to provide accounts of their experiences and changes throughout their undergraduate journeys. We examine changes in each student's trajectories in the STEM fields and identify themes present in the data based on students' experiences. We then use those themes to compare the experiences across the students in our study. Our results identify factors that develop throughout the students' journey and significantly impact their growth as scientists based on the amount of time the student was working in a research laboratory setting.

Stand-Alone Paper

Using Course-based Undergraduate Research to Expand Student Understanding of Quantum Phenomena in Biological Chemistry

Joi Walker*, East Carolina University, USA
Clark Andersen, East Carolina University, USA
Evan Brinkley, East Carolina University, USA
Adam Offenbacher, East Carolina University, USA

ABSTRACT

Course-based Undergraduate Research Experiences (CUREs) aim to integrate research into the undergraduate curriculum. CUREs are known for engaging students in research as well as producing publishable research for faculty. The potential for using CUREs as inductive learning tools has not been well documented. We have developed a cross-disciplinary CURE that exposes undergraduate students to quantum chemistry as it relates to biological systems. This CURE aims to test this question by examining tunneling efficiency in a library of plant LOXs through characterizing their reaction kinetics. The challenging nature of this research has the potential to expand knowledge and understanding of a scientific concept that is not presented in the undergraduate curriculum and can be seen as inaccessible to students. Two iterations of the CURE have demonstrated that undergraduate students can generate acceptable research on quantum tunneling. The third iteration (Fall 2024) will be used to determine the biological chemistry CURE's impact on student familiarity with quantum mechanics terminology and knowledge of everyday applications of quantum mechanics. We anticipate evidence supporting the potential to use a cross-disciplinary CURE to expand student understanding of advanced concepts such as quantum phenomena in biological chemistry.

Stand-Alone Paper

Experimental design skill may transfer to a scientific literacy skill in undergraduate introductory biology

Scott Kreher*, Dominican University, USA
Christopher Anderson, Dominican University, USA
Carissa Buber, Dominican University, USA

James Cerven, Dominican University, USA

ABSTRACT
An important development in science education has been the replacement of teaching science as a rigid, idealized, and sequential scientific method with the more flexible and accurate scientific processes and skills. Central to the process of science is the use of explanations, in the forms of theories and models, to frame and explain empirical research, often in the form of controlled experiments. Unfortunately primary, secondary and undergraduate students have gaps in their understanding of this central science process.Our theoretical framework is that there may be ways to teach experimental design in such a way to facilitate transfer of learning to scientific literacy, operationalized as evaluation of arguments through a scientific lens. In order to investigate possible transfer between experimental design skill and scientific literacy skill, we examined each using published instruments in US undergraduates in introductory biology. Upon analysis of linear models, we found that experimental design skill was associated with scientific literacy skill, but not with demographic factors or course grades. Our results suggest that students who are better at explaining experimental design have better scientific literacy, suggesting that either depth of knowledge or a theoretical framework may allow transfer of learning, consistent with transfer of learning hypotheses.

Stand-Alone Paper

Exploring socially mediated metacognition in small group discussions during undergraduate biology laboratory courses

Asghar Gill, University of Nebraska Lincoln, USA
Lyrica Lucas, University of Nebraska Lincoln, USA
Jenny Dauer, University of Nebraska Lincoln, USA
Tomas Helikar, University of Nebraska Lincoln, USA
Joseph Dauer, University of Nebraska Lincoln, USA

ABSTRACT
Peer interactions are an important part of undergraduate lab experiences that provide students opportunities to co-construct knowledge, develop scientific skills and attitudes, and understand the nature of scientific practice. Co-constructing knowledge involves developing a shared mental model from the contributions of each group member. Shared mental models can emerge from peer collaboration, especially from laboratory courses that are structured to provide opportunities for socially mediated metacognition (SMM). In this study, students in an undergraduate biology lab course worked in small groups to complete computational modeling-based lab activities about complex biological systems. Group dialogues provided evidence of students' metacognitive and transactive moves related to the development of a shared mental model. The development of a shared mental model occurred when students engaged in a lesson-oriented discussion that involved transactive moves including monitoring others' conceptual understanding and engaging in self-disclosure. Because SMM supports individual cognition when conditions for successful collaborative discussion are established, researchers and educators can develop strategies to support SMM. In the instructional design of laboratory activities, investigations and guiding

questions surpass typical task descriptions or procedural instructions as they encourage purposeful interactions that foster SMM.

Innovative Approaches in Informal Science Education

Strand 6: Science Learning in Informal Contexts
23-Mar-25, 2:45 PM-4:15 PM
Location: Magnolia 1

Stand-Alone Paper

Middle School Youths Identity Play as Investigators, Futurists, and Advocates During Critical Place-Based Learning

Heidi Carlone*, Vanderbilt University, USA
Hannah Ziegler, Vanderbilt University, USA
Tessaly Jen, Vanderbilt University, USA
Jingyi Chen, Vanderbilt University, USA
Zachary Conley, Vanderbilt University, USA
Alison Mercier, University of Wyoming, USA

ABSTRACT

Middle school youth operate in an ongoing state of self-reinvention. Though identity work as an analytic construct has provided the field valuable insights about inextricable connections of identity with power, scholarship using identity work does not generally attend to the process of exploration involved in forging new identities. This presentation unpacks the construct of identity play, defined as the exploratory process of trying out various narrations and performances of provisional selves. We were interested in identity play in horizon-expanding spaces that are not aligned with youths' prior interests and identities. Using design-based research and grounded theory, we asked: What are features of horizon-expanding spaces that promote identity play at a two-week, place-based learning camp for middle school youth? How do youth do identity play in those spaces? Data included video, youth-created artifacts, and interviews. We identified three kinds of horizon-expanding activities: 1) forging new connections to place; 2) advocacy and "using my voice"; and 3) futuring and imagining. This study should promote thoughtful discussion about relevance. Do STEM experiences need to be relevant before youth engage meaningfully? In horizon-expanding spaces, relevance can be constructed in practice as youth push through fear and discomfort to engage in activities previously deemed unthinkable.

Stand-Alone Paper

Making sense of a science-related poem by means of visual representations

Wilmo Francisco Junior*, Universidade Federal de Alagoas, Brazil
Miyuki Yamashita, Universidade Federal de Alagoas, Brazil

ABSTRACT
Considering the value of poetry to integrate creativity, imagination and emotion, this work investigated students' sense-making process by a poem reading. The study involved twenty chemistry students who attended a project of science popularization designed to meld art with science. The students' visual representations about the main topic of the poem were used as data source and analyzed qualitatively based on the Grammar of Visual Design. The students' representations demonstrated a variety of imaginative elements associated with both scientific and affective domains, albeit relating more strongly to the latter. The sense-making process was grounded in active and creative choices of multiple representations to express feelings and knowledge consciously.

Stand-Alone Paper

Science in Third Spaces: Exploring Community Motivations at Informal Brewery Events

Jill Zipperer*, Texas State University, USA
Carolyn Jess, Texas State University, USA
Carrie Bucklin, Texas State University, USA
Kristy Daniel, Texas State University, USA

ABSTRACT
Nontraditional educational settings provide unique opportunities for adults to learn about relevant science topics. Communal areas of recreation, known as third spaces, allow the public to learn about these topics from scientists in a relaxed and informal environment. The United States is seeing a rise in third spaces in the form of craft breweries, offering educators increased venues through which they can reach science outreach audiences. In this study, we gathered this data from 50 adult participants on their demographics and motivations for attending our informal science event focused on recycling and eco-friendly habits. The two-day event took place at two breweries and consisted of family-friendly crafts, games, and lessons. Using questionnaire and graffiti wall responses, we identified that women and adults of child-rearing age were more likely to attend. Additionally, we found that participants were motivated to attend based on personal interest, desire to connect with the community, and activities for children. Participants were also motivated due to their happenstance patronage at the breweries. These findings imply that future researchers can target female and parent outreach audiences by developing family-friendly events in third spaces.

Exploring AI in Teacher Education

Strand 7: Pre-service Science Teacher Education
23-Mar-25, 2:45 PM-4:15 PM
Location: Baltimore 1

Stand-Alone Paper

Pre-service Teachers' Interactions with an Artificial Intelligence Agent during Theory Testing on Diffusion

Marios Papaevripidou*, University of Cyprus, Cyprus
Yvoni Pavlou, University of Cyprus, Cyprus
Theodoros Karafyllidis, University of Cyprus, Cyprus
Zacharias Zacharia, University of Cyprus, Cyprus
Tamar Fuhrmann, Teachers College, Columbia University, USA

ABSTRACT

This exploratory study investigates the interactions between pre-service student teachers and an AI agent, ChatGPT, as they engage in theory testing about the diffusion of ink in water. The study aims to identify the types of questions participants pose, the key concepts they demonstrate while validating their diffusion theory, and the difficulties or misconceptions revealed through interacting with AI. Twenty-two participants engaged in a modeling-based curriculum designed to enhance their understanding of diffusion, culminating in a session where they interacted with ChatGPT to test their refined theories. The analysis uncovered six distinct inquiry patterns, with clarification and mechanistic questions being the most common. Key conceptual themes included fundamentals of diffusion, molecular dynamics, and the impact of experimental conditions. However, persistent misconceptions, particularly regarding molecular size and the nature of scientific models, were also identified. The findings suggest that while AI can provide valuable, personalized support and immediate feedback during theory testing, it must be integrated with structured, teacher-led discussions to address deeper epistemic challenges. This study contributes to the growing body of research on the role of AI in science education, emphasizing the need for a balanced approach that combines AI-driven tools with traditional instructional methods to optimize learning outcomes.

Stand-Alone Paper

AI Readiness and Preservice Secondary Science Teachers

Adam Bennion*, Brigham Young University, USA

ABSTRACT

The integration of AI technologies into science education is rapidly transforming teaching methodologies and student engagement. This study investigates the development of AI readiness among preservice secondary physical science teachers, focusing on the essential skills and beliefs required to effectively incorporate AI into science teaching. Drawing on a cohort of five preservice teachers, this research explores how these future educators engage with AI tools and translate their experiences into practical lesson plans.Utilizing a qualitative approach, data were collected through end-of-course surveys, assignments, and lesson plans. The study highlights the dual role of AI in education, serving both as a teaching aid and a student learning tool. Key activities included building teacher assistant chatbots, creating science-themed plays, and generating data for fictitious science principles. Findings reveal that preservice teachers developed confidence and skills in AI through iterative prompt engineering and critical evaluation of AI-generated content.This research underscores the importance of preparing preservice teachers for AI integration, emphasizing the need for comprehensive training that encompasses both technological proficiency and pedagogical

application. The study provides insights into the pathways for developing AI readiness, ultimately aiming to enhance science education through innovative AI-driven approaches.

Stand-Alone Paper

Investigating Factors Contributing to Pre-service Teachers' Acceptance of Artificial Intelligence in Education

Shuchen Guo, Nanjing Normal University, China
Xiaoming Zhai, University of Georgia, USA

ABSTRACT

With increasing integration of AI in education, it is vital to understand teachers' acceptance of AI (TAAI) and what factors contribute to their willingness to use AI in teaching. This study aimed to discover (1) the difference of pre-service teachers' TAAI by gender, age and major, (2) factors contributing to pre-service teachers' TAAI and (3) individual differences within determinants that affect those behavioral intentions. We surveyed 274 pre-service teachers and conducted descriptive analysis, t-test, and multigroup structural equational modeling (SEM) analysis. Results showed that male pre-service teachers have significantly higher perceived ease of use (PEU) and self-efficacy (SE) than female, while the latter have significantly higher anxiety (AN). Graduate students have higher Behavior intention (BI) of using AI than undergraduates, but no significant difference was found between STEM and Non-STEM students. We found that SE positively influences perceived usefulness (PU), which significantly contributes to BI. Age has a moderating effect on the path of PU to BI, in favor of younger (undergraduate) students. In contrast, PEU only significantly influences graduate students' BI. We did not find moderating effects of gender and major on the research model.

Stand-Alone Paper

Coding to Learn Science, Science to Learn Coding: Intersections Between Computational, Modeling and Data Practices

Cassia Fernandez, University of São Paulo, Brazil
Tamar Fuhrmann*, Teachers College, Columbia University, USA

ABSTRACT

This paper illustrates two case studies of computational models and data visualizations of block-based programming learning environments that aim to seamlessly integrate computational thinking into science classrooms. In both cases, the aim was to teach science, not coding. In both examples, students learn science and use computational thinking as a tool to explain scientific phenomena. We analyzed how students used the environment to learn science and developed a framework showing how science practices lead to computational thinking practices. In the paper, we show the intersection of those practices and how they mutually support each other in the learning process.

Advancing Teacher Professional Development: Scaling, Communities, and Impact

Strand 8: In-service Science Teacher Education
23-Mar-25, 2:45 PM-4:15 PM
Location: Annapolis 3

Stand-Alone Paper

Supporting STEMM Professional Development through Explicit Community of Practice Opportunities

Matthew Blank*, Baylor College of Medicine, USA
Alana Newell, Baylor College of Medicine, USA
Nancy Moreno, Baylor College of Medicine, USA

ABSTRACT

As science advances, there is a need to support the development of K-12 learners' health literacy and skills needed to recognize and navigate difficult scenarios as they emerge. However, health topics are not included in state and national science standards, leading to few curricular resources for educators interested in incorporating these topics into their existing curriculum. To meet this need, we have developed a three-day professional development institute for master teachers seeking to incorporate STEMM (health science and biomedical) topics into their existing curriculum. The program is not only intended to increase teaching skills, but also to develop a community of practice (CoP) dedicated to the core purpose of supporting K-12 learners into STEMM career pathways. Our framework includes 1) three-dimensional STEMM curriculum planning using associated planning tools, 2) professional development for teachers, and 3) support for CoP. We investigate the value of these components using pre- and retrospective pre/post-program surveys containing Likert-type items designed to measure participants' perceived changes in skills and abilities. There were significant gains in STEMM content knowledge and CoP for participants, highlighting the effectiveness of the institute. These results provide evidence for an applicable approach to support learners' career pathway in the STEMM workforce.

Stand-Alone Paper

Effects of a Professional Development Program related to Scientific Reasoning on Teachers, Instruction and Students

Richard Sannert*, IPN - Leibniz Institute for Science and Mathematics Education, Germany
Verena Petermann, Justus Liebig University, Germany
Janet Carlson, Stanford University, USA
Jan van Driel, The University of Melbourne, Australia
Moritz Krell, IPN - Leibniz Institute for Science and Mathematics Education, Germany

ABSTRACT

This study investigates the effects of an in-service teacher professional development program on promoting scientific reasoning competencies on teachers' knowledge and beliefs, their instruction, and student performance. A total of 47 science teachers took part in the professional development program. The sample for this study (pre- and post-design)

consists of a part of the participating teachers and 1,034 students (experimental and comparison group). The effect on teachers' knowledge (i.e., pedagogical content knowledge and content knowledge) and beliefs (i.e., self-efficacy beliefs) as well as on student performance was assessed using various test instruments. The effect on instruction was assessed via direct observations. The findings show that teachers' pedagogical content knowledge developed as a result of participating in the professional development program, while content knowledge and self-efficacy beliefs remained constant. After the professional development program, teachers' instruction was more in line with the criteria for effective teaching of scientific reasoning competencies. However, the data on student performance showed that neither the experimental group nor the comparison group exhibited higher performance directly after the professional development program. This way, the study provides evidence of the effects that professional learning can have and implications for practice and further research can be derived.

Stand-Alone Paper

Exploring Barriers to Scaling an Effective Teacher Professional Learning Program

Chris Wilson*, BSCS Science Learning, USA
Taylor Joseph, American Institutes for Research, USA
Amy Belcastro, BSCS Science Learning, USA
Jody Bintz, BSCS Science Learning, USA
Jenine Cotton-Proby, BSCS Science Learning, USA
Cindy Gay, BSCS Science Learning, USA
Janna Mahfoud, BSCS Science Learning, USA
Guy Ollison, BSCS Science Learning, USA
Molly Stuhlsatz, BSCS Science, USA
Bo Zhu, American Institutes for Research, USA

ABSTRACT

This study examines the scalability and impact of the [PROGRAM NAME] program, which aims to enhance science teaching aligned with the Next Generation Science Standards. Through a one-year cycle of professional learning communities, [PROGRAM NAME] focuses on student thinking and instructional coherence. The study involved fourth and fifth grade teachers across multiple cohorts in Tennessee and Kentucky, using a randomized trial design. Key findings indicate that [PROGRAM NAME] significantly improves teacher content knowledge, though its impact on student achievement was positive but not statistically significant. The study highlights the potential for scaling [PROGRAM NAME] with local leaders and hybrid delivery models, despite reduced effect sizes compared to expert-led implementations, suggesting a trade-off between cost and effectiveness at scale.

Stand-Alone Paper

Resource Networks Development and Their Impact on Implementing Digital Innovation in Physics Classrooms

Jaika Hott*, IPN, Germany
Stefan Sorge, IPN, Germany
Knut Neumann, IPN, Germany

ABSTRACT
The implementation of digital innovations enables teachers to create new teaching and learning arrangements. To implement these arrangements effectively in the classroom, teachers access resources. Prior research has indicated that individual resources are insufficient and that interactions between resources as resource networks are crucial for effective implementation. But, it remains unclear which resource networks are most effective in promoting the use of digital innovations in the classroom, and how these networks develop and influence the implementation process.To investigate teachers' resource networks development, seven secondary physics teachers implemented an innovative digitally-supported teaching unit centered around energy. Interviews were conducted to gather insights into the resource networks that physics teachers access during the implementation. Based on an inductive-deductive coding, it is identified that the strategic access of social and material resources supports teachers' pedagogical content knowledge. The access to social resources also holds symbolic value for teachers by providing confidence during the implementation. Additionally, resource networks developed during the implementation process, leading to more individualized lesson planning and adaptation of the digital innovation.The contribution provides a perspective on how to design more targeted professional development for teachers to promote an appropriate and sustainable implementation of digital innovations in the classroom.

Reflective Practices in Science Education: Discourse, Feedback, and Professional Development

Strand 8: In-service Science Teacher Education
23-Mar-25, 2:45 PM-4:15 PM
Location: Annapolis 2

Stand-Alone Paper

Negotiating Physics Teachers' Interpretations of Inequitable Patterns in Classroom Data During Coaching Sessions

Linsey Brennan*, Michigan State University, USA
Sunghwan Byun, North Carolina State University, USA
Julie Christensen, Michigan State University, USA
Nickolaus Ortiz, Georgia State University, USA
Niral Shah, University of Washington, USA
Daniel Reinholz, San Diego State University, USA
David Stroupe, University of Utah, USA
Marcos Caballero, Michigan State University, USA

ABSTRACT
Data use has become a professional expectation for teachers throughout school in the U.S.; however, when not appropriately supported, data-centric improvement efforts can diminish the quality of science teaching and reify existing deficit beliefs about students. Coaching is

one support that has been praised for its effectiveness in shifting teachers' practice, increasing students' learning, and supporting teachers in using data in meaningful ways. Despite this, work examining how coaches negotiate teachers' interpretations of classroom data is limited. Thus, this study analyzed discourse during coaching sessions to identify how physics teachers and coaches negotiate their interpretations of inequities in classroom data, using conversation analysis and discursive psychology to examine attribution of responsibility and attribution of knowledge. Findings indicate that 1) different types of interpretations add more or less responsibility to the physics teacher for responding to the inequitable patterns of participation, and 2) in the negotiation process, coaches and physics teachers balance the ways they attribute knowledge to themself and one another. As science teachers' data use continues to be a professional expectation, these findings offer possibilities for supporting science teachers in attributing responsibility to themselves and moving towards greater equity in their practice.

Stand-Alone Paper

Reflective or Directive? Analyzing High School Science Mentors Written Feedback Comments on Mentees Recorded Lessons

Lynn Huff*, North Carolina State University, USA
Soonhye Park, North Carolina State University, USA
Grace Carroll, North Carolina State University, USA
Laura Chalfant, North Carolina State University, USA
William Reynolds, North Carolina State University, USA
Scott Ragan, North Carolina State University, USA
Jason Painter, North Carolina State University, USA

ABSTRACT

This qualitative case study explores the nature and characteristics of written feedback provided by mentors to their mentees in high school science education, focusing on how this feedback supports instructional improvement and professional growth. Given the demanding schedules of both mentors and mentees, written feedback serves as a crucial tool for guidance in the absence of frequent face-to-face interaction. The study analyzes 436 written comments from eight mentors, utilizing both a priori coding based on Hattie and Timperley's (2007) model of feedback and an inductive thematic analysis to identify key themes and levels of feedback. Findings suggest that mentors' feedback is multifaceted, primarily focusing on actionable, task-related advice while also incorporating reflective elements aimed at deeper pedagogical understanding. These insights highlight the importance of understanding the nuances in mentor-mentee communication and suggest that effective mentoring requires a balanced approach that addresses both immediate classroom needs and the long-term professional development of teachers. The implications of these findings for mentor training and future research in teacher education are discussed.

Stand-Alone Paper

Facilitation strategies responding to emotional displays in PD discourse: Navigating social and learning goals

Dana Vedder Weiss*, Ben Gurion University of the Negev, Israel

Rotem Trachtenberg Maslaton, Ben Gurion University of the Negev, Israel
karin Tsarfati Shaulov, Ben Gurion University of the Negev, Israel

ABSTRACT
Collaborative learning in professional teacher communities is expected to advance both social and learning goals. While scholars have increasingly highlighted the central role of emotions in teacher learning, scarce research has examined how facilitators of teacher learning manage emotional displays and navigate between social and learning goals. In this study, we explored how professional development (PD) facilitators respond to science teacher emotional displays in a problem-based PD community. Applying a sociocultural perspective of teacher learning and emotions, we analyzed discourse data recorded in a 60-hour science teacher year-long PD program. We identified seven facilitation strategies in response to emotion display: Ignoring the emotion, Quick transition from emotion to practice, Acknowledging the emotion to prevent further discussing it, Mitigating and normalizing the emotion, Exploring the role of emotions in the problem, Normalizing and problematizing, and Exploring alternative responses to the emotion. We mapped these strategies onto a coordinate system of social goals (acknowledging the emotion) and learning goals (exploring the emotion). The findings offer a framework of strategies facilitators of collaborative problem-based PD can choose from in response to emotions teachers display, including strategies that settle the tension between social and learning goals.

Centering Equity in Science Curriculum and Pedagogy

Strand 10: Curriculum and Assessment
23-Mar-25, 2:45 PM-4:15 PM
Location: Magnolia 2

Stand-Alone Paper

Historically Relevant Science Pedagogy: Beyond Representation Moving Towards Critical Consciousness

Alexis Riley*, New York University - Steinhardt, USA

ABSTRACT
This paper introduces a theoretical contribution, Historically Relevant Science Pedagogy, to the science teaching and learning community and education field broadly. Historically Relevant Science Pedagogy is a by-product of (1) these Sista Circles, (2) a continuation of social justice oriented teaching in science teaching and learning and (3) the amalgamation of three previously established pedagogical frameworks: Culturally Relevant Pedagogy (Ladson-Billings, 1994), Liberatory Pedagogy (hooks, 1994), and Culturally and Historically Responsive Education (Muhammad, 2020; 2023). This framework is positioned within the history of science teaching and learning as a way to demonstrate the need for future approaches of teaching that center critical consciousness. Historically Relevant Science Pedagogy is a K-12 pedagogical approach that displays how Black women science teachers discuss their anti-

racist teaching and showcases several phenomena that center anti-oppression and liberation through science phenomena and history. Readers will find concrete examples of ideologies, actions, and phenomena that can be explored based on the development of the framework. The paper ends with implications for the field and an invitation for future works.

Stand-Alone Paper

Teachers' customization of curriculum: Professional learning to center equity in the customization process

Katherine McNeill*, Boston College, USA
Austin Moore, Boston College, USA
Maria Moreno Vera, Boston College, USA
Samuel Lee, California State University, Long Beach, USA
Renee Affolter, OpenSciEd, USA

ABSTRACT

Teachers need to customize curriculum for their particular localized classroom setting to be responsive to students' emergent ideas, interests and participation. Curriculum-based professional learning (CBPL) can potentially support teachers in this work. In this study, we worked with ninety middle school science teachers over the course of one school year as they customized and enacted the OpenSciEd curriculum. To investigate the influence of CBPL focused on customization, we conducted a randomized experimental study. Approximately half the teachers were in the customization treatment group and half the teachers were in the control group. All teachers participated in CBPL including four days in person and four hours virtually. We collected multiple data sources including surveys, curricular customizations and teacher reflections. Across the two groups, the types of customizations were similar; however, there were differences in the goals. The teachers in the customization group were more likely to design curricular changes with a specific focus on equitable participation or engagement for their students. For the control teachers, their customizations were more likely to focus on simplifying or clarifying a task, which may potentially shift the sensemaking responsibility away from the students.

Stand-Alone Paper

In-Service Science Teachers' Perceptions and Enactment of Equity from Employing Digitally-Delivered Educative Curriculum Materials

Rebecca Hite*, Texas Tech University, USA

ABSTRACT

Comprehensive digitally-delivered STEM educative curriculum materials provide teachers with resources and activities, aligned to state and/or national standards, to improve student experiences and achievement in K-12 science. Despite a national call for enhanced equity in STEM education with teachers leading that charge, it is unknown to what extent science teachers who employ educative curriculum materials utilize them for enhancing equity and/or disrupting the inequities that exist with science itself and in school science. The present study reports on the finding of a brief questionnaire completed by 175 K-12 science teachers who utilize an educative curriculum material program in their classroom. Analyses

indicated that teachers largely agreed (n=124, 71%) that such a product supported their efforts in teaching for equity, yet were undecided (n=78, 62%) on the use of these products to dismantle aspects of inequity in science and science education. Fifty-seven codes were yielded using a framework of enhancing equity and disrupting inequity factors cobbled together from various science education scholars. Enhanced equity strategies (n=35) reported were to inspire students' science interests, foster peer relationships, and promote student voice. Fewer codes (n=12) related to tackling inequity by empowering students, recognizing privilege, and supporting students in respecting peers' ideas.

Advocating for Gender Equity in Science Higher Education

Strand 11: Cultural, Social, and Gender Issues
23-Mar-25, 2:45 PM-4:15 PM
Location: Azalea 1

Stand-Alone Paper

Empowering Women in Physics: Exploring How Leadership, Mentorship, and Career Conceptualization Shape Undergraduates' Physics Identity

Laura Akesson*, George Mason University, USA
Jessica Rosenberg*, George Mason University, USA
Nancy Holincheck*, George Mason University, USA
Benjamin Dreyfus, George Mason University, USA
Rocio Quiroga-Velasquez, George Mason University, USA
Julia Lipman*, George Mason University, USA

ABSTRACT

This qualitative interview study explores how undergraduate women developed their physics identities, with a particular focus on their experiences with leadership, mentorship, and learning about careers in physics. Our team analyzed 15 interviews to understand how women in physics define physics identity and how our theorized factors (leadership, mentorship, and career conceptualization) were associated with an individual's physics identity. Understanding identity development for women in physics is important for their persistence in a field that still struggles with underrepresentation of women. Our findings have implications far beyond undergraduate education. K-12 educators and informal science educators may be positioned to provide STEM leadership and mentorship opportunities to minoritized students, which can help to build students' identities before they go on to college.

Stand-Alone Paper

Care, relationality and conflict in a geoscience department

Sarah El Halwany*, Université de l'Ontario français, Canada
Maryam Taheri, University of Calgary, Canada
Jennifer Adams, University of Calgary, Canada

ABSTRACT
This paper explores the experiences of a geoscience student, 'Jessica' and her professor/supervisor, 'Ruth' with sexual harassment and discrimination at a postsecondary institution. By focusing on their entangled stories, we seek to highlight the complex relationship between conflict, relationality and care and to illustrate how care intervenes in troubled worlds to makevisible/possible different ways of knowing, being and participating in those science fields.We turn to care as a practice and a committed involvement in troubled worlds, rather than a mere moral disposition between care giver and care receiver. Analytically, we work (with) notions of relationality by juxtaposing data fragments from Ruth and Jessica's experiences and by making visible our (affective) involvement in their stories. Through this work, we seek to look at tensions and possibilities of becoming accountable to our research participants through methodological and theoretical engagement.

Stand-Alone Paper

"I'm gay and Latino, but I'm still a man": Experiences of non-tenure track science faculty

Katherine Doerr*, Malmö University, Sweden

ABSTRACT
This paper examines an emerging and fast-growing category of science teachers: non-tenure track, teaching-intensive, full-time chemistry faculty.Although women remain underrepresented as STEM faculty overall, they are overrepresented in teaching-intensive positions. This disproportionality invokes a concern for equity. Guided by theories of intersectionality to purposely recruit interviewees, this qualitative study asked: what is the experience of non-tenure track faculty in science? How do their experiences vary across type of institution and race/ethnicity, as well as across gender identity? Findings were based upon grounded theory analysis of 19 interviews with14women and 5 men working in chemistry departments at universities around the United States. Gendered chutes and ladders are evident across the respondents; men were elevated while their female peers were marginalized. Moreover, aswhiteness confers belonging in STEM, white men describe themselves as 'just dads' or 'natural teachers', whereas women's childcare duties or preference for teaching are something that needs to be overcome. In particular, for women of color and women who immigrated to the United States, discrimination and harassment contribute to pernicious gender inequity in this occupation.

Stand-Alone Paper

A Critical Examination of How Physics Professors Describe Women in Physics Using Feminist Standpoint Theory

Christy Metzger*, University of Delaware, USA

ABSTRACT
This study explores how physics professors describe women in physics and what they suggest would help more women become physics majors. Feminist Standpoint Theory is used as a critical approach to explore how power is gendered within physics departments and how that may be contributing to a gender gap in physics. The data was collected

utilizing a qualitative methodology of semi-structured interviews with 18 professors from 10 different universities and colleges. Findings show three major themes: (1) some professors adopt a gender-blind philosophy; (2) some professors see their role as changing the culture while others see their role as equipping women for the culture; and (3) women in physics feel less competent than their male classmates and report feeling like they do not belong. Implications are discussed for how these findings contribute to physics departments that privilege men.

Stand-Alone Paper

Enhancing Professional Vision in Gender-Sensitive Physics Education: Predictors and Implications for Teacher Training

Sanja Atanasova*, University of Teacher Education St.Gallen, Switzerland
Nicolas Robin, University of Teacher Education St.Gallen, Switzerland
Dorothee Brovelli, University of Teacher Education Lucerne, Switzerland

ABSTRACT

Professional vision, which encompasses perception, interpretation, and decision-making, is essential for recognizing and addressing gender disparities in the classroom. This study investigates the predictors of pre-service teachers' professional vision in gender-sensitive physics education, focusing on the roles of interest, learning opportunities, and teaching experience. The study involved 586 pre-service teachers from Swiss universities. Results from structural equation modeling (SEM) revealed that interest was the strongest predictor of professional vision, followed by teaching experience and learning opportunities. Additionally, female pre-service teachers demonstrated higher levels of professional vision and greater interest in gender-sensitive teaching. These findings underscore the importance of aligning teacher training with pre-service teachers' interests, ensuring comprehensive coverage of gender-sensitive teaching in curricula, and enhancing practical teaching experiences through internships. The study highlights the critical role of teacher education in equipping future educators to promote gender equity in physics education, ultimately contributing to a more inclusive and effective learning environment.

Exploring Critical Epistemologies in Science Education

Strand 11: Cultural, Social, and Gender Issues
23-Mar-25, 2:45 PM-4:15 PM
Location: Azalea 2

Stand-Alone Paper

Bioethics as a Racial Project: Positionality and Ethics in Science

Matthew Weinstein*, University of Washington-Tacoma, USA

ABSTRACT

This paper uses discourse analysis and personal experience to examine the ways that bioethics operates as a racial project. Racial projects are collective efforts whose effect is to

expand, modify, create, and destroy racial categories. The paper examines two manifestations of bioethics: Institutional Review Board processes (IRB) and socioscientific issues in the OpenSci biology curriculum. The analytic approach used draws on a collection of feminist, anti-racist, and Marxist sociological and anthropological theories which look at how media (e.g., texts) position (idealize) their readers. These include hybridizing ideological analysis grounded in Louise Althusser analysis of "the hail", feminist work grounded in film theory (e.g., Laura Mulvey's theory of the gaze), STS work on categories (e.g., the work of Tom Gieryn as well as Susan Leigh Star). The paper looks at both how race is explicitly addressed in these texts, and how it is erased through new categories such as "vulnerable population" and the null curriculum (McCutcheon). The paper explores what that positioning looks like. Its conclusion reflects on how the resistance of the non-idealized reader results in disengagement with science.

Stand-Alone Paper

Responding to CRT and DEI Prohibitions with QuantCrit and "Post" Methods

Christopher Irwin*, Florida International University, USA

ABSTRACT

QuantCrit research challenges the White logic embedded in established research norms. However, translating critical quantitative research into science education practices is not as straightforward as a parallel challenge to established teaching norms. Many teaching norms that embody White logic are also effective means of addressing curriculum and time constraints on educators. Educators who perceive the effects of White logic in their practices may feel they lack the theoretical background necessary to re-orient their practices. Recent state prohibitions on Critical Race Theory (CRT) and Diversity, Equity, and Inclusion (DEI) initiatives further complicate the implementation of justice-oriented practices.In this paper, I argue that engagement with poststructuralist and posthuman perspectives offers researchers and teachers a pathway to enact tenets of CRT and QuantCrit without adopting the discursive markers targeted by CRT and DEI prohibitions. This paper explores parallel applications of Principal Components Analysis to a large dataset in which the normative use of PCA seems to foreclose the possibility of deriving justice-oriented science education practices. Re-evaluating the use of principal components through QuantCrit and postquant lenses yields tangible recommendations for practice that center the lives, experiences, and values of minoritized students and thus resist the systems that oppress them.

Stand-Alone Paper

Science Teacher Leaders' Grappling with the Role of Race in Science Content Knowledge Production

Althea Roy*, Clemson University, USA
Kristen Duncan, Clemson University, USA
Brooke Whitworth, Clemson University, USA
Julianne Wenner, Clemson University, USA

ABSTRACT
This study examines teacher understandings of the role of racism in the construction of science knowledge. Sheth's (2019) conceptual framework of "grappling with racism" was used to assess 28 teachers' understanding of the role race plays in science and how they grapple with that knowledge. The results from three detailed knowledge quizzes were used to predict teacher understandings of historical context, which impacts science knowledge construction. The relationship between the detailed knowledge quizzes and the Dispositions for Culturally Responsive Pedagogy Scale (DCRPS) (Whitaker Valtierra, 2018) was used to correlate teacher's historical knowledge and disposition toward social justice. Teacher responses to open-ended prompts explored how teachers' knowledge fits with their understanding of science knowledge production and how this knowledge impacts their future teaching practices when "grappling with racism." Preliminary analysis indicates a significant relationship between teachers' historical knowledge and their DCRPS scores, suggesting that awareness of historical contexts of science knowledge construction may be effective in supporting teachers in developing culturally responsive practices. Teachers indicated a desire to grapple with racism, but most did not know how to do so. This helps us better understand the kind of professional development that science teachers need to incorporate race in their teaching.

Stand-Alone Paper

Decolonizing Science Education Research and Practice: Introducing the Islamic Philosophical Perspective of Wasatiyyah

Zahra Hazari*, Florida International University, USA
Amal Ibourk, Florida State University, USA
Hulya Avci, Florida International University, USA
Shakhnoza Kayumova, University of Massachusetts Dartmouth, USA

ABSTRACT
This theoretical paper draws on decolonizing theory to present an Islamic philosophical perspective, Wasatiyyah, that can enhance and broaden the science education scholarship by leveraging a non-Western theory focused on justice. Wasatiyyah not only presents a framing for social justice work in science education that can help address critical issues in the classroom and at broader systemic levels, but also serves as a response to calls for the inclusion of non-Western epistemologies in science education. In addition, it counters dehumanizing and orientalist Western framings of Muslims/Arabs as uncivilized and extremist. Wasatiyyah is a philosophy of balance and moderation that centers on justice taking a middle position away from extremities such as seeking dominance/power or releasing all responsibility/commitment. It is a transitive concept that is applied to situations in order to assess deviations from the core of justice and enact processes that move toward the core. In this paper, we describe the motivation for this work (particularly utilizing a decolonial framing), present the theory and some of its defining features, and draw specific connections to science education research and practice.

AI and Future STEM Education

Strand 12: Technology for Teaching, Learning, and Research
23-Mar-25, 2:45 PM-4:15 PM
Location: Baltimore 5

Stand-Alone Paper

Bridging the Gap: Perceived vs. Actual Ethical Awareness in AI among Future Engineers and Scientists

Maya Usher, Technion - Israel Institute of Technology, Israel
Miri Barak*, Technion - Israel Institute of Technology, Israel

ABSTRACT

Recent developments in artificial intelligence (AI) have reignited debates regarding the ethical issues associated with AI technologies. A key concern is how to prepare undergraduate science and engineering students for their future roles as AI developers and practitioners. To address this, the current study examined the perceived and actual ethical awareness of science and engineering undergraduates engaged in reflective-collaborative case-based learning about AI ethics. Using a mixed-methods approach, data from 153 students were collected through pre- and post-intervention questionnaires. The questionnaires included a closed-ended Likert-type scale to assess students' perceived awareness, while actual awareness was evaluated through open-ended questions that focused on their ability to identify ethical dilemmas and propose potential solutions.Results indicate that before participating in the reflective-collaborative case-based learning, students displayed a medium level of perceived awareness of AI ethics, while their actual awareness was comparatively low. Both perceived and actual awareness increased after participation, narrowing the gap between the two. The most noted ethical issue was risks to subjects, including privacy loss, physical and psychological risks, legal issues, and job loss. Additional ethical issues included security breaches, involving data confidentiality violations, and manipulation, referring to the unethical use of transferred user data.

Stand-Alone Paper

How Should We Utilize AI for Science Learning? A Discussion Based on Systematic Review

Xinyu He*, University of Georgia, USA
Emily Adah Miller, University of Georgia, USA
Tingting Li, Washington State University, USA

ABSTRACT

Integrating AI into science classrooms is expected to facilitate a better future. However, researchers understand what is meant by "better future" in different ways. Reviewing how researchers have developed and applied AI for science learning environments can help us understand what approaches to science learning they are supporting and reflect on what future science learning the research can contribute to. This study discussed the development and application of AI in the K-12 science learning context. It systematically reviewed 46 articles. The review focused on the research motivations, the theoretical or conceptual

frameworks, and how AI was used and assessed. Preliminary results showed that studies had three types of motivations and employed six types of evaluation to examine AI's performance in facilitating science learning. Based on the results, we discussed insights for future AI-related research for science learning. This study will inform NARST members interested in the development and application of AI in K-12 science learning regarding how to justify AI's effectiveness. It will also contribute to discussions on how AI should or should not be used in science education.

Stand-Alone Paper

Using Large Language Models to Analyze Students' Hands-on Responses and Support Teachers' Timely Instructional Decisions

Peng He*, Washington State University, USA

ABSTRACT

This study aims to support science teachers' instruction decisions by leveraging large language models (e.g., GPT models) to analyze students' drawn responses to classroom assessment tasks and support teachers' timely instructional decisions. Students' hands-on responses to our assessment tasks were analyzed based on analytic and holistic perspectives on three-dimensional learning performance. We conducted a trial experiment by creating a workflow using the GPT approach to analyze students' drawn responses to three assessment tasks. The preliminary results show that the GPT models could identify the separate three dimensions across the patterns of analyzing the three tasks. However, it is challenging for GPT models to identify advanced levels of student learning performance. GPT models could follow our prompts to refine the criteria with more detailed information that added essential examples of students' responses at each level. This study would significantly contribute to the field's understanding of applying large language models to identify students' drawn responses on constructed assessments.

Stand-Alone Paper

Comparative Analysis of AI Chatbots' Impact on Scientific Inquiry and Misconceptions in Biochemistry

Rıdvan Elmas*, Afyon Kocatepe University, Turkey
Merve ADIGUZEL-ULUTAS, Gazi University, Turkey
Mehmet YILMAZ, Gazi University, Turkey

ABSTRACT

This study aims to analyze the scientific accuracy of the answers provided by different AI chatbots to biochemistry questions and determine which can produce more accurate answers on biochemistry (biochemical molecules). In this case study, fundamental discipline-related books were used to select five biochemistry questions and questions that commonly contained misconceptions in their explanations were intentionally chosen. Three of the most common chatbots were selected. Five biochemistry questions, structured at a three-tiered level, were posed to each chatbot. The responses obtained from the three chatbots were examined through document analysis. The accuracy of the responses was evaluated using a rubric specifically designed for scientific rigor. Misconceptions were identified depending on

the previously determined misconceptions in the literature and scientific accuracy. It is crucial to determine which of these chatbots, likely utilizing different language models and trained on various databases, produces more scientifically accurate data in biochemistry. The answers provided by these chatbots contain misconceptions, contributing to their spread. It has been found that there is a slight difference between the accuracy rate of chatbots Copilot and Gemini. ChatGPT-4o creates more accurate answers.

Nature of Science and Argumentation

Strand 13: History, Philosophy, Sociology, and Nature of Science
23-Mar-25, 2:45 PM-4:15 PM
Location: Baltimore 2

Stand-Alone Paper

Consistency of Nature of Science Conceptions and Argumentation Skills

Rola Khishfe*, American University of Beirut, Lebanon

ABSTRACT

The purpose of this study was to investigate the consistency of nature of science (NOS) conceptions and argumentation skills among undergraduate student teachers across different socioscientific issues (SSI) contexts. The participants included 80 undergraduate student teachers enrolled in a science methods course at six different universities in Lebanon. The study used a quantitative and qualitative design to compare the responses of students related to NOS and argumentation across different SSI contexts. Two data collection tools were used: questionnaires and interviews. The first questionnaire was a topic knowledge one and the second questionnaire included three scenarios that addressed SSI contexts about water fluoridation, global warming, and genetically modified food. Two sets of questions followed each scenario. The first set concentrated on the components of argumentation (arguments, counterarguments, and rebuttals), while the other set focused on three emphasized NOS aspects (subjective, tentative, and empirical). Results showed that there were differences in the levels of student teachers' sophistication regarding the argumentation components and NOS aspects across the different contexts. Recommendations for future research and implications for the teaching of NOS and arguments are discussed.

Stand-Alone Paper

Designing Discussion Questions for Nature of Science Read-Alouds

Jeanne Brunner*, University of Massachusetts Amherst, USA

ABSTRACT

Read-alouds that include explicit nature of science (NOS) discussion questions can be effective ways to teach NOS in the elementary grades. However, teachers need support in selecting books for use in the read-alouds and in designing appropriate questions. This study explores how participants used the Humanizing Science Read-Aloud Selection Guide to (a)

select appropriate trade books, (b) analyze which aspects of NOS best align with each trade book, and (c) design discussion questions to target those aspects. Findings indicate that the Selection Guide was successful at helping teachers select and analyze trade books. Participants were also able to design discussion questions that addressed NOS. However, these questions did not align with the most relevant aspects identified in the analysis of the trade book. Additional research is needed to determine why this disconnect occurred. Nevertheless, the Selection Guide is an easy-to-use tool for teachers to incorporate NOS discussion into their classrooms that does not require substantial researcher involvement to use. This study highlights the opportunity to scale up research on teaching NOS at the elementary level, as well as expand this area of study into other grade levels.

Stand-Alone Paper

Argument Driven Inquiry in Practice: Patterns and Variations in Teachers' Knowledge

Brendan Callahan*, Kennesaw State University, USA
Michael Dias, Kennesaw State University, USA

ABSTRACT

During the 2021-2023 academic years, a large suburban school district in the southeastern portion of the United States implemented Argument Driven Inquiry (ADI) across secondary science classes. While student learning of disciplinary content has traditionally been the primary goal of education, this work operates under the assumption that ADI allows science teachers to meet content objectives while developing process understandings essential for developing proficient young scientists. To investigate the practical knowledge needed for successful ADI implementation, researchers conducted a phenomenographic analysis of semi-structured interviews with a sample of 19 teachers. Educators emphasized the critical role of scientific explanations within ADI, considering it the most authentic form of scientific inquiry they had enacted in their teaching practice. However, teacher perceptions regarding the instructional time devoted to ADI varied, reflecting differing views on its value and alignment with the broader curricular agenda. Some advocated for fidelity to the ADI steps, emphasizing science-process outcomes, while others viewed the initiative as a top-down mandate lacking teacher input. The implications of this study extend to literacy supports and the identification of optimal learning progressions for effective ADI pedagogy. By exploring these facets, educators can better equip students to engage deeply with scientific concepts and processes.

Education for Sustainable Development

Strand 14: Environmental Education and Sustainability
23-Mar-25, 2:45 PM-4:15 PM
Location: Baltimore 3

Stand-Alone Paper

Student Competences in Education for Sustainable Development: Are teachers on board?

Tuba Stouthart, Eindhoven University of Technology, Netherlands
Duru Bayram*, Eindhoven University of Technology, Netherlands
Jan van der Veen, Eindhoven University of Technology, Netherlands

ABSTRACT

Education for sustainable development (ESD) equips learners of all ages with knowledge, skills, values, and attitudes needed to promote a sustainable future. This requires teachers to facilitate the acquisition of competences in ESD.However, the extent to which science teachers align with implementing the competences in ESD is unknown. For this reason, this study used Q methodology to identify 16 science teachers' views on student competences in ESD, based on the GreenCompcompetence framework developed by European Commission. Our analysis revealed three viewpoints.The largest group, with nine teachers, prioritized promoting evidence-based instruction while avoiding the political, ethical or value-laden dilemmas inherent in sustainability issues. While they advocated addressing critical thinking and system thinking, they feared that addressing dilemmas might lead to preaching their own values, or felt unprepared, or believed that science should remain objective and value-free. The second group, with four teachers, emphasized promoting nature and its well-being above all other competences. They felt responsible for encouraging students to adopt sustainable behavior. The third group, with three teachers, stood out by advocating fostering collective action in science education. Despite their differences, all groups agreed thatpolitical agencyis not relevant to address in secondary school science education.

Stand-Alone Paper

From attitudes to action: an integrated model for sustainability education

Tessa Baierl, University of Bayreuth, Germany
Juergen Paul, University of Bayreuth, Germany
Franz Bogner, University of Bayreuth, Germany

ABSTRACT

Despite increasing sustainability challenges, people often do not learn about or engage in sustainable behaviors. The EU project NEB | Lab ECO²-Schoolsaddresses these issues by teaching sustainability in a more holistic manner. The project centralizes knowledge, attitudes, and behaviors, and incorporates health-promoting factors as its foundation. Health promotion aims to maintain physical, mental, and social well-being rather than simply the absence of illness (Antonovsky, 1996). It includes people's belief in their ability to achieve desired outcomes (i.e., their self-efficacy: Bandura, 1982) and their coping strategies and resilience to deal with ambiguity and complexity (Bianchi et al., 2022). This is especially

important in sustainability education because many sustainability issues are complex and may only be solved over time. A study involving 794 participants(Mage [SD] = 18.86 [13.79]; 54.53% females, 39.67% males) used structural equation modeling to confirm the important role of health-promoting factors (such as self-efficacy, sense of coherence, and outdoor experiences) in shaping attitudes toward nature and the environment. These attitudes, in turn, were found to be supportive of learning and engaging in sustainable behaviors. The findings suggest that researchers and educators should consider integrating health-promotion efforts (e.g., by enhancing self-efficacy) with attitudes to promote consistent sustainable engagement.

Reframing Science and Engineering: Teachers' Strategies for Indigenizing STEM Education

23-Mar-25, 4:30 PM-6:00 PM
Location: Annapolis 4

Administrative Session

Reframing Science and Engineering: Teachers' Strategies for Indigenizing STEM Education

Julie Robinson, University of North Dakota, Grand Forks, USA
Pauline Chinn, University of Hawaii at Manoa, USA
Lenora Crabtree, University of North Carolina Charlotte, USA
Woei Hung, University of North Dakota, Grand Forks, USA
Paichi Shein, National Sun Yat-sen University, Taiwan
Stacy Potes, University of Hawai'i at Mānoa, USA
Stephanie Erickson, University of Minnesota, USA
Bhaskar Upadhyay, University of Minnesota, USA
Dimitri Smirnoff, University of Minnesota, USA
Devin Cavero, University of California-Berkley, USA

ABSTRACT

Reframing STEM educational experiences to center culture and Indigeneity creates relevance, fosters community and ecological stewardship, and increases pathways for students into science and engineering opportunities. Successfully implementing both pedagogical shifts and effective implementation of Indigenized practices and approaches requires training, intentionality, partnerships, and self-reflection on the part of practitioners and researchers (Azam & Goodnough, 2018). Such reframing is crucial at all educational levels, from PreK-12 to higher education STEM programs and within teacher education. Hearing directly from teachers and researchers who are meaningfully engaged in this work, learning explicitly from those who are decolonizing and enhancing their STEM practice and pedagogy, and reflecting on the methods that foster authentic collaborations and partnerships across communities can provide greater insight into how these ideas and approaches are enacted in practice. The purpose of this administrative session is to celebrate the work of teachers and researchers who are working collaboratively to reframe and reform

STEM instruction to be inclusive of Indigenous knowledge and knowledge systems, as well as to develop shared understandings of best practices across these contexts. Our session introduction will share about a collaborative book proposal in development that will include chapters describing vignettes of such powerful examples across settings, many that will be included in this session's presentations. Presenters in this Administrative Session from diverse cultures, regions, and science education contexts will share projects and findings that contribute to our understanding of how to meaningfully embed Indigenous Science Knowledge and community partnerships within science education and teacher professional learning.

Research on Creativity of Students in Integrated STEM Education: A Scoping Review

Strand 1: Science Learning: Development of student understanding
23-Mar-25, 4:30 PM-6:00 PM
Location: Azalea 3

Stand-Alone Paper

How Might a STEM Integrated Curriculum Influence Students' Design Thinking?

Dina Thomason*, UTEP, USA
Pei-Ling Hsu, UTEP, USA

ABSTRACT

STEM, the integration of science, technology, engineering, and mathematics subjects continues to be a popular topic as schools grapple with how to best prepare students for an ever-evolving society. The steps of the design thinking process, empathize, define, ideate, prototypeand testalign with engineering design and can be used as a problem-solving method in classrooms to help promote creativity, critical thinking, and collaboration. The purpose of this mixed methods study was to better understand if a STEM integrated curriculum helps promote design thinking. The study compared two middle school groups, one that uses an integrated STEM curriculum and one that does not. Quantitative data was collected using the design thinking disposition survey through pre and post testing.Qualitative data was collected through student and teacher interviews. There was no difference found in the change of design thinking dispositions between students at the two schools. Free response questions showed that students at the STEM integrated school perceived an increased ability to design solutions to problems. Student and teacher interviews highlighted benefits of using a STEM integrated curriculum including providing collaborative opportunities to solve hands-on, open-ended problems. Suggestions for improving STEM integration are also discussed.

Stand-Alone Paper

Creativity in Science Education – A Scoping Review

Annette Upmeier zu Belzen*, Humboldt-Universität zu Berlin, Germany
Paul Engelschalt, Humboldt-Universität zu Berlin, Germany

Leroy Großmann, Freie Universität Berlin, Germany
Dirk Krüger*, Freie Universität Berlin, Germany

ABSTRACT

Creativity is a fundamental concern in science education and can be defined as the ability to produce novel and appropriate work. However, creativity remains an elusive construct, with its definitions and assessments being discussed. Thus, there is a need to clarify the definition and assessment of creativity in our field of science education.To address this, we conduct a scoping review to analyze studies on creativity in science education systematically. We identified 183 studies that met our criteria, which required the studies to define and assess creativity in a science education context. We analyzed these studies using bibliometric analyses, examining citation counts and shared citations. In addition, we are qualitatively analyzing the studies' definitions and assessments for creativity.Our findings show that a study by Hu and Adey (2002) was influential in the field. Their study and connected studies define creativity by referring to novelty and appropriateness. However, many related creativity assessments addressed novelty rather than appropriateness. This raises the question of the importance of the appropriateness in science education's creativity discourse. We suggest that scientific reasoning criteria, such as grounding ideas in prior evidence and knowledge, could help to conceptualize and assess appropriateness in science education's creativity.

Stand-Alone Paper

Research on Creativity of Students in Integrated STEM Education: A Scoping Review

Shuaishuai Mi*, Faculty of Education, University of Macau, Macao
Xiufeng Liu, Faculty of Education, University of Macau, Macao

ABSTRACT

Promoting student creativity is one of the key objectives of STEM education. However, research has largely focused on domain-general or domain-specific creativity, rather than creativity specific to STEM education, which emphasizes interdisciplinary problem-solving. Despite the increased number of studies on creativity in integrated STEM education, it remains unclear how STEM education researchers have defined creativity and what the current state of creativity research in this field is. Therefore, there is a need for a scoping literature review that holistically maps the current state of these studies. This scoping literature review identified 44 empirical articles on the creativity of students in integrated STEM education and examined the studies' (a) theoretical frameworks on creativity, (b) factors identified as influencing students' creativity, and (c) interventions and their effectiveness in enhancing students' creativity. Specifically, there is an urgent need to develop a consensus definition of creativity, create and validate standardized measurement instruments based on this definition, analyze related factors, and develop effective intervention measures. This scoping review identifies both the progress and gaps in the current literature, as well as future directions for fostering students' creativity in integrated STEM education.

Stand-Alone Paper

Implementation of Engineering Design Process for Gifted Students: A Case of Science and Art Centers

Merve Adiguzel-Ulutas*, Gazi University, Turkey
Mehmet Yilmaz, Gazi University, Turkey

ABSTRACT

The present study aims to make a substantive contribution to research by not only conceptualizing an activity for pedagogical implementation but also by examining and evaluating the steps of the students' engineering design process. A case study, one of the qualitative research methods, was implemented. The study involved 14 sixth-grade students at a Science and Art Center, where they participated in 14 hours of activities over 7 weeks. The research used student worksheets and engineering notebooks as data collection tools. Student worksheets and engineering notebooks were descriptively assessed with an engineering design process evaluation rubric in line with the teacher's observations. The student designs framed by the engineering design process were evaluated with a design rubric. The research results revealed that gifted students mostly achieved the targeted level in using the engineering design process. However, it was found that the groups formed for problem-solving had lower average scores in the prototype-making and testing stages of the engineering design process compared to other stages. This study has demonstrated the effectiveness of activities based on the engineering design process in creating fruitful educational environments for gifted students.

Centering Affect and Emotion Toward Justice and Dignity in Science Education

Strand 2: Science Learning: Contexts, Characteristics and Interactions
23-Mar-25, 4:30 PM-6:00 PM
Location: Annapolis 1

Related Paper Set

Affective politics of belonging to STEM

Sarah El Halwany*, Université de l'Ontario français, Canada
Jennifer Adams*, University of Calgary, Canada

ABSTRACT

This paper engages with the affective politics of belonging to STEM by exploring racialized students' experiences in postsecondary STEM at a Canadian university. Rather than maintaining belonging as a positive, innocent feeling of being at home with STEM/science, we are interested in studying affective processes of belonging that delimit how STEM postsecondary spaces surface and take shape around some bodies more than others. Using data from an exploratory survey that explores racialized students' experiences in postsecondary STEM, our analysis focuses on body orientations and encounters within students' verbal accounts to follow how their bodies and emotions surface as racialized vis-à-

vis STEM. We argue that it's possible to alter our relationship with survey data not as holding internal meanings of students' sense of belonging but rather to highlight how STEM spaces already have feelings and affects circulating in specific ways. By reading students' accounts through theories of desire and care, we further engage with the speculative dimensions of their longings for STEM education spaces that center care both for and with STEM knowledges and each other.

Related Paper Set

Emotional Configurations of Whiteness in Learning to Teach Science in Anti-racist Ways

Jonathan McCausland*, Iona University, USA

ABSTRACT

This paper addresses the role of emotions in anti-racist learning for prospective White science teachers. Drawing upon White teacher identity studies and emotional configurations. Using storytelling as method, this study describes the experiences of three White interns and their participation in in a secondary science program at a large primarily White institution. Findings for this study demonstrate how emotional configurations of white shame and white ambivalence create constraints and affordances for anti-racist learning. This study advances understandings of the role of emotions within anti-racist learning for White science interns and steps away from perspectives that frame emotions as cognitive structures. Ultimately, this paper provides insights into how to design teacher learning contexts that address white supremacy in science education.

Related Paper Set

"That's just gonna make them upset": Youth authoring emerging epistemic ideals through rightful presence

Rishi Krishnamoorthy*, University of Toronto, Canada
Ravit Golan Duncan, Rutgers University, USA
Edna Tan, University of North Carolina - Greensboro, USA

ABSTRACT

There is a growing body of scholarship in science education that attends to the role of affect as shaping youths' negotiation of and experiences with disciplinary science practices. Building on this scholarship we examine how power, epistemic affect, and youth' resistance shape the uptake of youth's epistemic commitments as shared ideals and reliable processes for developing a community ethnography tool-- a survey to identify stressors in their school community. In the context of a larger implementation study of a justice-oriented middle-school biology unit on stress, we used interaction analysis methods to examine how care for the survey takers co-operatively emerged as an epistemic ideal when creating a community ethnography and was shaped by disrupting disciplinary practices and powered adult-youth relations in the classroom and youth's positionings in relation with macro sociopolitical worlds. How youth characterized care was not neutral but involved youth experiencing politicized empathy towards survey takers coupled with them taking action against survey takers experiencing harm through the survey. Overall, this work contributes to a critically

nuanced understanding of how affect is entangled with and visible through the complex powered dynamics that youth and adults negotiate when engaging in sociopolitical allyship towards more just ways of knowing.

Related Paper Set

Elevating Configurations of Data and Emotion: Dynamics of Co-production and Competition

Kathryn Lanouette*, William & Mary, USA

ABSTRACT

Creating, visualizing and critiquing data are integral knowledge building practices within science, as well as many other fields. Yet data is often treated as neutral and objective, perpetuating narratives of science as a dispassionate discipline where data are merely extracted, repackaged, and distributed anew. As researchers and educators seek to imagine, design and support more humanistic accounts of young people's data practices, attuning to emotion will be a key area for further study. Recent scholarship in science education has elevated emotion as inseparable from disciplinary knowledge building practices, yet studies of emotion emergent withinyoung people's data practices remain less understood. In response, I explore how emotion and data are co-produced as children construct and critique data visualizations together within a 5th grade 8-week ecology curriculum. Analyzing interviews and classroom videos, I reveal how emotional configurations emerge and shift for two children and their classmates, changing attention to the data itself (properties, histories, visualizations) and underlying organisms being studied. I argue that as science and data science education push forward a zeal for data, it will be important to attune to the emotional and relational dimensions that undergird children's emergent data practices, shaped by personal, cultural and sociopolitical dimensions.

Related Paper Set

'How do these data make you feel?": Emotional Pathways During Data Talks about Climate Justice

Imogen Herrick*, University of Kansas, USA
Michael Lawson, Kansas State University, USA
Ananya Matewos, Wilder Foundation, USA

ABSTRACT

This study explored how emotion is processed in the classroom when teachers specifically attend to emotion during a habitual small-scale justice-centered discourse routine centered on climate justice. Building on frameworks for critical data literacies and emotional awareness, this study is framed around understanding guided emotion participation and affective pedagogical goals during climate justice education. Conducted over two years across three design-based iterations in two different countries, this study involved fifteen K-12 teachers and their students. Analytically, we analyzed 58 classroom vides using the tenets of interaction analysis where we attempted to capture general patterns of emotional processing. Findings indicated teachers' attention to affective pedagogical goals opened access points for emotional pathways within dialogic exchange. These pathways led toward

constructive hope and critical civic empathy and emerged in two analytic ways—student-led and teacher-led pathways. By actively attending to emotions, teachers can disrupt traditional STEM practices that suppress emotion and privilege cognition. As this study highlights, teachers' attention to emotion enhances student understanding and reorients discourse toward dynamic and inclusive learning opportunities for climate justice. Aligning with the NARST 2025 conference theme, without partnerships with emotionally vulnerable teachers we are unable to empirically examine how emotion is processed during justice-centered learning.

Navigating Argumentation and Evidence in Science Education

Strand 2: Science Learning: Contexts, Characteristics and Interactions
23-Mar-25, 4:30 PM-6:00 PM
Location: Magnolia 2

Stand-Alone Paper

Students Knowledge and Sources of Information for Viruses and Vaccines: A Mixed Methods Study

Madeline Stallard*, North Carolina State University, USA
M. Gail Jones, North Carolina State University, USA
Julianna Nieuwsma, North Carolina State University, USA
Kathleen Bordewieck, North Carolina State University, USA
Tanzimul Ferdous, North Carolina State University, USA
Amber Meeks, North Carolina State University, USA

ABSTRACT

The COVID-19 pandemic exposed the general population's inadequate comprehension of viruses and vaccinations. Although this issue is significant, there is a scarcity of research which focuses on students' knowledge about vaccines and viruses, as well as the sources they rely on for information. In this mixed methods study, elementary, middle, and high school students were interviewed and surveyed regarding their sources of information and knowledge surrounding vaccines and viruses. The 40-question Vaccines and Viruses Survey was completed by 227 participants, and a 20-minute follow up interview was conducted with thirty-three randomly selected participants. Results revealed students' concepts of viruses and vaccines amongst different grade levels, as well as what sources of information they learned them from. Implications of this study for vaccine and virus instruction and curricula are discussed.

Stand-Alone Paper

Relationships Between Middle School Students' Epistemological Beliefs and Argumentation Quality in Genetically Modified Organisms

Burcu Bostancı*, Middle East Technical University, Turkey
Özgül Yılmaz-Tüzün, Middle East Technical University, Turkey

ABSTRACT
This study aimed to examine middle school students' epistemological beliefs, argumentation quality in genetically modified organisms (GMO), and their relationship. A correlational research approach was used. The Epistemological Beliefs Questionnaire (EBQ) was used to obtain students' scores concerning epistemological beliefs. Students' argumentation qualities in GMO were collected through the genetically modified organisms task developed by Xiao, 2015. Analysis of the data revealed that although students showed mid-quality arguments, the argumentation quality score was mainly obtained from their justification scores. Students had fairly sophisticated epistemological beliefs in all dimensions of the questionnaire. The argumentation quality of students showed significant relationships between each dimension of epistemological beliefs (source/certainty, development, justification). Multiple regression analysis revealed that one of the dimensions of epistemological beliefs (justification) significantly predicted students' argumentation quality in genetically modified organisms. It can be concluded that socioscientific issues can be used more frequently to improve students' epistemological beliefs and argumentation qualities. In this way, students can learn to make informed decisions with the help of socioscientific argumentation.

Stand-Alone Paper

Artificial Intelligence in Science Education Research: A systematic Review of NARST 2024

Gyeong-Geon Lee*, National Institute of Education, Singapore
Minji Yun*, University of Florida, USA
Xiaoming Zhai, University of Georgia, USA
Kent Crippen, University of Florida, USA

ABSTRACT
This study presents a systematic review of the integration of Artificial Intelligence (AI) into science education research, as observed at the NARST 2024 conference. The review aimed to explore the nature, trends, and characteristics of AI-related research within the science education community, particularly focusing on the work presented at the conference. The findings reveal a significant increase in AI-related presentations, growing from 10 in 2020 to 36 in 2024, reflecting the expanding interest and application of AI in this field. The study categorized these presentations based on their research methods, the types of AI employed, and the targeted educational levels and disciplines. The analysis also identified key challenges, including teachers' preparedness for AI, the complexity of assessing student knowledge, and potential biases in AI systems. The study concludes by emphasizing the need for further research to address these challenges and to develop theoretical frameworks that can guide the effective use of AI in science education. The findings are expected to contribute to the ongoing discourse on AI in education, ultimately benefiting the global science education community.

Stand-Alone Paper

Middle School Students' Use of and Rhetorical References to Inscriptions in Genetically Modified Organisms

Özgül Yılmaz-Tüzün*, Middle East Technical University, Turkey
Burcu Bostancı, Middle East Technical University, Turkey

ABSTRACT
The present study examines middle school students' use of and rhetorical references to inscriptions in genetically modified organisms (GMO). A descriptive research approach was adopted. GMO Task (Xiao, 2015) was used with a more extended argumentation process to reveal students' uses of different inscription types in arguments, counterarguments, and rebuttals, respectively. In addition to that, students' rhetorical references to inscriptions were examined separately across argument, counterargument, and rebuttal. The analyses revealed that students tend to use visual and simpler inscriptions (photographs and brochures) rather than complex inscriptions (tables and graphs) in their argumentation. With respect to rhetorical references, students were able to utilize higher levels of rhetorical references to inscription in their argumentation. Yet, in complex argumentation structures, such as counterargument and rebuttal generation, students showed a decrease in their use of inscriptions and high levels of rhetorical references. It can be concluded that socioscientific argumentation with the help of inscription can contribute to students' learning of informed decision-making. Thus, students can become conscious future citizens who evaluate and interpret data on issues concerning society and science at the same time.

Exploring strategies to enhance student engagement and learning outcomes across educational contexts

Strand 4: Science Teaching — Middle and High School (Grades 5-12): Characteristics and Strategies
23-Mar-25, 4:30 PM-6:00 PM
Location: Baltimore 4

Stand-Alone Paper

The Paradox of Project-based Learning in Chinese Science Education Reformation

Jiaojiao Hui*, The University of Hong Kong, China
Jiaxin Chen*, The University of Hong Kong, China
Yongping Shao, Hangzhou Yinhu Experimental Middle School, China
Chen Chen, The University of Hong Kong, China

ABSTRACT
This study investigates how frontline middle school science teachers in Hangzhou, China understand, develop, and implement project-based learning (PBL) courses amidst ongoing curriculum reform, and the challenges they encounter in the process. Through semi-structured interviews with eight junior middle school science teachers (5 male and 3 female), analyzed using thematic analysis, we found that while in- service teachers share researchers' conceptual understanding of PBL's pedagogical content knowledge (PCK), their actual practice often diverges from these ideals. Experienced teachers, accustomed to traditional teaching methods, struggle to break free from test-centered habits when adopting PBL.

Furthermore, teachers face three key challenges in implementing PBL: lack of PCK, lack of content and technological knowledge, and inadequate support from school management. Notably, the dissonance between teachers' understanding and implementation of PBL engenders doubt about "real PBL" and their own PCK. These findings underscore the urgent need for effective in-service professional development to bridge the chasm between PBL ideals and classroom realities, especially as China's science education curriculum undergoes reform to incorporate more PBL components.

Stand-Alone Paper

Model-Based Inquiry: Designing for Opportunities to Learn

Ron Gray*, Northern Arizona University, USA
Todd Campbell*, University of Connecticut, USA
Yue Bai*, University of Connecticut, USA

ABSTRACT

This study explores the intersections of model-based inquiry (MBI) and opportunities to learn within science classrooms. MBI, a planning and instructional model grounded in the practice turn, emphasizes student engagement in authentic scientific practices such as modeling, argumentation, and explanation to resolve uncertainties about real-world phenomena. Through a quasi-experimental design, this research compares student experiences in MBI and non-MBI units across middle and high school science classes, focusing on their engagement with four key constructs: understanding scientific explanations, generating scientific evidence, reflecting on scientific knowledge, and participating productively in science. The findings reveal that MBI provides significantly greater opportunities for students to generate evidence and reflect on scientific knowledge compared to non-MBI units, though engagement across the four constructs remains consistent within MBI contexts. This study contributes to the ongoing discourse on educational equity in science education, offering insights into how practice-turn-focused instructional models like MBI can enhance students' opportunities to learn, particularly in underserved schools. The implications for science teaching, learning, and policy are discussed, with a call for further research to explore the broader impacts of MBI on educational equity.

Stand-Alone Paper

From Anxiety to Confidence: Unlocking the Potential of CTCA in ICT Education

Chinyere Ikpah, Lagos State University, Nigeria
Peter Okebukola*, Lagos State University-, Nigeria
Rahman Alade, Lagos State University, Nigeria
Rasheed Sanni, Lagos State University, Nigeria
Deborah Agbanimu, National Open University of Nigeria, Nigeria

ABSTRACT

Meaningful learning of intrusion detection and prevention systems (IDPS) becomes impossible for students once anxiety takes hold. Anxiety, characterized by worry, nervousness, and fear, is a complex response to stress. This study aimed to test the effectiveness of culturally relevant pedagogy in reducing anxiety to IDPS among senior

secondary school students. A pre-test and post-test design was used, with data gathered through both quantitative and qualitative methods to assess the approach's efficacy. The sample included two senior secondary schools, with the experimental group consisting of 70 students (35 males and 35 females) and the control group consisting of 94 students (34 males and 60 females). Quantitative data was collected using the Intrusion Detection and Prevention System Anxiety Scale Test (IDPSAST), which had a reliability of 0.69, and qualitative data was gathered using the Intrusion Detection and Prevention System Interview Guide (IDPSIG). After administering the IDPSAST to both groups, a statistically significant reduction in anxiety was found in the experimental group using ANCOVA [F (1,161) = 8.27, p .05], favoring the CTCA group. Based on the study's findings, it is recommended that teachers use culturally relevant pedagogy (CTCA) in their teaching as it reduces students' learning anxiety.

Problem-Solving and Engagement in Undergraduate Physics Education

Strand 5: College Science Teaching and Learning (Grades 13-20)
23-Mar-25, 4:30 PM-6:00 PM
Location: Magnolia 3

Stand-Alone Paper

Changes in physics freshmens prior knowledge A comparison of the German 2013 and 2023 cohort

Dennys Gahrmann*, University of Potsdam, Germany
Irene Neumann, Leibniz Institute of Science and Mathematics Education (IPN), Germany
Andreas Borowski, University of Potsdam, Germany

ABSTRACT

Changes in educational systems have sparked the perception among university teachers that the prior knowledge of incoming physics students has decreased over time. However, a previous study comparing cohorts from 1978 and 2013 revealed no serious changes in students' prior knowledge. This study investigates how the prior knowledge of freshmen physics students in Germany has changed from 2013 to 2023. Utilizing an innovated and reliable version of the same entrance test, which was curricular validated by 75 and 22 university teachers beforehand and includes 14 mathematics and 14 physics items, we replicated the 2013 procedure in 2023. Our sample include 4268 students from the cohorts of 2013 and 2023 physics freshmen with similar characteristics. The results show that while the mathematics prior knowledge of the 2023 cohort was significantly higher than that of 2013 (p .001), the effect size was negligible (Cohen’s d = 0.10). In contrast, the physics prior knowledge was significantly higher in 2023 (p 0.0001), with a small effect size (Cohen’s d = 0.21). These findings contradict the university teachers' perception, as the prior knowledge in mathematics did not change notably and improved slightly in physics. The study highlights the need for further international analyses.

Stand-Alone Paper

How Students Use Knowledge Resources to Solve Problems in a Problem-Solving First Lesson

Cheng-Wen He*, University of Georgia, USA
Logan Fiorella, University of Georgia, USA
Paula Lemons, University of Georgia, USA

ABSTRACT

This study investigated how undergraduate students use knowledge resources in a problem-solving-first lesson (PS-I) to learn and apply biochemistry concepts. While the PS-I approach is shown to enhance conceptual understanding through cognitive mechanisms, few studies have qualitatively examined how students construct knowledge in this context. Resource theory provided a lens to characterize the individual elements of knowledge (i.e., knowledge resources) leveraged by students. Using a multiple-case study methodology, we analyzed how four students used resources during the problem-solving and posttest phases, focusing on their resource activation and organization. Data sources included written responses and think-aloud interviews. Resource graphs and cross-case analyses revealed that students consistently reused certain resources, such as polarity and electronegativity, across problem-solving and transfer tasks, highlighting students' productive resources and contextual activation of those resources. Individual differences were also evident in resource use, with some students expanding the scope of their resources and others narrowing the scope. These findings highlight the unique difference in resources between individuals and the adaptive reuse and contextual activation of cognitive resources in the context of complex problem solving. This study informs instructional strategies that recognize and support students' diverse learning processes through the lens of resource theory.

Stand-Alone Paper

Exploring Student Success In Undergraduate Physics Using A Hybrid Of Problem-Solving and Retrieval Practice Prompts

Carina Rebello*, Toronto Metropolitan University, Canada
Winter Allen, Purdue University, USA
Mina Megally, Toronto Metropolitan University, Canada
Atish Kabiraj, Toronto Metropolitan University, Canada

ABSTRACT

Retrieval practice, as used in psychology studies, relies on the learner retrieving the relevantinformation. A vast body of research shows that novices/beginning learners tend notto have well organized knowledge schemas. Therefore, learners will likely have difficulty retrieving productive resources for problem solving. Furthermore, problem solving performance tends to deteriorate for tasks with increasing complexity and most of the errors seem to be due to failure of retrieving the relevant information. Hence, there is a need to pair retrieval practice with a strategy that facilitates both encoding and retrieval of relevantschemas to facilitate productive problem-solving processes. In this study, retrieval prompts were integrated within a four-step problem solving strategy utilizing reflective

analysis. Prompts were designed to target how students can efficiently retrieve information from modified course equation sheets and how they approach problem-solving during tutorials. We will describe the development of course materials promoting retrieval practice and our implementation strategies. Results of our study suggest that instruction emphasizing retrieval practice yields statistically significant greater overall course performance and tutorial quiz performance compared to a control. Also, students expressed positive views towards modified course materials and retrieval practices. We will also address implications and share future work plans.

Stand-Alone Paper

Comparing engagement and cognitive load between game-based, inquiry-based, and design-based labs in introductory undergraduate physics

Razan (Rosie) Hamed*, Purdue University, USA
N. Sanjay Rebello, Purdue University, USA

ABSTRACT

Cognitive Load Theory (CLT) explores the working memory capacity when learning and applying new information. CLT is measured through three types of cognitive load: Intrinsic, Germane, and Extraneous, which could vary based on the instructional approach. In the present study, the three cognitive load types along with the level of engagement were compared across three different instructional conditions in the physics laboratory: Inquiry-based, Design-based, and Game-based labs. Data from the cognitive load and engagement survey were collected across multiple labs in a thermodynamics unit in a physical science course for elementary education majors. The inquiry-based labs imposed higher levels of intrinsic and extraneous cognitive load compared to design-based and game-based labs. Design-based labs showed the lowest levels of germane cognitive load and engagement. In contrast, game-based labs were found to have the highest levels of engagement and germane cognitive load and a low extraneous cognitive load. These results suggest that educational games could be beneficial for novice physics learners.

Family and Community Pathways to STEM Learning

Strand 6: Science Learning in Informal Contexts
23-Mar-25, 4:30 PM-6:00 PM
Location: Magnolia 1

Stand-Alone Paper

Comparing Three Models of Family STEM Conversations for Broadening STEM Participation

Cory Buxton*, Oregon State University, USA
Diana Crespo-Camacho*, Oregon State University, USA
Barbara Ettenauer, Oregon State University, USA

ABSTRACT
The STEM in Our Lives Project (a pseudonym) tests and refines a model of science teaching and learning that brings together current research about the role of language in science communication, the role of cultural and community connections in science engagement, and how people apply science knowledge to their daily decision making. One key component of the model seeks to bring families together as co-learners and co-teachers through family STEM workshops in afterschool settings. We argue that promoting family STEM conversations is critical for reaching the goal of broadening participation in STEM fields. We describe our work to introduce new models of family STEM engagement within an existing research practice partnership, using discourse analysis to provide initial comparisons of three approaches for promoting family STEM conversations. We conclude by proposing design principles for future work, framing family engagement as a key component of efforts to broaden STEM participation.

Stand-Alone Paper

Parents' Noticing of Opportunities to Trigger and Foster Science Interest in Everyday Life

Irit Vivante*, Ben-Gurion University, Israel
Dana Vedder-Weiss*, Ben-Gurion University, Israel

ABSTRACT
Interest is crucial for science learning. Parents play a key role in nurturing their childrens interest through everyday interactions at home. However, limited knowledge exists on how parents notice and capitalize on worthy-opportunities for supporting their children's science interest in the home environment. This study adopts the noticing framework to examine how parents identify opportunities to trigger and foster their children's science interest in daily life, and how their science capital manifests in this process. In this multiple case study, we collected data from 30 diverse families, yielding 314 reported science interest events. Through thematic analysis, we identified factors that elicit parents' noticing of triggering and fostering opportunities, their responding actions, and the science capital is manifest in this process.Our findings suggest that while parents triggered their children's interest in science less frequently (33%) than they fostered already-triggered interest (67%), they took a more active and initiating role during the former, employing richer practices and a broader range of scientific skills. Additionally, we found that parents used science interest to regulate their children's emotions. The findings contribute to the literature on science interest and the field of learning in informal environments, with practical implications for parents and educators.

Stand-Alone Paper

Exploring the effects of parent-child inquiry-based co-learning on children's scientific interest and self-efficacy

Zuway-R Hong*, Chung Shan Medical University, Taiwan
Li-ting Cheng, National Dong Hwa University, Taiwan
Huann-shyang Lin*, National Sun Yat-sen University, Taiwan
Ing-jer Huang, National Sun Yat-sen University, Taiwan
Thomas Smith, Northern Illinois University, USA

ABSTRACT
This study was explored the effects of parent-child co-learning in an inquiry-based activity (PC-IBCL) on elementary children's scientific interest and scientific self-efficacy.We conducted aPC-IBCLteaching intervention at a suburban elementary school in Kaohsiung City. A total of 18 4-6 graders was selected for inclusion in the experimental group (EG), who then attended the 10-week, 30-hourPC-IBCLon Saturday morning together with their parents. In addition, we randomly selected 30 children as the comparison group (CG) who did not receive the intervention. All children responded to the ILSS and SSES at the beginning and end of the intervention; five children and their parents were selected for interviews to confirm the quantitative results. The ANCOVA showed that the EG children's interest in mastering science and technology,mastery ability in science and technology, confidence in science and technology, attitude towards learning science and technology,as well as their total scientific self-efficacy scores were significantly higher their CG counterparts. The results provide for insight that can be applied to implementation of inquiry-based teaching as well as subsequent research involving science education in both formal and informal education settings..Keywords: Elementary school children; inquiry-based activity; parent-child co-learning; scientific interest; scientific self-efficacy

Stand-Alone Paper

Gaining insight into Rural, Underserved Students Experiences of an At-home, Justice-Centered STEM Curriculum

Margaret Blanchard*, North Carolina State University, USA
Karen Collier*, Augusta University, USA
Ana-Maria Topliceanu*, North Carolina State University, USA

ABSTRACT
Out-of-school activities have the potential to broaden participation in STEM, especially for groups with less access to school-based opportunities. In this exploratory, mixed methods study, at-home STEM kits were mailed to rural middle school students to address inequities in STEM access. The kits included nonfiction trade books featuring the stories of underrepresented minority STEM professionals and content-aligned STEM kits. The quasi-experimental design used repeated measures over four sets of mailed-home STEM kits to gauge students' responses to generic prompts (control) compared to those that addressed social justice constructs (intervention). Morales-Doyle's (2017) justice-centered science pedagogy framework was adapted as justice-centered STEM curriculum (JCSC) and guided the data analyses. The research question was: How did students respond to the at-home intervention, and were there differences between the intervention group and the control group? Findings indicate that the at-home STEM kits led to similar responses between both student groups. Overall, the analyses revealed how these students operationalized salient aspects of the JCSC around critical consciousness, academic success, and cultural competence. Within these three elements, themes were coded that highlighted students' perceived: STEM identity, self-efficacy, authentic STEM, enjoyable/engaging, learning, familial sharing, quality materials, learning, awareness, and inspiring. Implications and lessons learned are discussed.

Approaches to enhance STEM teaching

Strand 7: Pre-service Science Teacher Education
23-Mar-25, 4:30 PM-6:00 PM
Location: Baltimore 1

Stand-Alone Paper

The Impact of Field Placements on Pre-Service Teachers' Self-Efficacy Related to Teaching STEM: A Review

Lillian Bentley*, Georgia State University, USA
Xin Xia, University of Virginia, USA
Robert Tai, Australia Catholic university, Australia
Xitao Fan, The Chinese university of hing Kong, China

ABSTRACT

This systematic literature review explores the impact of field practicum experiences on pre-service teachers' self-efficacy in teaching Science, Technology, Engineering, and Mathematics (STEM). Field experiences, such as student teaching and clinical placements, are critical in teacher preparation programs and are widely seen as the most influential aspect of teacher training. Self-efficacy, or the belief in one's ability to achieve desired outcomes, is a key predictor of teaching performance. However, research on the impact of these experiences on pre-service teachers' self-efficacy in STEM presents mixed results, necessitating further investigation. The review focuses on empirical studies published between 2013 and 2023, identifying 13 relevant studies from an initial pool of 1,017. Findings suggest that field placements positively influence pre-service teachers' self-efficacy, particularly in integrating technology and teaching science through inquiry-based methods. However, significant research gaps exist, especially in middle and high school settings. The review calls for more comprehensive studies that consider the timing, duration, and specific contexts of field experiences. This review aims to inform discussions on the design of teacher preparation programs, emphasizing the need to optimize field experiences to enhance STEM teaching efficacy among pre-service teachers.

Stand-Alone Paper

Pre-Service Science and Mathematics Teachers' Perceptions of STEM Education: Towards a STEM Teacher Education Framework

Hopegay Williams*, The University of the West Indies, Mona, Jamaica
Sharon Bramwell-Lalor, The University of the West Indies, Mona, Jamaica
Aldrin Sweeney, Ross University School of Medicine, Barbados

ABSTRACT

The Ministry of Education of a Small Island developing state has been promoting STEM (Science, Technology, Engineering and Mathematics) education as one of the pedagogical approaches for equipping the nation's children for being global citizens. With increased emphasis being placed on STEM education, pre-service teachers are expected to function

effectively within an integrated STEM framework once they matriculate into service. Therefore, the problem that exists is that teacher education programs are not being guided by an explicit framework for STEM education. Hence, the purpose of this three-phase exploratory sequential design study will be to explore pre-service science and mathematics teachers' perceptions of integrated STEM education and subsequently use the perceptions to inform the development of an integrated STEM framework for teacher education programs. Semi-structured individual interviews will be used to collect data during phase one of the study from sixteen participants selected from four teacher preparation institutions across the island. The data collected in the qualitative phase will be used to guide the development of a 5-point Likert scale questionnaire. The questionnaire will be used to survey a sample of approximately 231 pre-service science and mathematics teachers across nine teacher education institutions in the quantitative phase of the study.

Stand-Alone Paper

Does grouping influence STEM and non-STEM major pre-service teachers' acquiring STEM teaching competence

Hsiao-Lin Tuan*, National Changhua University of Education, Taiwan
Chi-Chin Chin, National Taichung University of Education, Taiwan
Li-Yu Huang, National Changhua University of Education, Taiwan
Fen-Mei Chou, Changhua CityTeacher Center, Taiwan
Chien-Ying Chou, National Changhua University of Education, Taiwan

ABSTRACT

This study is to investigate the influence of grouping on STEM and non-STEM pre-service teachers' perception of acquiring STEM teaching competence. Two groups pre and post experimental design were conducted in the study, qualitative data were also collected. For the experimental group(total 87, non-STEM 57, STEM 30), pre-service teachers were grouped heterogeneously, each group members consisted of mixed gender, STEM major and non-STEM major from different departments. For the control group(total 71, non-STEM 31, STEM 40), pre-service teachers group their own without any requirement. Each semester, two 2-credit one-semester STEM teaching method courses were offered, one for experimental group another for control group. Two semesters data were collected.All pre-service teachers filled the Teachers' Perception of STEM teaching competency [TPSTEMTC] questionnaire in the beginning and at the end of semester. Pre-service teachers' STEM lesson plans and their reflection on their learning were also collected. Finding indicated that grouping has some subtle affect on STEM and non-STEM major pre-service teachers' perception of acquiring STEM teaching competence. Both STEM and non-STEM major preservice teachers gain significantly on their perception STEM teaching competence after the STEM method course.

Stand-Alone Paper

Cognitive Aspect of Collaborative Problem-Solving Skills of Pre-Service Science Teachers Through STEM Activities

Ayşe Şatgeldi*, Middle East Technical University, Turkey
Ömer Özdemir, Middle East Technical University, Turkey
Ufuk Yıldırım, Middle East Technical University, Turkey

ABSTRACT
This qualitative study investigates variations of cognitive skills of collaborative problem solving skills (CPS) of pre-service science teacher (PST)s through STEM activities. Specifically, there were three activities that included hands-on STEM activities. Moreover, PSTs used Arduino and basic electronic components. Three senior PSTs (2 males and 1 female) were participated in the study. Data were collected through interviews before and after the activities, activity sheets and video recordings throughout the activities. In the study, Assessment and Teaching of 21st Century Skills (ATC21S) framework was used to analyze data according to cognitive aspect of CPS. The analysis in the study extended the framework and yielded several variations of the dimensions in the framework. Therefore, results of the study explains and shows how the dimensions can be observed in the classroom.Keywords: Pre-service science teachers, STEM education, 21st century skills, Collaborative Problem-solving skills

---

Examining Science Teacher Efficacy, Beliefs, and Inclusivity

Strand 8: In-service Science Teacher Education
23-Mar-25, 4:30 PM-6:00 PM
Location: Annapolis 3

Stand-Alone Paper

Investigating Elementary Teachers' Self-Efficacy in Science and Engineering Throughout a Year-Long Online Professional Learning Program

Ryan Summers*, University of North Dakota, USA
Rebekah Hammack, Purdue University, USA
Ashley Iveland, WestEd, USA
Meghan Macias, WestEd, USA
John Galisky, WestEd, USA
Michael Herbert, University of North Dakota, USA

ABSTRACT
To deliver instruction consistent with the Next Generation Science Standards (NGSS), especially with the inclusion of engineering, teachers need a high level of self-efficacy. Professional learning can foster self-efficacy, but short-term interventions have been found to have a limited impact on teachers' instructional practices. The present study examines survey data collected from elementary teachers who were participating in a year-long NGSS-aligned professional learning program that was extended by professional learning communities (PLCs) and other supports. Experts led a 5-day institute which modeled shifts called for by NGSS (e.g., equitable, discourse-rich, phenomena-based) and provided teachers with opportunities to experience next-generation instruction. Participants (n=150) were recruited from rural communities, so, being mindful of historic challenges with access to professional learning, the institute in summer 2023 and the PLC sessions were delivered online. Four surveys were administered during 2023-2024, including a pre-, immediate post-,

and delayed post-intervention surveys that captured teachers' self-efficacy and outcome expectations related to science and engineering teaching and learning (T-STEM). We found teachers pre-intervention responses were more favorable for science, initially, but significant growth in engineering occurred throughout the period of study. Importantly, we also found evidence that ongoing supports, like PLCs, helped to sustain professional learning outcomes.

Stand-Alone Paper

Exploring Secondary Science Teachers' Motivations, Goals, and Epistemological Beliefs in Reform-Oriented Professional Development Program

Khalid Alharbi*, North Carolina State University, USA
Soonhye Park*, North Carolina State University, USA
Grace Carroll*, North Carolina State University, USA
Laura Chalfant, North Carolina State University, USA
Elizabeth Kluckman, North Carolina State University, USA
William Reynolds, North Carolina State University, USA
Scott Ragan, North Carolina State University, USA
Jason Painter, North Carolina State University, USA

ABSTRACT

This study explores the motivations, primary goals, and initial epistemological beliefs of in-service secondary science teachers for participating in an intensive professional development program (PD) on a reform-oriented science teaching approach, Modeling Instruction. Employing a qualitative research design, the study utilized an open-ended survey and interviews as major data sources, and analyzed the data through both inductive and deductive approaches. Major findings include: (1) teachers' desire to attend the PD were influenced by multiple motivations simultaneously, (2) teachers' motivations and goals were closely aligned and more teaching-focused than student learning-focused, and (3) most of teachers held either instructive or transitional epistemological beliefs, reflecting more teacher-centered perspectives. The study emphasizes the need for PDs to offer opportunities for teachers to examine new teaching approaches in relation to student learning, rather than viewing teaching and learning as two separate entities. Moreover, given the prevalent teacher-centered beliefs, it is recommended that PD developers assess teachers' existing epistemological beliefs and provide tailored support rather than adopting a one-size-fits-all approach. Further research should investigate how teachers' initial epistemological beliefs evolve after participating in PDs and how these changes impact their teaching practices, providing insights into improving support for the implementation of reform-oriented science teaching.

Stand-Alone Paper

Participant Perceptions About the Value of a Professional Development Program for Biology Teachers from Mexico

Gonzalo Peñaloza*, Centro de Investigació y de Estudios Avanzados del IPN, Unidad Monterrey, Mexico
María Guerra Ramos, Centro de Investigació y de Estudios Avanzados del IPN, Unidad Monterrey, Mexico

Zulmarie Pérez Horta, Science and Educational Media Group, Howard Hughes Medical Institute, USA
Javier Robalino, Science and Educational Media Group, Howard Hughes Medical Institute, USA
Tatiana Salazar López, Centro de Investigació y de Estudios Avanzados del IPN, Unidad Monterrey, Mexico
Irwing Vásquez Cerqueda, Centro de Investigació y de Estudios Avanzados del IPN, Unidad Monterrey, Mexico

ABSTRACT
Research on professional development (PD) programs for science teachers in Mexico is relatively scarce, and it remains unclear whether the desirable features of such programs, identified in other contexts, are applicable in Latin America. This study addresses this gap by examining a three-year PD program for high school biology teachers in Mexico. Participants' perceptions of the program's value were assessed through interviews, which were analyzed using seven analytical dimensions. The findings indicate that Community, Reflection, and Leadership were the most frequently emphasized dimensions. The study concludes that designing PD programs with research-based characteristics of effective PD can lead to positive outcomes for teachers in a Latin American context.

Stand-Alone Paper

Impact of Gender and Sexual Diversity-Inclusive Professional Development on Rural Science Teachers' Attitudes and Beliefs

Gary Wright*, University of Missouri, USA
Austin Gaskin, University of Missouri, USA

ABSTRACT
Rural schools in the United States struggle to provide affirming gender and sexual diversity (GSD)-inclusive education for LGBTQ youth due to restrictive anti-LGBTQ legislation which impedes discussions on gender identity and sexual orientation. This legislative context, combined with traditional science education's focus on objectivism and determinism, exacerbates the lack of GSD-inclusive resources in rural science classrooms. This study addresses this gap by exploring the impact of a GSD-aligned professional development (PD) program on rural science teachers' attitudes and beliefs about GSD-inclusive science teaching (GSDST). Using a mixed methods approach, we investigated rural science teachers' initial attitudes towards GSDST, how these attitudes and beliefs change post-PD, and which features of the PD are perceived as most impactful. Key findings reveal there was on overall trend in favor of GSDST with medium to large effect sizes after the intervention, which did reach statistical significance. These results highlight the need for targeted PD programs to foster inclusive science education practices in rural settings, ultimately supporting both LGBTQ students and educators.4o mini

Exploring Methodologies in Education Research: Insights and Applications from Early Career Scholars

Strand 10: Curriculum and Assessment
23-Mar-25, 4:30 PM-6:00 PM
Location: Annapolis 2

Symposium

Exploring Methodologies in Education Research: Insights and Applications from Early Career Scholars

Evelyn Boyd*, University of Mississippi, USA
Elizabeth Vaughan*, Reed College, USA
Katherine Doerr, Malmö University, Sweden
Emine Topalcengiz, University of Arkansas, USA
Jonathan Barcelo, Saint Louis University, Philippines

ABSTRACT

This symposium, organized by early career chemistry education researchers from the 2024 NARST Early Career Institute, explores and discusses diverse methodologies in education research, emphasizing the significance of methodological choices on study outcomes. Symposium participants will address challenges researchers face in selecting and implementing methodologies, highlighting the benefits of cross-disciplinary methodological discussions. Featuring five methodologies—diffractive methodology, self-study, adapting quantitative assessment instruments, Rasch analysis, and topological data analysis (TDA)—the symposium aims to foster in-depth conversations related to these techniques. Through a structured format of brief presentations, a poster session, and an open discussion, participants will engage with each method's advantages, limitations, and applications. The symposium seeks to advance understanding of these methodologies, foster collaboration, and support researchers at all career stages in selecting and applying suitable study methods. By bridging theoretical and practical aspects, the symposium aims to enrich the methodological toolkit of education researchers and encourage innovative approaches in educational research.

Advancing Multilingualism in Science Education

Strand 11: Cultural, Social, and Gender Issues
23-Mar-25, 4:30 PM-6:00 PM
Location: Azalea 1

Stand-Alone Paper

Creating a third space for multilingual learners through intertextuality: How are science textbooks faring?

Sara Salloum*, Ohio University, USA
Rana Baddour, American University of Beirut, Lebanon
Saouma BouJaoude, American University of Beirut, Lebanon

ABSTRACT
In COUNTRY, international languages are deployed in teaching science and mathematics. This study examines, from the perspective of multilingual learners and their science teachers, the extent to which intertextual links among multimodal texts in science textbooks facilitate the creation of a third space, wherby hybrid discourses intermingle and expand. A qualitative approach was employed, and data were collected from focus-group discussions with public school students along with semi-structured interviews with nine Life Science teachers. Data was analyzed based on an analytic framework outlining four intertextuality categories. Thematic analysis was used to identify themes from the students' and teachers' responses. The results indicate that the COUNTRY's Life Science national textbook has serious issues in the four intertextuality categories; mainly for creating links among written and visual text, hands-on exploration, and bridging students' experiences and lives, and their processing of scientific concepts, discourse and language. Therefore, limited opportunities are left for the creation of transformational third spaces that leverage diverse students' in-depth understanding and engagement in science learning. Interestingly, a new theme related to textbook affordability emerged in the interview with one of the teachers. The discussion offers practical and pedagogical implications for instruction and curriculum design.

Stand-Alone Paper

Shifts towards heteroglossic ideologies and pedagogical translanguaging through researcher-practitioner collaborative design of middle-school science curricula

Haemin Kim*, University of Houston, USA
Zhenjie Hou, University of Houston, USA
Araceli Enriquez-Andrade*, University of Houston, USA
Jie Zhang, University of Houston, USA
Mimi Lee, University of Houston, USA
Hien Tran, University of Houston, USA
Sissy Wong, University of Houston, USA
May JadAllah, University of Houston, USA

ABSTRACT
Given the growing emphasis on equity-focused science education for multilingual learners (MLs), this study aimed to explore the shifts in middle school science teachers' language ideologies and pedagogical translanguaging after one year of researcher-practitioner collaboration. Twelve science teachers from grades 6-8 and three science specialists were interviewed at the end of Year 1. This study analyzed the interviews of six teachers with different linguistic and racial backgrounds, two from each grade level (6 to 8). A team of bilingual and science researchers collectively familiarized with each teacher's interview and debriefed on findings. Three major themes emerged. First, teachers' language ideologies for science sensemaking evolved from viewing students' home language as a scaffold to embracing the legitimacy of bilingual ways of knowing. Second, teachers shifted from spontaneous use of translanguaging to intentional use of translanguaging in lesson planning and implementation. Lastly, teachers confronted practical challenges when incorporating translanguaging in science lesson planning and implementation such as time constraints,

lack of resources, and misalignment between instruction and assessment. This study provides future research directions and pedagogical implications to cultivate a more inclusive and equitable environment for science learning.

Stand-Alone Paper

Multilingual College Students Blending Linguistic Experimentation with Science Learning

Margaret Jeong, University of Illinois Chicago, USA
Adeesha Jayathilaka, University of Illinois Chicago, USA
Minjung Ryu, University of Illinois Chicago, USA

ABSTRACT

Multilingual Learners (MLs) are increasingly represented throughout all levels of education, yet few institutional resources are dedicated to serving them in specific disciplinary areas, especially at the college level. In response to increasing calls to identify actionable STEM pedagogical practices for MLs, we sought to better understand the agentive science learning practices of college MLs. To that end, we adopted a pragmatic, qualitative approach to study the communicative potential (Blommaert et al., 2005) of MLs in a task-based interview context. Communicative potential foregrounds the value attributed to a speaker's linguistic assets by themselves and by other interlocuters. For the present paper, we analyzed video data and multilingual transcripts from eight colingual pairs from diverse linguistic backgrounds. We present an in-depth analysis of the emergent linguistic experimentation by a pair of students who speak two Arabic dialects. Through linguistic experimentation, these students proposed and performed linguistic actions that deviated from the interactional or structural norms. As a result, they expanded each other's ways of participating in collaborative STEM problem-solving. These findings hold implications for how science educators position their multilingual students in the classroom context.

Creating a rightful presence for LGBTQ+ people in STEM

Strand 11: Cultural, Social, and Gender Issues
23-Mar-25, 4:30 PM-6:00 PM
Location: Azalea 2

Related Paper Set

Social Supports for Nonbinary Scientists: An Autoethnography on a Transdisciplinary Collaboration in LGBTQ-Inclusive STEM Scholarship

Ezra Kottler*, University of the Pacific, USA
Adrian Gentry, Purdue University, USA
Emily Haluschak*, Purdue University, USA
K. "Ren" Mendoza*, University of Nebraska at Omaha, USA
Riley DeHority, Virginia Tech, USA
Parker Lund, University of British Columbia, Canada
Miriam Backens, University of Lorraine, France

ABSTRACT
Transdisciplinary LGBTQ+ research in STEM is crucial for addressing complex issues that cannot be fully explored by a single discipline. By combining perspectives from various fields, such as STEM, education, and trans/gender studies, researchers can develop a more comprehensive understanding of key questions and create more inclusive STEM environments. Our trans*-led research team, guided by participatory transdisciplinarity, explored the impacts of support systems on the persistence and well-being of nonbinary individuals in STEM. We conducted reflexive autoethnography with eight trans* researchers across different STEM fields. Through qualitative surveys and focus groups, we identified themes including motivations, positionality, and challenges both within and outside the team.The team was driven by a desire to support the nonbinary STEM community despite internal disagreements and external barriers, such as IRB setbacks and reliance on unpaid labor. To improve future transdisciplinary LGBTQ+ research, we recommend investing in capacity-building activities to strengthen interdisciplinary collaboration and fostering inclusive environments that value diverse contributions. These efforts can further enrich the research process and outcomes.

Related Paper Set

Spilling tea and kikis: Counternarrative explorations of a high school biology teacher

Khanh Tran*, Purdue University, USA

ABSTRACT
Scholars have articulated that engaging in scientific inquiry is a cultural and gendered endeavor rooted in heteronormative Eurocentricity. In science education, these endeavors are normalized and become settled expectations for students who engage in school science: a cis-heteronormative Eurocentric reality for understanding the natural world. In this study, I collaborated with a gender-nonconforming science teacher to consider what disrupting settled expectations looks like by drawing on queer theory and science teachers beliefs. Using spilling tea and kikis as qualitative methods, the safeguarded community of practice embodies queerness through sharing information, social connectivity, and gossiping as forms of counterstorytelling in resisting cultural, social, personal, and political domination of heteronormativity. Using narrative analysis, I developed two narrative threads highlighting stories that elucidate perspectives about nature when revitalizing their indigeneity and the interconnections between indigeneity, nature, and gender expression. The findings suggest that the nature of science could be enacted as a practice of resistance to injustice by distinguishing science epistemology from multiple epistemologies. Secondly, science teachers beliefs and identities are critical to cultivating a rightful presence for queerness. Lastly, this work utilizes spilling tea and kiki, expanding approaches to counterstorytelling for LGBTQ+ individuals.

Related Paper Set

Queering the Scientific Method: How Rosalind Franklin's DNA Work "Reveals" the Queer Nature of Inquiry

Alexander Paulchell*, University of Arizona, USA
Kristin Gunckel, University of Arizona, USA

ABSTRACT

Enhancing the visibility of queer figures in scientific spaces is necessary to promote diversity within the discipline. However, the addition of queer thought moves ideas like rightful presence beyond inclusion towards the disruption and expansion of views of how scientific knowledge is produced and legitimized. This paper challenges prominent depictions of the scientific method to uncover the desire-driven, playful, and queer nature of scientific inquiry. This queer examination reveals a collection of actions that lead to discovery: pleasurable desire, disruption of the normalized confines of knowledge, playful engagement, collaborative exploration, and acts of resistance. To illustrate the liberating value of queering science, this paper revisits Rosalind Franklin's work on the discovery of DNA's helical shape: her willingness to tap into the body's inherent desire to uncover the world's curiosities, the disruption of her fear of failure, her playful engagement with DNA's two forms under different humidity conditions, the elusion of collaborative exploration that hindered the entire research team, and her resistance of simple solutions in favor of more queer, creative insights into data patterns. Working towards rightful presence for queer folks in STEM requires acknowledgement of the long-standing queer nature of scientific inquiries.

Related Paper Set

Designing effective LGBTQ inclusive science curricula and assessing pseudoscientific anti-LGBTQ bias in students

Charlie Blake*, Southern Illinois University Edwardsville, USA

ABSTRACT

Despite recent increases in awareness around inclusive education, LGBTQ students continue to face significant social alienation and violence in educational settings, which also impacts their access to learning and eventually working in STEM fields. Current literature underscores the scarcity of inclusive curriculum content within science education and highlights the pivotal role of inclusive curriculum in increasing safety and success for LGBTQ students. This study employs a collaborative approach with high school educators experienced in inclusive teaching to design inclusive biology materials. The inclusive activities were designed to target prevalent biases in students' thinking such as biological essentialism, binarism, and heterosexism. Preliminary survey data from the high school classrooms participating in the project reveal prevalent bioessentialist beliefs among students, underscoring the urgent need for educational interventions. For example, when presented with a bioessentialist prompt that is not scientifically factual, over a third of students surveyed expressed some level of agreement with the statement: "Femininity and masculinity are determined by biological factors, such as genes and hormones, before birth." This study offers education researchers timely insights into effective DEI strategies for science education and will foster future exploration of additional questions on effective and impactful LGBTQ-inclusive teaching.

Related Paper Set

Imagining Queer Past, Present, and Future Selves in STEM through Manga

Lisa Lundgren*, Utah State University, USA
Mario Suárez, Utah State University, USA
Colby Tofel-Grehl, Utah State University, USA

ABSTRACT

Studies which feature queer youth often focus on the challenges that youth face: bullying, inadequate access to gender-affirming care, and high rates of suicide. In an effort to shift away from a joy deficit perspective (shuster Westbrook, 2022) and damage-centered research (Tuck, 2009), we focus queer and trans joy (Duran Sintos Coloma, 2023; Holloway, 2023; shuster Westbrook, 2022) as frameworks to highlight affirming informal STEM spaces that contribute to thriving. We examined a two-week long informal STEM summer camp, held at a semi-rural college campus in a mostly white, highly religious, Republican-leaning state in the western United States. We collected daily journal sheets with questions about campers science identity and video recordings of consented participants as they shared their storyboards and finished mangas with other campers while using design critique prompts. We postulate that campers who authored themselves into their manga in positive ways (i.e. as heroes), were authoring themselves in as their own role models to counter the context they exist in (semi-rural, highly religious, conservative) that does not necessarily allow for queer joy to exist. Our findings contribute to the literature on how affirming STEM spaces afford youth the opportunity to self actualize queer joy

---

AI in Education Evaluation and Feedback

Strand 12: Technology for Teaching, Learning, and Research
23-Mar-25, 4:30 PM-6:00 PM
Location: Baltimore 5

Stand-Alone Paper

Multilingual Automated Scoring: Enhancing Equity in Science Education with NLP-SCR Across Polysemous Languages

Van Ngo*, Graduate Institute of Science Education, National Taiwan Normal University, Taiwan
John Lin, Graduate Institute of Science Education, National Taiwan Normal University, Taiwan
Chun-Yen Chang, Graduate Institute of Science Education, National Taiwan Normal University, Taiwan

ABSTRACT

In recent years, international assessments have increasingly incorporated constructed response items to better assess students' higher-order thinking skills. These items, which require students to express their understanding in their own words, provide valuable insights but also pose challenges in ensuring consistent and fair scoring across different languages.

This study examines the effectiveness of NLP-SCR, a Natural Language Processing model trained on 900 samples each for Chinese and Vietnamese, in automatically scoring these responses. We evaluated the model's performance on two science education items using key metrics: Precision, Recall, F1-Score, ROC-AUC, and Accuracy. The results indicated no significant difference in scoring accuracy between the two languages, with the metrics demonstrating comparable performance across both. Statistical analysis, including paired sample t-tests ($t = 1.36$, $p = 0.245$ for Item 1 and $t = 0.81$, $p = 0.463$ for Item 2) and effect size calculations (Cohen's $d = .61$ for Item 1 and .36 for Item 2), confirmed that NLP-SCR maintains consistent performance across languages without compromising the validity of the assessment items. These findings suggest that NLP-SCR is capable of effectively automating the scoring of constructed responses in multilingual contexts, supporting equitable and valid assessments in international science education.

Stand-Alone Paper

Cognitive synergy of human intelligence and artificial intelligence in designing equitable science assessments

Tingting Li*, Washington State University, USA

ABSTRACT

This study explores the intersection of human intelligence and Artificial Intelligence (AI) to design knowledge-in-use science assessments for supporting students' deep science learning. In the context of evolving educational paradigms, it seeks to harness AI tools (GPT), to democratize and elevate knowledge-in-use assessments, ensuring equitable opportunities for diverse learners. Anchored in the Next Generation Science Assessment and an evidence-centered design, this study aspires to harmonize AI's computational strengths with human expertise in assessment design. Drawing from an array of theoretical frameworks-Hybrid Intelligence System, Distributed Cognition, and Self-Regulated Learning Theory-the study underscores the multifaceted and dynamic nature of knowledge-in-use and the symbiotic integration of human and AI. Employing a Design-Based Research approach, the study proceeds in two stages: (1) Iteratively training GPT models for effective designing knowledge-in-use assessments; and (2) Gathering multidisciplinary expert feedback on AI-co-designed assessments. Diverse data analysis techniques, encompassing thematic analysis, descriptive statistics, hierarchal coding, and user experience feedback, are leveraged. Anticipated results spotlight an exploratory GPT model adept at creating tailored assessments resonating with diverse learning needs while emphasizing equity, adaptability, and inclusivity. This study holds the potential to significantly enhance the educational landscape by advocating a balanced approach where AI complements human expertise.

Stand-Alone Paper

Knowing Lecturer through Cyber-Security Students' Eyes, an Insights for Teaching Success with Machine Learning Algorithms

Michael Adewusi*, Kampala Internation University, Uganda
Ola Odekeye, Osun State University, Nigeria
Adeshina Adebanjo, Lagos State University, Nigeria

ABSTRACT
This study investigates the significant impact of lecturer behaviors and personality traits on teaching success, with a focus on fostering an interactive classroom environment. This study employed a structured survey using Google Forms, consisting of 30 questions, to gather data from 477 cybersecurity students across various institutions. Data preprocessing included handling outliers and normalizing scales to ensure quality and consistency, with no missing values detected due to compulsory fields. Reliability analysis yielded a Cronbach's Alpha coefficient of 0.83, indicating good internal consistency. Using statistical models, including decision tree and neural networks, the analysis found that traits such as clear guidelines for assignments, lecturer enthusiasm, and encouragement of critical thinking were most strongly associated with teaching success. The neural network model, emerged as the most accurate predictor, demonstrating perfect linear relationships between personality traits, student evaluations, and teaching success, with an R value and R Square of 1.000. In conclusion, the study suggests that educational institutions should support lecturers in implementing active learning strategies, providing constructive feedback, and maintaining approachability to enhance teaching effectiveness. Addressing negative behaviors through professional development can improve teaching practices.

Stand-Alone Paper
Integrating Open-Source LLMs for Automatic Feedback into Physics Classes
André Meyer*, Leibniz University Hannover - Physics Education Group, Germany
Tom Bleckmann, Leibniz University Hannover - Physics Education Group, Germany
Gunnar Friege, Leibniz University Hannover - Physics Education Group, Germany

ABSTRACT
This paper investigates the potential of quantized open-source Large Language Models (LLMs) for automatically providing feedback on students' written responses to physics problem-solving tasks. A quantized version of the OpenChat-3.6-8b LLM achieved an accuracy of 85% when dichotomously rating 410 student answers to seven different physics tasks and generated physically correct feedback for 92% of the student answers. These results are comparable to those of popular closed-source LLMs like ChatGPT.The computation was performed on a standard computer to explore the feasibility of using this model on hardware accessible to schools. Under these conditions, a computation time of 7.5 seconds per student answer was achieved, which is considered reasonable for providing feedback in a classroom setting.

Uncertainty, Perspective Taking and Reasoning in Science
Strand 13: History, Philosophy, Sociology, and Nature of Science
23-Mar-25, 4:30 PM-6:00 PM
Location: Baltimore 2

Stand-Alone Paper
Towards an Integrative Framework on Uncertainty in Science Teaching

Simon Blauza*, University of Münster, Centre for Biology Education, Germany
Kerstin Kremer, Justus Liebig University, Institute for Biology Education, Germany
Benedikt Heuckmann, University of Münster, Centre for Biology Education, Germany

ABSTRACT
Uncertainty is central to science and increasingly recognized in STEM education, yet the types of uncertainties discussed, and the competencies described for navigating uncertainty vary between subjects. To propose an integrative framework on uncertainty in science teaching, we conducted a two-stage Delphi study with STEM experts (nRound1 = 33; nRound2 = 48). In the first qualitative round, experts provided written statements on their conceptions of uncertainty, rated definitions, added missing aspects, and reported important aspects of uncertainty for STEM education. In the second quantitative round, 58 closed-ended items were used to assess consensus regarding types of uncertainty and competencies to navigate it using a 5-point rating scale, with consensus defined as at least 70% agreement. The first round revealed that experts largely agreed on the relevance of uncertainty in STEM education but provided nuanced critiques influenced by their disciplines. The second round demonstrated a high level of consensus on the types of uncertainty and corresponding competencies, suggesting that the proposed framework can support comprehensive interdisciplinary discussions in science education and can serve as a starting point for navigating uncertainty. This research is significant for science educators and STEM instructors interested in nature of science and interdisciplinary science education.

Stand-Alone Paper

Dealing with Uncertainty in Science Education: A Systematic Review

Isa Korfmacher*, University of Münster, Centre for Biology Education, Germany
Christiane Konnemann, University of Münster, Centre for Biology Education, Germany
Marcus Hammann, University of Münster, Centre for Biology Education, Germany

ABSTRACT
Uncertainty is an inherent aspect of science, yet current events like the COVID-19 pandemic and the climate crisis highlight that individuals often struggle to understand uncertainty in science, resulting in confusion and distrust. While both science education and science communication aim to address this issue, a review in the latter field has shown varying effects of communicating different types of uncertainty. Building on this, this study presents a systematic review of relevant studies in science education to explore educationally focused questions. We investigate how a deductively derived categorization of uncertainty (e.g., internal uncertainty, technical uncertainty, consensus uncertainty) provides insights into associations between types of uncertainty and different educational objectives (RQ1), as well as different strategies for dealing with uncertainty (RQ2). Additionally, we examine the effects of interventions aimed at achieving the learning goal of understanding uncertainty in science (RQ3). Relevant papers (n = 48) were systematically categorized inductively for RQ1 (e.g., scientific knowledge, scientific meta-knowledge) and RQ2 (e.g., using uncertainty, engaging with uncertainty). Our results indicate that different uncertainty types are associated with different educational objectives and different strategies. Few studies

reported intervention effects towards understanding uncertainty. Research desiderata are formulated and recommendations for practice are discussed.

Stand-Alone Paper

Suffering as a lens through which to motivate socioscientific perspective taking

David Owens*, University of Montana, USA
Robert Warner, University of Utah, USA
Mark Newton, East Carolina University, USA

ABSTRACT

Scientific literacy requires the ability to understand different perspectives, but motivating individuals to consider viewpoints differing from their own can be challenging. Compassion, characterized by a desire to alleviate others' suffering, might naturally provide such motivation. This study investigated whether experiencing another's suffering could impel participants to reason more deeply about their perspectives of those adversely affected in the context of online instruction about the Coronavirus outbreak and the potential for mandatory public vaccination to address it. Participants were one hundred five undergraduates enrolled in a science course who completed pre- and post-assessments, including open-ended questions on motivation and perspective taking, which were thematically analyzed, and the codes that resulted quantified. Thematic analysis revealed that 30% of participants indicated being motivated to understand and address the issues out of concern for others' wellbeing. Path analysis indicated that suffering only influenced perspective taking when it was accompanied by motivation to understand and respond to the issue. This suggests that a compassionate lens could serve to motivate perspective taking, and that engendering empathy and an ethic of care in your students could impel them to more deeply consider opposing perspectives and thereby exhibit scientific literacy.

Stand-Alone Paper

Futures Reasoning for Science Education

Senay Purzer*, Purdue University, USA
Duru Bayram*, Eindhoven University of Technology, Netherlands
Nazan Bautista*, Miami University, USA

ABSTRACT

Capacity for futures reasoning is essential to support decisions with long-term consequences, particularly in the context of competing criteria such as climate actions and other socioscientific issues. This state-of-the-art review synthesizes the existing body of literature on futures reasoning, identifying the current state of research and highlighting potential opportunities for education and further inquiry. The findings reveal that futures reasoning emerges as a necessary competency, encompassing critical thinking about the long-term implications of decisions and the integration of qualitative evidence, values, and ethical considerations into decision-making processes. This paper underscores the urgent need to incorporate futures reasoning into K-12 science education, thereby preparing students to engage with complex, ethically charged issues and to envision and work towards sustainable and just futures. By reimagining the future of science education through the lens

of futures reasoning, educators can empower students to think critically, creatively, and collaboratively about the challenges they will face, fostering a generation capable of making informed decisions that positively impact society and the environment.

Climate Change

Strand 14: Environmental Education and Sustainability
23-Mar-25, 4:30 PM-6:00 PM
Location: Baltimore 3

Stand-Alone Paper

New Jersey Elementary Teachers' Professional Learning about Climate Change

Lauren Madden*, The College of New Jersey, USA

ABSTRACT

New Jersey became the first state in the US to adopt learning standards that support climate change education K-12 in science and across all subject areas. Though there has been some funding from the state providing teachers with support for teaching about climate change, little is known about teachers' preparedness to implement developmentally appropriate climate change instruction in K-5 settings. This study uses interviews from 17 NJ elementary school teachers who participated in a classroom observation study to describe professional learning related to climate change. Though professional learning varied across the dataset, a large majority of respondents indicated that self-directed learning was their primary mode of professional development about climate change, followed by attendance at workshops or webinars. Additionally, several participants reported having no access to professional development provided by their school or district on the topic, despite the introduction of standards. When asked about plans for future professional development related to climate change, only two of the interviewees were able to provide specific examples.These findings suggest that more coherent professional learning opportunities are needed to support teachers in integrating climate change, and that mechanisms should be created to acknowledge teachers' self-directed learning on climate change and other up-and-coming topics.

Stand-Alone Paper

Teachers' Perceptions of Climate Science Uncertainty and Concerns about Implementing Climate Change Education

Ren-Ping Li*, National Taiwan Normal University, Taiwan
Shiang-Yao Liu, National Taiwan Normal University, Taiwan

ABSTRACT

Amid the global climate emergency, climate change education (CCE) is essential for raising awareness and equipping individuals to manage climate-related risks and uncertainties. Despite the international trend toward mainstreaming CCE, many teachers are hesitant to address these topics due to misunderstandings about climate science and concerns about

adopting new curricula. This study investigated Taiwanese teachers' perceptions of uncertainty in climate science using Visschers' (2018) instrument and identified their primary concerns about implementing CCE using the Stage of Concern (SoC) questionnaire. Employing a sequential explanatory mixed methods design, the study analyzed quantitative data from 409 teachers and conducted semi-structured interviews with 19 teachers. Results indicated that both science and non-science teachers generally recognized the inherent uncertainties in climate science, though the underlying reasons for their perceptions differed according to interview results. Regarding SoC, most teachers remained in the lower stage, primarily seeking more information about CCE. Science teachers showed significantly higher concerns in the personal and refocusing stages compared to non-science teachers, reflecting a greater focus on CCE curriculum implications and improvements. The interviews suggested that perceptions of uncertainty might be influenced by interdisciplinary thinking and attitudes toward science, beyond mere familiarity with climate science.

Stand-Alone Paper

Fostering Agency and Decision-Making in Dealing With Climate Change: A Three-Lenses Approach

Giulia Tasquier*, ALMA MATER STUDIORUM - University of Bologna, Italy
Francesca Pongiglione, Vita-Salute S. Raffaele University, Italy
Elena Ricci, University of Verona, Italy

ABSTRACT

The young generations show an unprecedent willingness to contribute to climate change (CC). However, surveys show that false beliefs about CC are widespread, with the result of concentrating efforts on ineffective actions. Forms of radical activism are taking place, and show a lack of orientation among young people, who have trouble understanding how to become agents of change. Youngsters' widespread false beliefs should perhaps not come as a surprise. The improvement of science education in schools, despite being in the UNESCO agenda for over 60 years, is still underrealised. Almost half of the national curricula worldwide do not refer explicitly to CC. The importance of incorporating social and transformative dimensions of science into school curricula has been widely investigated in science education in recent years. However, the point is how to do this effectively since the complexity of the processes involved in CC and the difficulty of associating one's own actions with CC often lead to inaction. In this paper, cross-cutting knowledge from the lenses of philosophy, economics, and science education will be combined to investigate agency in the context of CC.

Stand-Alone Paper

Beyond their carbon footprints: Secondary school students' hope and action in face of climate change

Veronika Winter, University of Vienna, Austria
Miloslav Kolenatý, J. E. Purkyně University, Czech Republic
Jan Činčera, Masaryk university, Czech Republic
Andrea Möller*, University of Vienna, Austria

ABSTRACT
To address negative emotions and overcome a lack of efficacy in combatting climate change, fostering students' hope that a climate just transition can be achieved is pivotal. Hereby, learning environments are needed which integrate an affective dimension and focus on efficient, collaborative ways to reduce carbon emissions. To provide the ground for designing such interventions, this cross-sectional study investigates the connections between secondary school students' climate change hope and action both on the individual and collective sphere, considering low-impact as well as high-impact actions. Further, students' reasons for hope (or the lack of it) were examined. In a mixed methods approach, data of 437 students (grades 8-11) were collected. Results reveal that much of students' hope is placed on the individual, in contrast to the collective ability of society to respond to the climate crisis. However, they at the same time scored low on their current climate action, especially for multiplicative and political climate action. To confront former individualistic, disempowering frameworks, our results imply that climate change instruction should increasingly focus on providing positive narratives of how to combat climate change, theories of societal change and a holistic approach towards solutions including both actions at the individual and collective sphere.

Supporting Policy Infrastructure in Computer Science and Engineering

Strand 15: Policy, Reform, and Program Evaluation
23-Mar-25, 4:30 PM-6:00 PM
Location: Camellia 1

Stand-Alone Paper

Working Across Boundaries: Examining the Computer Science Education Social Networks Within States

Stefanie Marshall*, Michigan State University, USA
Ain Grooms, University of Wisconsin, USA
Joshua Childs, University of Texas, USA
SJ Hemmerich*, University of Wisconsin, USA
Grace Tukurah*, Michigan State University, USA

ABSTRACT
The scalability of Computer Science Education (CSEd) is largely dependent upon a state's infrastructure design to support and translate state-level equity-centered CSEd policies for local school contexts. CSEd must be addressed at the state level for substantive changes to support equitable CSEd adequately. Therefore, CSEd leaders from various organizations must work collectively to build the necessary infrastructure for equitable CSEd in their state. This study uses comparative case study design to understand the designs of state CSEd infrastructure, the actors that participate in and contribute to a state's CSEd infrastructure, and the ways actors are connected within and across states to advance CSEd. Preliminary findings of this study thus far include: 1) The capacity within a network is related to the ability to advocate across diverse institutions and their boundaries; and 2) there is a misalignment

of power and goals between the technology industry and state K-12 CSEd equity goals preventing the realization of equity-focused CSEd goals.

Stand-Alone Paper

Inventing the Inventor: Identifying the capacities needed to be an inventive problem solver.

Adam Maltese, Indiana University, USA
Lauren Penney, Indiana University, USA
Kelli Paul*, Indiana University, USA
Peter Wardrip, University of Wisconsin, USA
Joanna Garner, Old Dominion University, USA

ABSTRACT

Educators and researchers face a persistent challenge – how to best prepare learners to be inventive problem-solvers for the future. Despite consistent calls for making youth future-ready, there have been few major shifts in educational practice in this direction. We feel that one reason for this is due to the lack of clear, consistent terminology, definitions and indicators of the capacities needed for learners to become inventive. We used a modified Delphi study with a diverse panel of experts, to address the research question: What capacities do youth need to become inventive problem-solvers? Through multiple rounds of surveys and analysis we created a set of 43 capacities and strategies that are useful for problem solving. In this presentation we will share this process, the results and engage the audience in discussion around how these ideas can be used in future research and reform.

Stand-Alone Paper

Engineering Undergraduate Students' and Engineers' Career Choice and Retention with Focus on the Gender Aspect

Yehudit Dori*, Technion—Israel Institute of Technology, Israel
Hagit Refaeli-Mishkin, Technion—Israel Institute of Technology, Israel
Niva Wengrowicz, Technion—Israel Institute of Technology, Israel
Shahaf Rocker Yoel, Technion—Israel Institute of Technology, Israel
Dov Dori, Technion—Israel Institute of Technology, Israel

ABSTRACT

The underrepresentation of women in engineering is a significant concern. This study employs theSocial Cognitive Theory (SCT) and theSocial Career Cognitive Theory (SCCT) to explore career choice factors among 19 systems engineers—Group 1 and 330 engineering undergraduate students—Group 2. Using interviews and questionnaires, we identified and validated SCCT categories for each SCT theme, uncovering gender differences across various categories. Two new categories:''Challenges and opportunities'' and ''Current job suitability'' emerged for engineers within the behavioral theme. We analyzed the variations in distributions across themes and categories between genders within each group. For engineers, 'Self-efficacy' correlated significantly with 'Challenges and opportunities' and 'Current job suitability'. Undergraduate engineering students favored the personal over environmental theme, and the behavioral theme was the least frequent.The research

provides valuable insights into gender-dependent engineering career choice and retention factors by expanding SCCT categories, including two newly found categories. These findings contribute to a deeper understanding of the factors influencing engineering career decisions and retention, potentially informing strategies to address gender disparities.The study's implications extend to educational institutions, industry stakeholders, and policymakers, offering a foundation for developing targeted interventions to promote gender diversity and inclusivity in engineering education and careers.

Mentor-Mentee Nexus
23-Mar-25, 6:00 PM-7:00 PM
Location: Annapolis 1
Social Event

President's Welcome Reception & Dance
23-Mar-25, 7:00 PM-10:00 PM
Location: Woodrow Wilson Ballroom
Social Event

In-Person Conference Day 2
24 March 2025

RIG Business Meetings
24-Mar-25, 7:00 AM-8:00 AM

Latino/a RIG (LARIG) Business Meeting
Location: Annapolis 1

Contemporary Methods for Science Education Research Business Meeting
Location: Annapolis 2

Engineering Education RIG (ENE-RIG) Business Meeting
Location: Annapolis 3

Indigenous Science Knowledge Research Interest Group (ISK-RIG) Business Meeting
Location: Baltimore 1

Lesbian, Gay, Bisexual, Transgender, Queer, Plus Science Education Research Group (LGBTQ + RIG) Business Meeting
Location: Baltimore 2

Research in Artificial Intelligence-Involved Science Education (RAISE) Business Meeting
Location: Baltimore 3

Asian and Pacific Islander Science Education Research (APISER) Business Meeting
Location: Baltimore 4

Continental and Diasporic Africa in Science Education RIG (CADASE) Business Meeting
Location: Baltimore 5

Mind and Sole Fun Run
24-Mar-25, 7:00 AM-8:00 AM
Location: Offsite
Social Event

Early Career Faculty Forum
24-Mar-25, 7:00 AM-8:00 AM
Location: Magnolia 1

Administrative Session
Organizers
Joi Merritt, James Madison University, USA
Harleen Singh, California State University Stanislaus, USA

ABSTRACT
The Early Career Faculty Forum introduces junior faculty members and post-doctoral fellows to peers, to a panel of recently promoted colleagues, and prominent scholars. The forum will focus on the nuances of succeeding during the early career years. Our discussions will include issues of developing and maintaining a research agenda (e.g., publications & grant writing), adhering to teaching responsibilities, and effective ways for engaging in meaningful service experiences. In addition, the forum will explore many of the challenges related to maintaining balance in your life in the process.

Fostering Inquiry in Southern African Schools
24-Mar-25, 8:15 AM-9:45 AM
Location: Camellia 1

Administrative Session
Organizers
Umesh Ramnarain, University of Johannesburg, South Africa
Joseph Krajcik, Michigan State University, East Lansing, USA
Panelists
Tebogo Moloi, University of Johannesburg, South Africa
Sechaba Koma, National University of Lesotho, Roma, Lesotho
Lereko Mohafa,National University of Lesotho, Roma, Lesotho
Katlego Leshabane, University of Johannesburg, South Africa
Nolutuando Mdlalose, University of Johannesburg, South Africa
Mafor Penn, University of Johannesburg, South Africa

ABSTRACT
The landscape of science education is continuously evolving, driven by the need to equip future generations with 21st-century skills such as decision-making, critical thinking, creative thinking, communication, and collaboration necessary to navigate a complex and rapidly changing world. Reform for school science in Southern Africa reflects this global trend (Department of Basic Education, 2011), with various curriculum documents underscoring goals for learners to acquire these competencies through student-centered instructional approaches such as inquiry-based learning. This paper-set of oral presentations by six panelists focuses on a set of research papers that delve into and examine innovative approaches in science teaching and learning, focusing on the experiences and strategies of pre-service and in-service teachers as they adapt to new pedagogical strategies and the challenges they pose. .Together, these papers offer a comprehensive look at the current trends and challenges in science education in Southern Africa, providing valuable insights for educators, researchers, and policymakers throughout the globe. By exploring innovative teaching strategies and technological innovations, this paper aims to contribute to the ongoing discourse on how to support students in taking part in the inquiry and how best to prepare teachers and students for the demands of 21st-century science classrooms.

Graduate Student Research Symposium

24-Mar-25, 8:15 AM-9:45 AM
Location: Cherry Blossom Ballroom

Administrative Session
Organizers
Savannah Graham Hayes, Space Center Houston, USA
Johan Tabora, University of Illinois at Chicago, USA
Mutiara Syifa, The Ohio State University, USA
Austin Jenkins, Purdue University, USA
Andrea Reeder, Middle Tennessee State University, USA
Brandin Conrath, Pennsylvania State University, USA
Alyssa Freeman, Middle Tennessee State University, USA
Sierra Morandi, Florida State University, USA
Cathy Cullicott, Arizona State University, USA
Allison Metcalf, Florida State University, USA

ABSTRACT
The purpose of this symposium is to support graduate students as they develop their research projects by providing an opportunity to present works-in-progress and receive feedback from a symposium mentor in addition to NARST attendees. The works-in-progress are emerging research undertaken by yourself as a graduate student where you collected data or began to analyze the findings with support from NARST members.

Research in Artificial Intelligence-involved Science Education: RAISE RIG Poster Session

24-Mar-25, 8:15 AM-9:45 AM
Location: Annapolis 2

Administrative Session

Organizers
Xiaoming Zhai, University of Georgia, USA
Kent Crippen, University of Florida, USA
Van Hoang Ngo, Taiwan Normal University, Taiwan
John Lin, Taiwan Normal University, Taiwan
Chun-Yen Chang, Taiwan Normal University, Taiwan
Shuchen Guo, Nanjing Normal University, USA
Ehsan Latif, University of Georgia, USA
Jinnie Shin, University of Florida, USA
Richard Lamb, University of Georgia, USA
Gyeong-Geon Lee, National Institute of Education, Singapore

ABSTRACT
The burgeoning of artificial intelligence (AI) technologies has offered considerable potential to revolutionize the field of education, while also invited various challenges to fulfill successful practice, especially in the realm of science education. There is an urgent and unmet need to scrutinize the multifaceted roles, capabilities, ethical considerations, and potential biases of applying AI in science educational context. This symposium serves as a timely platform to address these critical issues, featuring a curated selection of groundbreaking research papers that delve into diverse aspects of AI's application in education. The papers cover a wide range of topics, including exploring the impact of imbalanced datasets on the efficacy of automated scoring using NLP, the use of multi-agent LLMs for improving automatic feedback and the evaluation of teacher performance in critiquing AI-generated items. The session will also present studies on emphasizing and enhancing students' holistic reading of socio-scientific issues in GenAI scenario, the use of AI to analyze and predict student cognitive and affective states during science assessment through mouse micromovement, and a review of the policy and actions taken for Integrating Generative AI in U.S. Through this intellectual gathering, we aim to catalyze a rich, multidisciplinary dialogue among educators, researchers, technologists, and policymakers. We hope to foster a more nuanced and comprehensive understanding of how we can responsibly and effectively navigate the increasingly complex intersection of AI and science education, thereby shaping a more equitable and informed future.

Making sense of the microcosm: Perspectives of educators and learners on immunobiology

Strand 1: Science Learning: Development of student understanding
24-Mar-25, 8:15 AM-9:45 AM
Location: Azalea 3

Related Paper Set

US childrens understanding of viral transmission

David Menendez*, University of California Santa Cruz, USA
Tania Dhaliwal, University of Chicago, USA
Danielle Labotka, University of michigan, USA
Susan Gelman, University of michigan, USA

ABSTRACT

Since the onset of the pandemic, it has become increasingly obvious how having a robust understanding of viruses and viral transmission is critical to childrens everyday lives. This study was designed to examine whether these different communities would think differently about viruses. We recruited children ages 5-12 from suburban communities near universities (N = 104), low-income Black and Latinx communities (N = 101), and white rural communities (N = 108) to assess their knowledge of viruses and viral transmission. Children completed two one-on-one online sessions, one about COVID and one about the flu. All children had some knowledge about viruses, but many had a mechanical model of viruses thinking of them as dust; university communities (COVID = 74%, Flu = 76%), white rural communities (COVID = 71%, Flu = 65%), Black and Latinx communities (COVID = 53%, Flu = 62%). Older children in all communities knew more about viruses than younger children; university communities (F(1, 103.55) = 59.31, p.001), Black and Latinx communities (F(1, 98.23) = 45.62, p.001, rural communities (F(1, 105.75) = 47.01, p.001). These results highlight that elementary school students have some understanding of illness, but might not have a scientifically accurate model of viruses

Related Paper Set

Multilingual Students Use of Metaphors in the Context of Immunological Processes

Ronja Sowinski*, Leuphana University Lueneburg, Germany
Elisabeth Hofer, Leuphana University Lueneburg, Germany
Simone Abels, Leuphana University Lueneburg, Germany

ABSTRACT

Metaphors are a crucial factor in students biological content learning, as they are used to make abstract phenomena more comprehensible. Therefore, metaphors are used in biology education to support students learning. However, metaphors might even impede the understanding of non-native speakers: They must not be understood literally, but in a transferred sense, and the usage of metaphors differs between different languages as well as cultures. So far, it is still unclear what impact different first languages have on students use of metaphors with respect to their biological content learning.This study examines which metaphors students with different first languages use when talking about immunology, and

to what extent and kind the metaphors differ. For this purpose, guided interviews with 10th grade students (1517 years old) were conducted. Additionally, information about students language biography was collected.The interviews are analyzed by using a combination of Qualitative Content Analysis and Systematic Metaphor Analysis. Using these methods, a deeper insight into the connection between content and language was gained.Results show that students use of metaphors differs individually. Contradictory to the state of research, 18 different types of metaphors were found, of which some metaphors were used just by single students.

Related Paper Set

Evil witches invading your house: How pre-service teachers use metaphors and anthropomorphisms to explain immunobiology

Isabell Adler*, Teacher University Bern, Switzerland
Jakub Sowula, Teacher University Bern, Switzerland
Trix Cacchione, University of Applied Sciences and Arts Northwestern Switzerland, Switzerland
Sebastian Tempelmann, Teacher University Bern, Switzerland

ABSTRACT

The field of immunobiology involves a high number of metaphors and anthropomorphisms in its scientific terminology. In education, metaphors and anthropomorphisms can aid learning but are also frequently applied unconsciously and not always effectively. This study investigates how pre-service primary school teachers use such language when explaining viral infections and immune responses to different audiences first graders, sixth graders, and experts. Twenty-four pre-service teachers from Switzerland participated, each producing explanatory texts for two of the target groups. The findings reveal that teachers use more metaphors and anthropomorphisms when addressing younger students, with the highest levels in first-grade explanations, employing a variety of living and non-living metaphors. The most metaphors were triggered by the contexts of immune cells and viruses, with virus metaphors for first graders often containing the attribute evil, which was largely absent in explanations for sixth graders or experts. Notably, none of the teachers explicitly introduced metaphors or anthropomorphisms, nor did they highlight their limitations, indicating unreflective use. The study underscores the need for teacher education programs to provide guidance on the strategic use of metaphors and anthropomorphisms, ensuring effective and accurate science communication in classrooms.

Related Paper Set

Children's Questions and Teacher's Responses about COVID-19 in Türkiye and the US

David Menendez, University of California, Santa Cruz, USA
Ronja Sowinski, Leuphana University of Lüneburg, Germany
Isabell Adler, University of Teacher Education Bern, Switzerland
Anna-Clara Rönner, University West, Sweden
Graciela Trujillo Hernandez*, University of Rochester, USA

ABSTRACT

Children use questions as tool to help them acquire information about unseen entities, such as viruses. Therefore, considering children's questions in the context of COVID-19 can provide some insight into how and what children learned about Coronaviruses.The study examined 3-12-year-old children's questions and teachers' responses about the COVID-19 pandemic in Türkiye, a non-Western developing context, and the US, a Western cultural context. A total of 119 teachers from Türkiye and 95 teachers from the US participated in the study. Teachers completed an online survey consisting of a demographic form and a questionnaire asking them to report three questions about COVID-19 asked by children in their classrooms and their responses to these questions. We analyzed children's questions and teachers' responses for their type and content and examined demographic factors associated with children's questions and teachers' responses. Consistent with the literature, children from Türkiye asked fewer explanation-seeking (i.e., why/how) questions than children from the US. Children asked questions about viruses and precautions. Teachers responded to children's questions realistically in both countries.These findings demonstrate the important role that teachers play in how children acquire knowledge about health, disease, and viruses.

Related Paper Set

Teaching infectious diseases at middle schools during and in the aftermath of the COVID-19 pandemic

Anna-Clara Roenner, Department of Environmental and Life Sciences, Sweden
Anna Jakobsson, Department of Educational Sciences, Individual and Society, Sweden
Niklas Gericke*, Department of Environmental and Life Sciences, Sweden

ABSTRACT

The COVID-19 pandemic had an impact on pupil's daily lives worldwide, emphasising the pivotal importance of infectious diseases. This study aims to delineate the teaching of diseases in middle schools, investigating how content and instruction was influenced by the pandemic. Semi-structured individual interviews were conducted with teachers. The analytical method involved thematic analysis. The first analysis concerned teaching content and was based on the framework of contagion literacy. The second analysis investigated the teaching approaches and used an inductive analysis. Our findings suggest that the pandemic had an impact on the enacted biology teaching in relation to diseases. Teaching largely revolved around student-initiated, question-driven discussions about current events related to societal health initiatives within schools, rather than expanding the planned biology curriculum. The main finding is that teachers focused on hygiene and to influence students' behaviours interactively, and that the pandemic was not fully exploited by the participating teachers to develop more curriculum-based teaching including functional and critical health literacy perspectives. The study recommends that biology teachers collaborate with school health teams and engage in interdisciplinary work. It also suggests amending primary science teacher education to meet the need to teach the young people in the event of future pandemics.

Enhancing Science Teacher Knowledge and Practices

Strand 10: Curriculum and Assessment
24-Mar-25, 8:15 AM-9:45 AM
Location: Magnolia 1

Stand-Alone Paper

The Challenge of Competence in Primary and Lower Secondary Science Education – examples from Denmark

Jørgen Christiansen*, University of Copenhagen, Denmark

ABSTRACT

This paper explores the challenges associated with competence-based science education in Danish primary and lower secondary schools. Denmark's science curriculum emphasizes four sub-competences: inquiry, modelling, perspective-taking, and communication. However, difficulties arise from varying interpretations of these competences and the complexities involved in their assessment. Through interviews and classroom observations with 27 teachers, the study reveals significant challenges in both understanding and implementing competence-oriented teaching. Teachers often struggle to distinguish competence-based approaches from traditional methods. The paper argues for a re-evaluation of the competences deemed essential for scientific literacy, proposing a focus on empirical and modelling competences that align more closely with scientific methodologies. Additionally, the study highlights the need for structural support and professional development to facilitate effective competence-oriented education.

Stand-Alone Paper

Exploring Chemistry Teachers' Professional Knowledge and Noticing Through the Experience in a Chemistry-based Escape Room

Abir Saleh*, Technion – Israel Institute of Technology, Israel
Shirly Avargil, Technion – Israel Institute of Technology, Israel

ABSTRACT

Studies have examined the experiences and perceptions of students in collaborative and dynamic learning environments. However, the aspect of teachers' knowledge of assessment had not been studied in this setting.Through a physical chemistry-based escape room (CER), designed for high school students, we examined chemistry teachers' formative assessment (FA) knowledge and their perceptions of noticing a variety of students' learning situations. The CER helps teachers focus not only on content knowledge but also on students' discourse and 21st century skills. Qualitative approach was employed. Study participants were 52 chemistry teachers who attended a professional development program and then visited the CER with their students. We collected data using teachers' assignments, reflections and interviews, based on video recordings of their students in the CER.Results indicated that three characteristics of teacher assessment knowledge were identified. Also, in CER chemistry teachers emphasized students' 21st century skills, such as strategies, collaboration, and involvement. In addition, they emphasized chemical thinking, as well as affective aspects. Moreover, teachers suggested five different techniques for acting and responding to

students' CER experiences.This study advances the knowledge about FA and assessment knowledge through teachers' professional noticing specifically in learning environments that promote collaboration in problem-solving.

Stand-Alone Paper

Intellectual humility and other content transcendent goals for science education

Jonathan Osborne*, Stanford University, USA
Daniel Pimentel*, University of Alabama, USA

ABSTRACT

Many arguments for learning science focus on content-transcendent goals. For instance, that students will become "critical consumers' of scientific information. Such goals are not dependent on any specific content but can be seen as a general outcome – the product of a set of cumulative experiences of diverse content.Such goals matter as they have the potential to endure long after elements of content have been forgotten and provide something which communicates the cultural and intellectual value of the discipline.In this paper, we argue for the importance of two long forgotten but interconnected goals – intellectual humility and awe and wonder. School science operates under the Kantian imperative that it is sufficient to warrant intellectual independence. This contributes to a misplaced intellectual hubris and serves students poorly. As for awe and wonder, this has become lost in an 'anaesthetic of familiarity' of the unequivocal, unquestioned and uncontested content that dominates standard curricula.We begin by discussing each of these elements separately making the case for their import and then draw on evidence which shows the two are associated. We then look at pedagogic strategies which can be deployed to place these more centrally in the science curriculum for K-12 students.

Stand-Alone Paper

Examining Students' Scientific Inquiry Patterns Using Sequential Process Data

Yizhu Gao*, University of Georgia, USA
Xiaoming Zhai, University of Georgia, USA
Hee-Sun Lee, The Concord Consortium, USA

ABSTRACT

Univariable reasoning is widely used in science inquiry and problem-solving, which denotes coordinating effects of a single variable on an outcome. Previous studies have identified strategies that students apply univariable reasoning and their impact on science investigation. However, students often do not immediately figure out an optimal strategy. Instead, they typically engage in an iterative process of testing and refining their approaches as they investigate the phenomena. This trial-and-error process is crucial for understanding how students' univariable reasoning evolves to construct a comprehensive profile of students' scientific inquiry processes. This study combined theory-driven and data-driven analyses to profile students' scientific inquiry patterns, which comprise sequential strategies combinations, and compare them across varying grades. Specifically, this study involved 251 high school students from the United States who participated in interactive simulations about influential factors of wildfire. We extracted students' process data and task

performance recorded in log files. Results from K-means Clustering and full-path sequence analyses revealed eight groups with distinct inquiry patterns. By comparing representative inquiry patterns of each group, we identified students' different cognitive processes, even when their task performance is similar.

Stand-Alone Paper

A Mixed-Methods Investigation of Elementary/Middle School Science Teachers' Curriculum Use and Perceptions of Effectiveness

Tina Vo*, University of Nevada, Las Vegas, USA
Mayra Marquez-Mendez, University of Nevada, Las Vegas, USA
Adjoa Mensah, University of Nevada, Las Vegas, USA

ABSTRACT

Science teacher shortages are at an all-time high, with shortages across 48 states (Darling-Hammond et al., 2023). The retention and attrition of science teachers in education is a critical concern, as it directly impacts the quality of science education in schools, with high teacher turnover being connected to student achievement and well-being (Carver-Thomas, D. Darling-Hammond, 2017). While there are many factors that play a role in general teacher attrition (e.g., student-to-discipline ratio; Harrell et al., 2019), there are additional complexities that should be considered in a high-needs discipline like science education, which often requires additional materials, training, and curriculum to meet the needs of students and create opportunities for science learning and growth. Currently, commercial curricula are the most prevalent resource used within science classrooms. As the expectations for districts, schools, and teachers to help students become more science literate continue to grow, it becomes important to understand how teachers perceive and evaluate the usage of these materials and how that reflects their effectiveness in teaching science. This mixed methods study of 119 elementary and middle school teachers investigates these perceptions.

Considering Context: Space and Place in Engineering Education

Strand 11: Cultural, Social, and Gender Issues
24-Mar-25, 8:15 AM-9:45 AM
Location: Azalea 1

Related Paper Set

Community-Based Engineering Learning in Familiar Contexts: Learning and Engineering Design Supported by Long-Term Relationships

Monica Cardella*, Florida International University, USA

ABSTRACT

Many undergraduate engineering programs have adopted Community-Based Learning approaches where students work on projects with community partners. One concern in community-based engineering learning is the relationships that students have with the

community partners; do students see community partners as having relevant knowledge and expertise, or just as needing the students' help? This paper explores how contexts of familiar spaces and long-term relationships might support student-community partnerships that nurture student learning in ways that are respectful and beneficial to community members. The focal case study in this study is a group of students who centered local non-profit organizations in the design work they conducted for an undergraduate course -- non-profit organizations the students had prior relationships with through their pre-college experiences living and learning in this community. Here, the university's place in the community facilitated learning and relationships. Inviting students to continue to prioritize the relationships they have already developed and maintained can allow students to envision engineering work as relational work. This case helps us see how a university that primarily serves students from the local community can facilitate this, and opens the question of how to similarly support students who are attending universities away from their home communities.

Related Paper Set

Enacting Critical Science and Engineering Agency in a Community Focused Climate-Tech Journalism Project

Fatima Rahman*, Tufts University, USA
Kristen Wendell, Tufts University, USA
Chelsea Andrews, Tufts University, USA
Clara Mabour, Tufts University, USA
Greses Pérez, Tufts University, USA

ABSTRACT

Recontextualizing science and engineering in local places encourages youth to draw connections between their own lived experiences and their disciplinary work. This presents opportunities for youth to reauthor their science and engineering in service of their own communities and push the boundaries of what knowledge and practices are valuable. In this research, we build on the idea of critical science agency to include engineering, and explore how three middle school students contextualized and reauthored their science and engineering work during a community-facing climate tech journalism project. Through a comparative case-study we find that the youth made strategic choices on how they chose to include their insights and goals into their climate tech journalism videos. This work reveals the opportunities and tensions that arise as grapple with viewing their own communities as places of science and engineering knowledge and action.

Related Paper Set

Principles for Designing Culturally Sustaining Hip Hop STEM-rich Learning Spaces

Brian Gravel*, Tufts University, USA
Dionne Champion, TERC, USA
Eli Tucker-Raymond, Boston University, USA
Amon Millner, Olin College of Engineering, USA
Christopher Wright, Drexel University, USA
Ayana Allen-Handy, Drexel University, USA

Clara Mabour, Tufts University, USA

ABSTRACT

The research focuses on developing culturally sustaining STEM learning spaces for youth of color through hip hop education practices and interdisciplinary computational making practices. The paper outlines the design principles created by the research collective through a design retreat and analysis of design enactments with youth in various research sites. These principles aim to transform the educational and social circumstances of youth of color in STEM spaces. The research emphasizes the critical importance of these design principles in developing humanizing learning environments and invites the research community to envision new possibilities for STEM education. By drawing on culturally relevant and sustaining literature, hip hop education, and computational making, the principles were derived and enacted in the implementations, intending to sustain STEM educational futures for youth of color. Ultimately, the research advocates for speculative education that asks what new learning arrangements are possible, echoing the history of hip hop as a movement that cultivated new futures and possibilities.

Related Paper Set

The Zone of Transition: Language as mediator of Space and Place in Engineering Education

Greses Perez, Tufts University, USA
G.R. Marvez, Tufts University, USA
Clara Mabour, Tufts University, USA
Ymbar Polanco Pino, Tufts University, USA

ABSTRACT

Engineering, under the pressures of objectivity and rigor, has traditionally stripped engineers and engineering students of the histories and essence of what it means to be members of social, cultural and ethnic/racial communities, and the places and spaces of possibilities within them. To rise to the challenge of engineering solutions for diverse populations, we need engineers that reflect the communities they serve through explicit instruction in their education about incorporating people's varied perspectives, including their understanding of contexts, in engineering practices. However, it is unclear how the contextual conditions and histories of people can be connected with the learning processes associated with the engineering practices and epistemologies. This study focuses on investigating the role of language as a mediator of context on how students define social problems in engineering.Four overarching themes were found in the students' responses to how they would redesign the US-Mexico border as the lead engineer: The Self, The Problem's Problems, Empathetic Insights, and The Community as Solutions.

National Academies of Sciences, Engineering, and Medicine Consensus Study: Equity in K-12

24-Mar-25, 8:15 AM-9:45 AM
Location: Azalea 2

Symposium

Organizers
Kenne Dibner, NASEM Board on Science Education, Washington, DC, USA
Leticia Garcilazo Green, NASEM Board on Science Education, Washington, DC, USA
Eileen Parsons, University of North Carolina at Chapel Hill, USA
Kenne Dibner, NASEM Board on Science Education, Washington, DC, USA
Eileen Parsons, University of North Carolina at Chapel Hill, USA
Stefanie Marshall, Michigan State University, East Lansing, USA
William Penuel, University of Colorado Boulder, USA

ABSTRACT
Despite the importance of the science, technology, engineering, and mathematics (STEM) disciplines in the landscape of U.S. political, economic, and social priorities, STEM learning opportunities are unevenly distributed and greatly differ in quality. The experiences an individual has in STEM education are likely to vary tremendously based on their race, ethnicity, socio-economic class, gender, and a myriad of other factors.

The report, from the National Academies of Sciences, Engineering, and Medicine, approaches equity in STEM education not as a singular goal but as an ongoing process that requires intentional decision-making and action toward addressing and disrupting existing inequities and envisioning a more just future. Stakeholders at all levels of the education system - including state, district, and school leaders and classroom teachers - have roles as decision-makers who can advance equity. This consensus study report provides five equity frames as a guide to help decision-makers articulate short- and long-term goals for equity and make decisions about policy and practice. The President's Administrative Session will unpack the consensus study's implications for science education, specifically science education research and science teacher education.

Innovative STEM Instruction

Strand 12: Technology for Teaching, Learning, and Research
24-Mar-25, 8:15 AM-9:45 AM
Location: Baltimore 5

Stand-Alone Paper

In-Field and Out-of-Field Teachers' Integration of a MOOC into their Instruction

Asnat Zohar*, Technion - Israel Institute of Technology, Israel
Shulamit Kapon, Technion - Israel Institute of Technology, Israel

ABSTRACT
Out-of-field (OOF) teachers, as compared to in-field (IF) teachers, teach subjects that are not within their formal academic expertise. Studies have highlighted the difficulties faced by OOF teachers, and their negative influence on students' learning. Due to the severe shortage of physics teachers, physics is often taught by OOF teachers. The hypothesis that guided this study was that the incorporation of an appropriate Massive Open Online Course in physics in a blended instruction mode could help alleviate some OOF teachers' disciplinary disadvantages, while capitalizing on their non-disciplinary professional strengths by positioning them as mentors of learning rather than as the source of knowledge. For this purpose, we developed a MOOC in kinematics and accompanied the implementation of the pilot chapters in the 9th grade with an online professional development course for the implementing teachers. Semi-structured interviews with 7 OOF and 4 IF teachers were conducted at the end of the implementation. Several themes emerged from the analysis of the IF and OOF teachers' accounts of the implementation. Some were similar but others diverged. The implications for research and practice are discussed.

Stand-Alone Paper

Lessons Learned from a Research-Practice Partnership to Integrate Agent-based Modeling into High School Science Classrooms

Aditi Wagh*, Massachusetts Institute of Technology, USA
Margaret Harrison, District of Columbia Public Schools, USA
Daniel Wendel, Massachusetts Institute of Technology, USA
Luke Conlin, Salem State University, USA
Emma Anderson, Massachusetts Institute of Technology, USA
Ilana Schoenfeld, Massachusetts Institute of Technology, USA

ABSTRACT
This paper draws from a Research-Practice Partnership that aims to integrate NGSS-aligned computational agent-based modeling curricula into all high school science classrooms in a large, urban school district in the United States.To realize this aim,seven high school science teachers, a district administrator and five researchers have been collaboratively developing curricular materials that bring this new representational practice into three science subjects in ways that are aligned with district-supported standards. In this paper, we report on lessons learned from the work done so far in terms of teacher uptake and contributions to this work. Drawing on data from observation notes of co-design and professional development sessions, classroom implementations, and teacher interviews, we identify four lessons we have learned about how to support teacher uptake of this practice and the specific kinds of contributions teachers make to the work. In the discussion, we reflect on the implications of these lessons for the field more broadly, and other scholars and educators aiming to adopt CM within a school district.

Stand-Alone Paper

The Effect Of Flipped Learning On Sixth Grade Students' Digital Literacy And Scientific Epistemological Beliefs

Feride Gökdaş*, Muğla Sıtkı Koçman University, Turkey

Aylin Çam, Muğla Sıtkı Koçman University, Turkey

ABSTRACT

The purpose of this research is to examine the effect of the flipped learning on sixth grade students' digital literacy skills and epistemological beliefs. In the study, a convergent parallel design, a mixed research method in which qualitative and quantitative methods are used together, was used. The study group of the research consisted of 41 students studying in the 6th grade. Lessons with 20 students in the experimental group were conducted according to the colloborative flipped learning model, and with 21 students in the control group, the lessons were conducted according to the cooperative learning method. The research lasted a total of ten weeks. ''Digital Literacy Scale'', ''Scientific Epistemological Beliefs Scale'', semi-structured interviews and reflective diaries were used to collect data in the study. Two-factor ANOVA for mixed measures were used in the analysis of quantitative data; Content analysis was used to analyze qualitative data. Based on the results of this study, it can be said that the use of the flipped learning model is effective in improving students' digital literacy and positive thoughts about the course. However,similar effects on increasing epistemological beliefs. In this regard, it may be recommended to include the flipped learning model in curriculum.

Stand-Alone Paper

Lesson planning with ChatGPT for inquiry-based biology education – A(I) roll of the dice?

Leroy Grossmann*, Freie Universitaet Berlin, Germany
Maren Koberstein-Schwarz, IPN – Leibniz Institute for Science and Mathematics Education, Germany
Moritz Krell, IPN – Leibniz Institute for Science and Mathematics Education, Germany
Dirk Krueger, Freie Universitaet Berlin, Germany

ABSTRACT

The study explores the use of Generative Artificial Intelligence (GAI), specifically ChatGPT-4o, in the lesson planning process for inquiry-based biology education. It addresses the potential benefits and challenges of using GAI for creating high-quality lesson plans aligned with curricular standards in Germany. The research utilized an exploratory sequential mixed methods design, generating 60 lesson plans using six piloted prompts across four biology topics and five scientific inquiry standards. The quality of these plans was assessed by two independent raters (Cohens Kappa, = .67) using a modified rubric, revealing significant variability in their effectiveness. While ChatGPT-4o showed promise in generating clear learning objectives and performance indicators, it struggled to maintain a cohesive lesson structure and adequately address students conceptions. We found high variability in the lesson plan quality across topics and scientific inquiry standards. The study concludes that while GAI tools like ChatGPT-4o can serve as a useful starting point, they should not be relied upon exclusively for lesson planning. Educators must critically evaluate and adapt AI-generated plans to ensure they meet educational standards, particularly in fostering scientific inquiry. The findings underscore the need for further research on how pre-service teachers can effectively use and critique AI-generated lesson plans.

Nature of Science and Socioscientific Issues in Biology and Undergraduate Settings

Strand 13: History, Philosophy, Sociology, and Nature of Science
24-Mar-25, 8:15 AM-9:45 AM
Location: Baltimore 2

Stand-Alone Paper

Reflections of Pre-Service Biology Teachers on the Nature of Science – What Does It Entail?

Sophie Kurschildgen*, Justus Liebig University, Germany
Alexander Büssing, Technische Universität Braunschweig/ Institute for Science Education, Germany
Stefan Schwarzer, University of Tübingen, Germany
Kerstin Kremer, Justus Liebig University, Germany

ABSTRACT

To develop a comprehensive understanding of Nature of Science, it is important to reflect on scientific inquiry and social-institutional structures in science at a meta-level. The objective of the study is to provide a more detailed account of the reflection of Nature of Science in interviews with pre-service biology teachers in more detail by adapting the reflection model by Atkins and Murphys (1993). This is used to emphasize different stages within the process of reflection (awareness, description, analysis, synthesis, evaluation). The study was conducted through interviews with 19 pre-service biology teachers between April and May2024. The participants engaged with 360° recordings, which incorporated videos of the laboratory of the Nobel Prizewinnersin Medicine 2014, May-Britt and Edvard Moser. They do animal experiments with rats to gain knowledge about gridcells of the brain. Theinterview data was analyzed by matching statements from the interview with the key stages of reflection.The preliminary results indicate the presence of quotes for each reflection stagewithin the collected interview data. The extent to which the various phases of the model can be adapted for nature of science will be discussed.

Stand-Alone Paper

On the construction and relation of science and sustainability in biology lessons

Charlotte Wolff*, University of Kassel, Germany
Helge Martens, University of Kassel, Germany

ABSTRACT

The discussion of sustainability issues in public and in the school-context is based on (un)certain scientific-technical knowledge as well as on a political-normative foundation. The elaboration of sustainability issues in (biology) lessons therefore requires teachers' epistemic knowledge, e.g., about the fragility, tentativeness, and social construction of scientific knowledge. Teaching about complex decision-making situations in sustainability issues is

characterized by a tension between tentativeness of evidence in science and normativity, ambiguity of action and morality. Therefore, it was investigated how teachers construct the dimensions of science and sustainability in their own lessons, relate them to each other in their professional everyday actions. To address these research questions, semi-structured interviews with biology teachers were conducted and analyzed using the Documentary Method. This method aims at reconstructing the implicit knowledge that underlies everyday practice and gives an orientation to habitualized actions. In the analysis were two typification frameworks reconstructed focusing on teaching science and sustainability. Furthermore, these typifications can be interrelated and analyzed focusing on their interactions and interrelations. Regarding this study, it is therefore central to enlighten the relationship between the processes of understanding a problem in its whole and developing an action based on that information.

Stand-Alone Paper

Factors Associated with University Biology Students' Evolution Acceptance of and Emotive Receptivity Toward Learning Evolution

Benjamin Herman*, Texas A&M University, USA
Daniel DeJesus, Texas A&M University, USA
Aaron Kidd, University of Oklahoma, USA
Benjamin Janney, University of Utah, USA
Magda Villwock, Texas A&M University, USA
Carlos Perez, Texas A&M University, USA
Sarah Poor, University of Missouri, USA
Michael Clough, Texas A&M University, USA
Asha Rao, Texas A&M University, USA

ABSTRACT

A long history of scholarship has attempted to address factors associated with evolution views to include nature of science and mis/disinformation perspectives (e.g., the relationship between science and religion) and sociocultural characteristics such as religiosity and political orientation (Author, 2024, Hodson, 2009). However, little scholarship regarding evolution acceptance focuses on those expected to fully embrace the idea – university biology majors. This mixed-methods investigation investigates the extent and why 1,548 university students in a biology for majors' course accept evolution and how they feel about being expected to learn evolution. Salient findings include that higher levels of students' evolution acceptance and receptivity toward learning evolution associated with more informed views about mis/disinformation strategies and NOS to include the extent religious ideas should be incorporated into scientific explanations. However, being increasingly politically conservative and religious significantly associated with lower levels of evolution acceptance and higher levels of emotive angst and negativity regarding being expected to learn evolution. This presentation will address these findings in detail and how biology educators can employ pedagogical approaches that consider students' sociocultural backgrounds, biases, and NOS views and support them to develop perceptions of evolution commensurate with a functional scientific literacy and more informed decision-making.

Stand-Alone Paper

Exploring Factors Associated with Undergraduate Students' Engagement with Socioscientific Issues Mis/disinformation

Sarah Poor*, University of Missouri, USA
Benjamin Herman, Texas A&M University, USA

ABSTRACT

The rise of social media, the spread of mis/disinformation, and science skepticism pose formidable challenges that science education/communication initiatives must proactively confront. The rapidly growing presence of unchallenged and inaccurate beliefs amongst the public regarding SSI threatens civic engagement, poses serious environmental and public health risks, and disproportionately impacts across sociocultural groups. The purpose of this investigation was to examine how students' navigation of mis/disinformation associates with cognitive, emotive, and sociocultural factors. The design used in this study entailed collecting data from the students to identify factors associated with their navigation of mis/disinformation. Students in this study took a contemporary environmental issues course (n=193) and primarily consisted of first-year, non-science majors. A multi-mediator analysis using Hayes' Process for SPSS and a thematic analysis of qualitative data explored indirect effects present in the data. Political orientation is a key factor associated with students' perceptions of mis/disinformation across SSI contexts. Qualitative analysis revealed that perceived expertise was a common justification for rating mis/disinformation as credible, while a lack of expertise led to lower credibility ratings for water fluoridation and fracking mis/disinformation. Findings from this investigation have important implications for teaching SSI and mis/disinformation resistance.

Climate Literacy 1

Strand 14: Environmental Education and Sustainability
24-Mar-25, 8:15 AM-9:45 AM
Location: Baltimore 3

Stand-Alone Paper

The Dark Corners of Southern Taiwan: An Investigation into the Ecological Identity and Littering Behavior

Jhu-Chun Yang*, National Sun Yat-sen University, Taiwan
Paichi Pat Shein, National Sun Yat-sen University, Taiwan

ABSTRACT

Environmental pollution constitutes a pervasive global crisis. Since the 1970s, the study of littering has emerged as a prominent field, as littering remains a primary source of environmental pollution worldwide, especially in coastal areas where littering pollution affects marine life, impacting their health, feeding patterns, and reproductive capabilities, and potentially resulting in death.This study centers on a vocational high school in a

prominent fishing town in southern Taiwan. Data was collected from 299 students in grades 9-12 at the school, along with a survey of 133 Taiwanese adults, to compare the ecological identity perspectives between these students and the broader adult population. Additionally, 20 vocational high school students were interviewed.This study finds that the establishment of ecological identity requires a foundation of public morality, a sense of responsibility, and support from social and cultural backgrounds. The local environment of the case study provides students with negative role models, leading to a more pronounced disinterest in ecology compared to Taiwanese adults and resulting in the perpetuation of anti-environmental behavior. As we strive towards sustainable development, we must address these "Dark Corners" to truly achieve a sustainable future for all.

Stand-Alone Paper

'There have always been hot days" – Analyzing high school students' argumentation from real-world climate data

Kay Burger*, Institut für Physik und Technische Bildung, Germany
Engin Kardaş, Institut für Physik und Technische Bildung, Germany
Tobias Ludwig, Institut für Physik und Technische Bildung, Germany

ABSTRACT

The climate crisis demands more than scientific understanding; it requires the development of climate literacy—skills in interpreting, evaluating, and communicating climate data. This study investigates how students use a digital learning app to analyze a large dataset of local climate time series from there hometown in Germany and to construct scientific arguments. The app enables students to engage with complex data through user-friendly tools, promoting critical data literacy. Involving 97 tenth-grade students, the research employs concept cartoons to provoke data-driven argumentation on climate issues. Our analysis reveals that while some students effectively use climate data to support their arguments, others rely on intuition or misinterpret the data. We identified nine categories of argumentation, from ignoring data to combining multiple analyses. These findings highlight the challenges students face in using data to construct sound arguments and underscore the need for targeted educational interventions. This research contributes to understanding how students engage with climate data and offers insights for enhancing climate literacy, which is essential for informed decision-making on climate-related socioscientific issues.

Stand-Alone Paper

What motivates citizens to engage in different scientific activities of Citizen Science projects?

Till Bruckermann*, Leibniz University Hannover, Germany
Denise Bock, IPN–Leibniz Institute for Science and Mathematics Education, Germany
Hannah Greving, Leibniz University Hannover, Germany
Anke Schumann, Leibniz Institute for Zoo and Wildlife Research, Germany
Milena Stillfried,Leibniz Institute for Zoo and Wildlife Research, Germany
Konstantin Börner, Leibniz Institute for Zoo and Wildlife Research, Germany
Robert Hagen, Landwirtschaftliches Zentrum Baden-Württemberg, Germany
Sophia Kimmig, Leibniz Institute of Freshwater Ecology and Inland Fisheries, Germany

Miriam Brandt, Leibniz Institute for Zoo and Wildlife Research, Germany
Ute Harms, IPN–Leibniz Institute for Science and Mathematics Education, Germany

ABSTRACT
Citizen Science (CS) projects involve citizens and scientists in collaborative research, offering informal learning opportunities and contributing to scientific processes. This study investigates how citizens engage in scientific activities in the data collection and data analysis phase in five field studies of an urban ecology CS project (N = 733). It also explores the influence of citizens' motivations and attitudes on their scientific activities. Using log files and Latent Profile Analyses, we identified four distinct activity profiles in each phase. The Hardworking, Persistent, and Moderate profiles were common in both phases. Phase-specific profiles were the Loyal (data collection) and the Lurker profile (data analysis). Multinomial Logistic Regression Analyses revealed that intrinsic motivation and positive attitudes toward science and wildlife promoted active engagement in data collection, but had reversed effects during data analysis. These findings suggest that citizens' engagement levels and their driving factors vary between the data collection and data analysis phases. Implications highlight the need for changing support strategies to enhance citizens' involvement in all scientific processes and for pointing to potential structural adjustments in CS project designs. This research underscores the importance of motivational and tailored support mechanisms to achieve greater epistemic justice in citizen contributions.

Roundtables Session 1

24-Mar-25, 8:15 AM-9:45 AM
Location: Woodrow Wilson Ballroom

Strand 2: Science Learning: Contexts, Characteristics and Interactions
Roundtable

Investigating inquiry-based learning in inclusive science education

Leonie Willmes*, University Duisburg-Essen, Germany
Helena van Vorst, University Duisburg-Essen, Germany
Mathias Ropohl, University Duisburg-Essen, Germany

ABSTRACT
In 2006, the UN Convention on the Rights of Persons with Disabilities highlighted the need for inclusive education. Inquiry-based learning, as a hypothesis-driven, student-centered approach for solving a problem, is seen as beneficial for heterogenous learning groups due to its possibility to vary openness and structure. However, implementing inquiry-based learning in inclusive classrooms is challenging, as it must meet students' individual needs. Current research lacks comprehensive guidelines for implementing inclusive inquiry-based learning.A literature review on criteria for implementing inquiry-based learning in inclusive science education, conducted previously to this study, revealed e.g. that structured inquiry-

based learning, visualizations, and small-step learning (scaffolding, checklists, graphic organizers) are crucial for success. Based on these results, it is the central aim of this study to test selected criteria of visualization in inclusive chemistry lessons. An empirical video study with N = 155 students, including n = 94 students with special educational needs has been conducted. Preliminary results show that students liked and understood lessons with visual adaptations significantly better than those without any adaptation.Ongoing analysis will further explore these adaptations, aiming to provide actionable insights for inclusive science education and contribute to practical teaching strategies for heterogenous classrooms.

Strand 2: Science Learning: Contexts, Characteristics and Interactions
Roundtable

Evaluating Pedagogical Design Capacities for Differentiated Instruction in a digital environment. A case study.

Stephanie Bismuth*, Weizmann Institute of Science, Israel
Yael Shwartz, Weizmann Institute of Science, Israel
Anat Yarden, Weizmann Institute of Science, Israel

ABSTRACT

Addressing the needs of diverse student populations in science education presents a significant challenge for educators. Digital platforms have the potential to assist teachers in managing this complexity. This study seeks to evaluate science teachers' Pedagogical Design Capacities (PDC) for implementing Differentiated Instruction (DI) within the Moodle-based [X] (blinded for review) environment. We present a three-step process for developing a quantitative tool to assess teachers' PDC for DI in digital environments. Drawing on the "Design Capacity for Enactment" framework (Brown, 2009), we created the three-dimensional UOI model, comprising the Use of resources, Orchestration of learning units, and Integration of DI. This model was applied in a mixed-methods case study involving an experienced science teacher who designed courses for both public use and her own classrooms over two years. The analysis revealed the teacher's evolving PDC, demonstrated by increased use of digital resources, more sophisticated orchestration of learning activities, and greater intentional integration of DI. Supplemented by qualitative interview analysis, the findings suggest that teachers' goals and commitment are key factors influencing her design practices, particularly when developing public courses for students. This study integrates theoretical frameworks with practical applications, supporting the evaluation and professional development of teachers' DI design capacities.

Strand 2: Science Learning: Contexts, Characteristics and Interactions
Roundtable

The Impact of Students' Participation in Scientific Experiments on Scientific Achievements

Chaochao Jia*, China Research Institute for Science Popularization, China
Xiuju Li, China Research Institute for Science Popularization, China
Yu Qian, College of Physics and Optoelectronics Technology, Baoji University of Arts and Science, China

Tao Yang, Collaborative Innovation Center of Assessment for Basic Education Quality, Beijing Normal University, China
Yue Zhang,Institute on Educational Policy and Evaluation of International Students, Beijing Language and Culture University, China

ABSTRACT
In order to explore the influence mechanism of scientific experiment on scientific academic achievement, two theoretical models of multiple mediation effects are established between scientific experiments (demonstrative experiment and hands-on experiment), scientific interests, scientific academic self-efficacies and scientific achievements, and 2 535 students are employed to take science test and questionnaire. The results show that physical hands-on experiment, biological demonstrative experiment and hands-on experiment can significantly positively predict achievements, while physical demonstrative experiment significantly negatively predicts achievement. The mediation models are almost indistinguishable between physical and biological subjects, while the models change greatly with the mediator variables (scientific interest and self-efficacy) reversed the action directions. The paths of the mediation models are examined, which revealing that students' engagement in experiments can positively influence interest, and interest can significantly positively predict science academic self-efficacy and then influence the achievement of science. Advice is given for science teachers that more attention should be paid on students' hands-on experiments rather than demonstrative one.

Strand 2: Science Learning: Contexts, Characteristics and Interactions
Roundtable

Inclusive science education: Recognizing barriers and enabling participation via vignettes

Nathalie Beck*, University Duisburg-Essen, Germany
Mathias Ropohl, University Duisburg-Essen, Germany
Helena van Vorst, University Duisburg-Essen, Germany

ABSTRACT
The presented project explores the challenges and opportunities in implementing inquiry-based learning (IBL) in inclusive science education. Despite its benefits, IBL's effectiveness for students with special educational needs — specifically those with learning disabilities (LD) and emotional and behavioral disabilities (EBD)—remains under-researched. This PhD project aims to identify potential barriers of IBL for these students and to gain instructional strategies to overcome them. Using a systematic literature review, the project delineates the prerequisites and behaviors associated with LD and EBD which were confronted with the different phases of IBL to discover potential barriers occurring through the meeting of the different Aspects. A vignette-based survey of special education teachers from North Rhine-Westphalia, Germany, is being conducted to gather data on these barriers and corresponding instructional approaches. These vignettes combine real-world classroom scenarios with student profiles, allowing teachers to identify obstacles and suggest solutions. The preliminary results highlight the complexity of inclusive education and suggest that barriers are often linked to the underlying aspects of a student's diagnosis, rather than the

diagnosis itself. This research is expected to inform the development of future teacher training materials aimed at improving inclusive teaching practices in science education through IBL.

Strand 2: Science Learning: Contexts, Characteristics and Interactions
Roundtable

Education Needs Uncertainty: The Objective of Being in a Different Place

Leah Master*, NYU-Steinhardt, USA
Catherine Milne*, NYU-Steinhardt, USA
Anna Skorupa*, NYU-Steinhardt, USA
Shaghig Chaparian*, NYU-Steinhardt, USA
Kathryn Scantlebury, University of Delaware, USA

ABSTRACT

Many structures in education speak to the value assigned to certainty as a requirement for fostering and evaluating learning (knowledge making) including standards, binary-thinking, and cause-and-effect reasoning. The goal for certainty also encourages the dismissal of non-Western, indigenous, feminist or other knowledge systems that do not endorse this approach to knowledge making. Through engagement with feminist materialisms, we show how implementing diffractive meaning-making approaches in the classroom provide methods for participating in science practices that support students in a world of uncertainty and unpredictability. Since the world is not certain and never has been, we envision a different way of teaching and learning in science that begins first with a world composed of phenomena. In this presentation, we discuss the joy of uncertainty in both university and nonformal science curriculum and we invite curriculum developers and educators to consider a different vision. We celebrate science teaching that challenges taken-for-granted beliefs in order to make education more inclusive and relational.

Strand 5: College Science Teaching and Learning (Grades 13-20)
Roundtable

From Expectations to Reality: Female Students' Experiences and Struggles in Introductory Physics

Liliana Garcia*, University of California, Santa Barbara, USA

ABSTRACT

This study investigates the challenges female STEM majors face in introductory physics courses, focusing on their interactions and perceptions of course goals. Utilizing Cultural-Historical Activity Theory (CHAT), the research examines how female students' expectations align with the objectives of their physics courses. Through semi-structured interviews conducted at Central University, this study assesses female students' sense of belonging, perceived support, and connectivity within the academic community. The findings reveal significant insights into the obstacles female students encounter. This research is crucial for understanding these dynamics. It aims to inform educators on creating a more supportive and equitable learning environment, ultimately contributing to improved diversity and retention in STEM fields.

Strand 5: College Science Teaching and Learning (Grades 13-20)
Roundtable

Supporting first-generation college students in the sciences: An exploration of transformative teaching in higher education

Lisa Marco-Bujosa*, Villanova University, USA
Gracie Petrelli, Villanova University, USA

ABSTRACT

First-generation college students (FGCS) represent a sizable 33% of the undergraduate population. Research indicates disparities in FGCS persistence in STEM fields. We know faculty play an important role in FGCS success and persistence, but can also, often unknowingly, serve as gatekeepers by tacitly perpetuating inequalities while upholding disciplinary values. This qualitative study explores how exemplary undergraduate science educators support FGCS. We utilized sociotransformative constructivism as a framework for exploring the extent to which these supports transformed undergraduate science learning experiences. Findings indicated that while some educators engaged in providing transformative supports, much of the support provided addressed individual student academic needs and did not dismantle inequities for FGCS in STEM majors. Three underlying orientations were linked to undergraduate educators' engagement in transformative action: orientation toward students (deficit vs. asset); orientation toward STEM (process vs. product); and orientation toward their role (scholar vs. educator). Findings indicate the important role STEM instructors can play within the classroom, but also illuminate the ways in which institutional structures and scientific norms inhibit their ability to reframe undergraduate science programs to promote inclusion. This roundtable will discuss findings and opportunities to empower undergraduate science educators to reimagine undergraduate science education.

Strand 5: College Science Teaching and Learning (Grades 13-20)
Roundtable

Engaging Faculty in Professional Development to Support Revisions to a Non-Majors' Environmental Science Course

Hannah Jardine*, American University, USA
Barbara Balestra, American University, USA
Dhananjaya Katju, American University, USA
Alicia DeBruin, American University, USA
Carolyn Parker*, American University, USA

ABSTRACT

Research demonstrates that a problem-based approach to science instruction addresses issues of equity and will better meet the needs of all students, especially students who do not intend to major in science. Our project applies an interdisciplinary, problem-based approach to an undergraduate environmental science course for non-majors. To support the course instructors in redesigning the course, we offered and evaluated a professional development (PD) program focused on the integration of problem-based learning in undergraduate

science. In this roundtable discussion, we will respond to the following research question: Does participating in the project (i.e., the professional development and revising of coursework) change the instructional beliefs and practices of the science faculty involved? We will describe our approach to the faculty PD and the ongoing learning community that led to some of the course developments and design decisions. We will also provide evidence from interviews, document analyses, observations of instruction, and meeting field notes that faculty have shifted their instructional practices and beliefs to include more problem-based, student-centered instruction. We aim to discuss the successes, challenges, and lessons learned from engaging as a learning community and determine possibilities for future PD on problem-based learning in undergraduate science.

Strand 6: Science Learning in Informal Contexts
Roundtable

Development and Application of the Scripted Animation Survey (SAS) for Afterschool Professional Development

Heidi Cian*, Maine Mathematics and Science Alliance, USA

ABSTRACT

Despite their unique position among out-of-school educators in serving youth and families identifying with racial, socioeconomic, and geographic groups marginalized by systemic barriers to STEM participation, professional development is often inaccessible for afterschool educators. As a partner of afterschool educators and networks for over a decade, our program sought to fill this need by providing high-quality, free, virtual professional development to afterschool educators across the country, and to train local coaches to continue the professional development in their regions. Through these relationships, we recognized a demand for assessment tools that could be easily used to inform professional development efforts. To answer this call, we developed the Scripted Animated Survey (SAS). Here, we outline a validation process for the SAS and exemplify its use for exploring educators' shifting awareness of opportunities for youth ownership in their learning–an application motivated by current efforts in the field. We illustrate that scripted animations with open-ended response formats provide flexibility for responses and video content that are necessary for rapidly-evolving sectors such as afterschool education. We describe future efforts to structure a codebook for making sense of SAS responses that can be readily used by PD providers or educators themselves to understand their progress.

Strand 6: Science Learning in Informal Contexts
Roundtable

Supporting Learners Through Emotional Anchors in an AI and Paleontology Curriculum: A Social Constructivist Perspective

Nazanin Adhami*, University of Florida, USA
Tonika Jones, University of Florida, USA
Ray Opoku, University of Florida, USA
Gabriella Haire, University of Florida, USA
Christine Wusylko, University of Florida, USA
Chih Hsuan Lin*, University of Florida, USA

Bruce MacFadden, University of Florida, USA
Victor Perez, St. Mary's College of Maryland, USA
Brian Abramowitz, University of Florida, USA
Pavlo Antonenko, University of Florida, USA

ABSTRACT
This study explored the emotional anchors that emerged during Black middle school girls' participation in a summer camp focused on AI and paleontology, using a social constructivist framework. The camp, held at a Title I charter school in the Southeastern United States, and was designed to introduce AI and paleontology concepts through interactive hands-on activities. The research examined how peer interactions, collaborative activities, and instructional materials contribute to forming emotional anchors that increase learning experiences. Data were collected through semi-structured interviews with 20 participants, focusing on their emotional responses. The analysis identified key emotional anchors, including supportive peer and facilitator interactions, a sense of team and personal accomplishment, and excitement about learning. These anchors were found to play an important role in increasing participants' confidence and engagement with STEM education. The findings contribute to understanding how social and collaborative learning can be designed to foster emotional engagement and support, thereby improving educational experiences. The Roundtable discussion will focus on strategies for implementing these findings in educational practices and how to effectively support learners in similar contexts.

Strand 6: Science Learning in Informal Contexts
Roundtable

Use of tactile prompts to increase memory of scientific experiences

Rhea Miles*, East Carolina University, USA

ABSTRACT
Many of the participants with blindness or visual impairments provide more thick descriptions of their memories of experiences from participation in an Earth science informal learning program when provided a tactile prompt.

Strand 6: Science Learning in Informal Contexts
WIP Roundtable

Reception by primary-school pupils and parents of comic strips launching inquiries at home or school

Estelle Blanquet*, INSPE de l'académie de Bordeaux, France

ABSTRACT
The main aim of the presented research project is to explore the potential of comic strips to engage a wide audience, especially elementary school children and their parents, in playful learning about science and the scientific process. Recognizing a growing distrust towards science among young people, the project aims to make scientific inquiry accessible and enjoyable for children, encouraging them to explore scientific concepts both at home and in school. The comic strips, developed in collaboration with a graphic designer, are designed to

provoke inquiry and experimentation using everyday materials.We present here the preliminary results obtained with test strips and involving around 800 children (aged 7 to 12) and 80 adults. They have elicited a promising response from children, parents and teachers, with the majority of adults involved in the study declaring themselves ready to accompany children in experimental investigative approaches based on these strips. The study also allowed to narrow down the parameters of this tool format, colours, optimal number of characters, type of characters (children vs. animals), etc. Quite unexpectedly, while adults showed a marked preference for the universe with children's characters, children preferred the universe with rats.

Strand 8: In-service Science Teacher Education
Roundtable

Teacher Disposition and Professional Development Outcomes: A Case Study of Physics Teachers.

Justina Ogodo*, Baylor University, USA

ABSTRACT

The acute shortage of physics teachers in America's classrooms necessitates the placement of teachers without physics degrees or certification in high school classrooms. To address this protracted issue, additional training is required for the high number of non-credentialed physics teachers to develop their content knowledge and instructional practice. This case study focuses on the role of disposition on teachers' learning outcomes during professional development. Pulling participants from 69 physics teachers participating in a three-year intensive physics-focused professional development, the findings reveal that teachers who were positively disposed to the professional development demonstrated a) growth in their content knowledge and implemented reformed-based instructional practices and b) enhanced their physics teaching self-efficacy compared to those not disposed to the training.

Strand 8: In-service Science Teacher Education
Roundtable

K-12 Teacher Motivations to Attend Climate Change Professional Development

Amber Meeks*, North Carolina State University, USA
M. Gail Jones*, North Carolina State University, USA
Rebecca Ward, North Carolina State University, USA
Kathleen Bordewieck, North Carolina State University, USA
Tanzimul Ferdous, North Carolina State University, USA
Madeline Stallard, North Carolina State University, USA

ABSTRACT

Climate change education is critical for individuals to make informed decisions, and teachers play a critical role in helping individuals acquire this knowledge. Professional development (PD) is key to equipping educators with essential classroom knowledge and skills. This exploratory study analyzed 82 K-12 teachers' perceptions of attending climate professional development. Results showed that most teachers had positive views of professional

development. Teachers' responses were analyzed based on their county's political leaning (Democrat or Republican) in the 2020 presidential election, and results revealed statistically significant differences in teachers' perceptions of their own knowledge of climate change.

Strand 8: In-service Science Teacher Education
Roundtable

Implementing Phenomenon-Based Instruction in Secondary Science Classrooms: A Case Study of Science Teachers' Approaches

Ezgi Yesilyurt*, Weber State University, USA
Jennifer Claesgens, California State University, East Bay, USA

ABSTRACT

This qualitative case study examines the implementation of phenomenon-based science instruction aligned with Next Generation Science Standards (NGSS) in secondary science classrooms. This case study focuses on three high school science teachers who participated in a professional development program designed to support the transition to three-dimensional, phenomenon-based instruction. This study analyzed how these teachers incorporated phenomena and NGSS Science and Engineering Practices (SEPs) into their teaching. Data were collected from storyline vignettes, SEP tools, lesson plans, lesson evaluations, and teaching reflections developed by the teachers during the program. Findings reveal that while all teachers successfully used relevant phenomena to drive student inquiry, they varied in their integration of SEPs and consistent use of phenomena throughout their units. The study also highlights the challenges teachers face in fully implementing NGSS practices and maintaining strong connections between phenomena and scientific concepts. The research contributes to the understanding of phenomenon-based science instruction and suggests the need for ongoing, targeted support for teachers transitioning to this approach. Implications for teacher education programs and professional development providers are discussed, emphasizing the importance of sustained support in helping teachers navigate this shift in science education.

Strand 8: In-service Science Teacher Education
Roundtable

A Participatory Professional Development Workshop: Exploring Middle School Students and Teachers Reflections

Michael Cassidy, TERC, USA
Debra Bernstein, TERC, USA
Gillian Puttick, TERC, USA
Santiago Gasca, TERC, USA

ABSTRACT

Through a theoretical framework emphasizing participatory practices as creating compelling learning spaces for schools, we explore ways to create participatory culture environments in professional development (PD) workshops. We conjectured that teachers see how participatory practices can be useful and can empower students when creating games using Scratch,a block-based programming language. Ten teachers were involved from New

England and the Southeast. Two different PD models engaged teachers and students to support participatory learning: one is a help desk and one is pair programming. Findings and discussion emphasize the importance of students presence in PD.

Strand 8: In-service Science Teacher Education
Roundtable

Computational Classrooms: A Constructivist, Research-Based Approach to Designing a Computer Science Course for Teachers

Jonathan Rivera*, University of Maryland, USA
Jennifer Radoff, University of Maryland, USA

ABSTRACT

This paper presents the design, testing, and implementation of a professional learning model to help in-service educators integrate computer science (CS) and computational thinking (CT) into their pedagogy. The central question addressed is: How can we create learning experiences that support teachers' authentic engagement with computational concepts, practices, and tools? The authors are part of a Research Practitioner Partnership (RPP), which meet monthly to develop principles for modifying curricula to include sustainability education and CT. Stressing a "bottom-up" constructivist approach, teachers are able to engage with real-world problems that naturally lead to computational understandings. The approach centers on inquiry cycles, where teachers engage with CS principles, reflect, and connect experiences to classroom practices. These cycles, prototyped during RPP meetings, aim to build confidence in delivering transdisciplinary lessons incorporating CS and CT. Data from the meetings indicates that the inquiry activities demystified computational principles, making them more accessible and relevant to educators, suggesting that a "bottom-up" approach to teaching CS and CT that is rooted in meaningful and contextualized problems can support learners' self-efficacy and understanding of core concepts and practices. If successful, this model could help teachers effectively integrate CS and CT into their STEM classrooms.

Strand 8: In-service Science Teacher Education
WIP Roundtable

'You're Scientists Because You're Doing Research": How Teachers Take Up Doing "Authentic" Science With Students

Megan Walser*, Michigan State University, USA
David Stroupe*, University of Utah, USA

ABSTRACT

A long-standing goal of science education has been for students to engage in "authentic" science. This goal of authentic science has appeared in many policy documents, and most recently, in the Next Generation Science Standards (NGSS; Achieve, 2013). Yet, the field lacks consensus on what it means to do "authentic" science: does it mean students should mirror the practices of professional scientists, and/or does it mean students should make their own epistemological decisions about the science that happens in their classroom? In this paper, we investigate how teachers took up the goal of "authentic" science, and what curricular

resources supported them in doing so. Based on interviews, classroom observations, and artifacts from classrooms and professional learning sessions, we conclude that teachers defined "authentic" science in multiple ways, incorporating elements of both professional science and student epistemic agency, and created curricular resources to achieve both goals.

Strand 11: Cultural, Social, and Gender Issues
Roundtable

TRANSforming language use in science education through trans and queer studies

Ayça Fackler*, University of Missouri, USA
Gary Wright*, University of Missouri, USA

ABSTRACT

This theoretical paper explores how trans-queer studies localize critical praxes and inform inclusive language practices in science education.Despite advances in equity and social justice for marginalized learners, epistemic injustice remains a significant barrier in science learning and teaching spaces. Dominant norms in science educationare often tied to White, able-bodied, cisgender, and English-speaking practices.We argue that integrating trans-queer perspectives into language use in science education can challenge these traditional binaries and hierarchies. We propose that science education should move beyond performative diversity, adopting a transformative practice thatcreates safe spaces, agency, and resistance among marginalized bodies, identities, and languages.By embracing critical trans studies and queer theory, we advocate for dismantling normative structures and fostering epistemic justice, creating an inclusive science learning environments where all students can thrive.We call on the science education community to reflect on how to shift from perpetuating the norms of the powerful to empowering marginalized learners, transforming educational spaces into environments that prioritize what can be, rather than what is.

Strand 11: Cultural, Social, and Gender Issues
Roundtable

Embodied Inquiry: Intersecting Queer/Trans Self-Determination with the Nature of Science

K. "Ren" Mendoza*, University of Nebraska at Omaha, USA
Khanh Tran*, Purdue University, USA

ABSTRACT

This presentation argues that the Nature of Science (NOS) is an inherently queer and trans endeavor, one that involves the continuous questioning and revising of what we know as truth. Just as queer and trans identities are shaped through ongoing self-discovery and self-determination, science too is a dynamic process of revision and reconsideration. In this roundtable session, we aim to foster discussions around the trends and observations in NOS education, emphasizing the need for a critical queer approach to its frameworks and their implementation. By queering NOS, we propose a pedagogical shift that supports the development of more inclusive and socially just science curricula. We will present our

analysis exploring the tenets of NOS through queer and trans lenses, revealing how these perspectives can challenge traditional norms and enrich educational practices. Our goal extends beyond merely incorporating discussions of sex, gender, and LGBTQ+ issues into the curriculum. While these topics are vital, our approach is not confined to creating a curriculum for queer individuals. Instead, we aim to create a pedagogical space that reimagines what science can be, rather than prescribing what it should be.

Strand 11: Cultural, Social, and Gender Issues
Roundtable

Navigating the Margins: Self-Advocacy, Mentorship, and Institutional Barriers in the Careers of Nonbinary STEM Faculty

Ezra Kottler*, University of the Pacific, USA
K. "Ren" Mendoza*, University of Nebraska at Omaha, USA
Adrian Gentry, Purdue University, USA
Emily Haluschak*, Purdue University, USA

ABSTRACT

This study examines the support systems available to nonbinary faculty members in STEM fields, with a focus on how these systems contribute to their career persistence and well-being. Despite increasing visibility, nonbinary individuals often navigate academic environments entrenched in heteronormative and cisnormative practices, which can lead to elevated stress and challenges in balancing identity and professional acceptance. Through semi-structured interviews with four nonbinary faculty members, this research highlights the critical role of expressive and instrumental support in fostering their success. The findings underscore the importance of self-advocacy and the evolution of support networks as these faculty members advance in their careers. However, the study also reveals the inadequacies of institutional support, emphasizing the need for systemic changes that provide tangible, institutionalized support for nonbinary faculty. Our research calls for higher education institutions to move beyond relying on nonbinary faculty to self-advocate, advocating instead for clear pathways of support that acknowledge and address the unique challenges faced by nonbinary faculty. Ultimately, this study contributes to a deeper understanding of the unique challenges faced by nonbinary faculty in STEM and the critical need for more research on inclusive and supportive academic environments.

Strand 10: Curriculum and Assessment
WIP Roundtable

Centering Student Voice to Engage a Teacher's Critical Noticing to (w)Holistically Assess Student Thinking

Terrance Burgess, Michigan State University, USA

ABSTRACT

As we enter the second decade of enacting the vision of the framework of the Next Generation Science Standards (NGSS), we should take stock of how science assessments at the elementary grades have been developed. As reports have indicated, many states across the US are currently in the early implementation phase of the standards, despite their

introduction in 2013. Coupled with the delayed implementation is the delay in assessments that adequately capture the essence of both equitable and 3-dimensional learning. While it may in fact be difficult to meaningfully assess this new science instruction, this paper argues that it is indeed possible. In this case, the possibility resides within science teacher education. By supporting elementary teachers to build their capacities to notice the value of children's ideas, we can better do the work of making science more equitable (Author, 2022) per the standards. Engaging in this work during the elementary grades is crucial, as it allows for teachers to develop instructional practices that would build students' capacities to develop deeper connections to science where they are feel prepared to engage in a society that increasingly requires a scientifically literate populace to enact meaningful local and national change.

Strand 10: Curriculum and Assessment
WIP Roundtable

Exploring Core Ideas: A Systematic Literature Review of Core Ideas in Science Education

Helen Semilarski*, University of Tartu, Estonia
Helin Semilarski, University of Tartu, Estonia

ABSTRACT

One way to address fragmented knowledge is to identify core ideas within and across disciplines, providing students with a conceptual framework to understand the world around them. Many countries are currently making changes to the science curriculum, which are tied to the core ideas of science education. However, these core ideas have different interpretations. Many countries are currently making changes to the science curriculum, which are tied to the core ideas of science education. However, these core ideas have different interpretations.Since there has not been a systematic literature review (SLR) related to the definition of core ideas, this study aims to establish a theoretically justified concept for core ideas. A systematic analysis is carried out to conceptualize core ideas and develop a theoretical model to achieve this goal. . The results of this study emphasize the need to put more focus on core ideas. To identify disciplinary and interdisciplinary core ideas taught in the school program and create meaningful models and frameworks on how these are progressing throughout the school years.

Strand 10: Curriculum and Assessment
WIP Roundtable

Designing research-based STEM frameworks for student-focused holistic aquatic robotics kits (SHARK) for children and adolescents

Zoubeida Dagher*, University of Delaware, USA
Jennifer Gallo-Fox, University of Delaware, USA
Maisha Mouli, University of Delaware, USA
Faezeh Vahdat-Nia, University of Delaware, USA
Tyler Van Buren, University of Delaware, USA

ABSTRACT
This conceptual paper describes the process used to develop bioinspired aquatic robotic engineering curriculum kits to develop children's and adolescents' understanding of biomimicry and engineering design practices. This project is significant because it expands the range of quality engineering curricula available to preschool through high school students. Recent scholarship in engineering education, integrated STEM education, and social constructivist theories of learning informed the selection of the curriculum design principles that guided the development of the bioinspired robotics curricula. We present the mapping of the unit's integrated STEM components and epistemic practices of engineering across three age groups and discuss the implications of the identified design principles for ongoing project development.

Strand 14: Environmental Education and Sustainability
Roundtable
Problem-Based Learning in a Non-Majors Environmental Science Class. Is it Science?
Carolyn Parker*, American University, USA
Nicole LeVee, American University, USA
Hannah Jardine, American University, USA
Alicia Debruin, American University, USA

ABSTRACT
Recent advances in STEM education indicate that a problem-based approach can positively support the science learning of non-science majors (Hmelo-Silver, 2004). Our National Science Foundation IUSE project works with environmental science faculty to align a non-major environmental science course with an interdisciplinary, problem-based approach. In this roundtable discussion, we will review the revisions of the course while responding to the following research question: How does an interdisciplinary, problem-based approach improve students' motivation to learn environmental science? Using Glynn's (2011) validated survey, we quantitatively assessed the revised coursework on students' motivation to learn science. We also completed semi-structured interviews with a sample of students, probing their experiences with the revised course and their understanding of the processes of science. Results from three semesters of pre and post-test data from the Glynn (2011) survey indicate improved student motivation and self-efficacy for science. An analysis of the qualitative data indicated that the students believed the course's problem-based approach did motivate them to learn science as they had been traditionally taught. Moreover, the course did not reflect the more traditional scientific coursework they had completed. In our roundtable discussion, we would like to discuss the possible contradictions between the project's quantitative and qualitative data.

Strand 14: Environmental Education and Sustainability
WIP Roundtable
Assessing students' knowledge in the field of green chemistry
Laura Freude*, University of Duisburg-Essen, Germany
Mathias Ropohl, University of Duisburg-Essen, Germany

ABSTRACT
The term Education for Sustainable Development(ESD) was established by the Agenda 21. As part of the educational system, schools should contribute to ESD. A common aim of ESD and schools, in particular, chemistry education is the purpose to enable students to address environmental and developmental issues in their everyday lives. This raises the question of how chemistry lessons can contribute to ESD. A successful approach at the industry to reach the Sustainable Development Goals is the approach of green chemistry. Green chemistry is already part of the curriculum at many universities. Even though green chemistry is taught at universities only a few studies on green chemistry can be found related to science instruction in school so far. For example, the topic of green chemistry cannot be found explicitly in the German curricular. Only some of the basic ideas of green chemistry can be found implicitly. In order to successfully implement green chemistry in school lessons, the current situation about students' green chemistry knowledge should first be analyzed. Therefore, the knowledge about green chemistry is differentiated in content, procedural and epistemic knowledge. In the framework of this PhD project a test instrument for each kind of knowledge will be developed.

Strand 14: Environmental Education and Sustainability
WIP Roundtable

Systems thinking in chemistry education – modelingand test development

Silja Herholz*, University of Duisburg-Essen, Germany
Mathias Ropohl, University of Duisburg-Essen, Germany

ABSTRACT
Education for sustainable development (ESD) deals with phenomena and processes from the perspective of sustainability and relies on systems thinking as one key competence in this regard. Systems thinking is a set of analytical skills for dealing with complex systems. Chemistry education is essential in ESD since many phenomena, processes, and systems related to sustainability involve chemical concepts. Therefore, systems thinking should be acquired and promoted in chemistry and chemistry education. However, research on systems thinking related to chemistry focuses on undergraduate students. The few existing studies related to chemistry in school focus on implementing systems thinking in the curriculum. Against this background, the present PhD project aims to get more insight into the development of upper secondary school students' systems thinking skills in chemistry. Therefore, a competence model for systems thinking in chemistry education is first adopted using existing competence models from geography and biology. Based on this model, test items are then designed to be used in the school context to measure the systems thinking skills of upper secondary school students in chemistry.

Developing Scientific Attitudes and Identities

Strand 2: Science Learning: Contexts, Characteristics and Interactions
24-Mar-25, 8:15 AM-9:45 AM
Location: Annapolis 1

Stand-Alone Paper

Middle School Science Interest: Elementary School Science Experiences and Middle School Science and Mathematics Grades

Katherine Dabney*, Virginia Commonwealth University, USA
Gerhard Sonnert, Harvard, USA
Susan Sunbury, Harvard, USA
Philip Sadler, Harvard, USA

ABSTRACT

This study explores the association of elementary school science experiences with middle school science grades and end of middle school science interest using logistic regression analyses. The data set included more than 4,719 youth participants across a wide array of demographic differences. The initial results show that positive elementary school science experiences are strongly associated with A/B grades in middle school science. A subsequent logistic regression model shows that students who had positive elementary school science experiences and A/B grades in middle school science were more likely than those who did not to have an interest in science at the end of middle school. The study adds support to policymakers and organizations seeking to increase the availability of positive elementary school experiences for young children.

Stand-Alone Paper

Bridging the Attitude Gap: Trust in Science vs. Learning Science

Adi Moskovits*, Weizmann Institute of Science, Israel
David Fortus, Weizmann Institute of Science, Israel

ABSTRACT

The rise of anti-science movements in recent years, such as the Flat-Earth theory and the anti-vaccine movement, has raised concerns about their potential impact on young children exposed to these theories. This exposure could exacerbate the already well-documented decline in attitudes toward science and science education(Galton, 2009; Osborne et al., 2003; Sjøberg, 2019).To address this concern, we measured the attitudes of 1,803 junior high school students from seven different schools, considering various demographic variables. We assessed three aspects of their attitudes toward science: trust in scientific authorities, perceived importance of science for humanity, and attitudes toward science education, as well as their interest in learning different scientific topics framed through their application in the world.Our findings suggest that although, as expected from past studies, junior high school students exhibit negative attitudes toward science learning in the classroom, they retain high trust in scientific authorities and recognize the importance of science for life and humanity. Furthermore, we demonstrate that these students show a greater inclination to learn science subjects when presented with an emphasis on applications rather than being

organized around core scientific ideas. This suggests a potential strategy for improving their attitudes toward learning science.

Stand-Alone Paper

Reducing Chemophobia and Improving Chemistry Learning through an Amalgam of Culture-Technology-Context-and-Humor

Adekunle Oladejo, Lagos State University (LASU-ACEITSE), Nigeria
Peter Okebukola, Lagos State University (LASU-ACEITSE), Nigeria
Rasheed Sanni, Lagos State University (LASU-ACEITSE), Nigeria
Taibat Olateju, Obafemi Awolowo University, Nigeria
Franklin Onowugbeda, Lagos State University (LASU-ACEITSE), Nigeria
Deborah Agbanimu, National Open University of Nigeria (NOUN), Nigeria
Olasunkanmi Gbeleyi, Lagos State University (LASU-ACEITSE), Nigeria
Ademola Ibukunolu, Lagos State University (LASU-ACEITSE), Nigeria
Esther Peter, Lagos State University (LASU-ACEITSE), Nigeria

ABSTRACT

The desire to improve science education and encourage diversity and inclusion underscores the need for more effective and culturally sensitive approaches to science teaching. This study explored the effectiveness of Culturo-Techno-Contextual approach (CTCA) in reducing science anxiety and promoting meaningful learning of chemistry among secondary school students. A mixed-method (explanatory sequential) design involving a quasi-experimental design, and individual in-depth interviews was adopted as the study design. Data were sought from 208 students (102 - experimental group, 106 - control group) senior secondary one (grade 10) who participated in this study using the science anxiety scale and chemistry achievement test for the quantitative data and students' perception about CTCA interview guide for the qualitative data. The quantitative instruments were used in pre, post, and post-posttests administrations to measure the treatment effect on anxiety and achievement after being validated and found reliable with a correlation coefficient of 0.83 and 0.82. Findings indicate that CTCA is significantly more effective than the traditional teaching method in enhancing learning in chemistry while reducing students' anxiety towards learning chemistry. Also, from students' reports, CTCA promotes critical thinking ability of students. Within the scope and limitations of the study, recommendations for adoption of the approach were provided.

Stand-Alone Paper

Examining Science Identity Shifts: The Role of Peer and Teacher Positioning in Classroom Interactions

Wenya Yang, Ruixiang Experimental School, China
Weiwei He*, Michigan State University, USA
Huixian Wu, Institute of Problem-Systematized-Learning, China

ABSTRACT

Science identity, an important aspect of scientific literacy, has sparked researchers' great interest in its construction. To foster students' productive science identity, it is crucial to

understand how students accept, negotiate, or resist diverse identities from moment to moment. This study uses positioning theory to investigate the micro-identity of a single student in science activities. The findings show two shifts in science identity occurred in a short period. Specifically, peers' collective positioning caused the identity crisis, shaking the student's positive identity, while the teacher's authoritative positioning helped strengthen the positive identity.

Examining science teacher identity, beliefs, and transformative practices to improve educational outcomes

Strand 4: Science Teaching — Middle and High School (Grades 5-12): Characteristics and Strategies
24-Mar-25, 8:15 AM-9:45 AM
Location: Baltimore 4

Stand-Alone Paper

Science Teacher Identity Among National Board-Certified Science Teachers

Jennifer Tripp*, University at Buffalo, SUNY, USA
Xiufeng Liu, University at Buffalo, SUNY, USA

ABSTRACT

Quality science teaching is vital for robust public science engagement, informed decision making, and a capable STEM workforce. Yet, teacher attrition and longevity have been persistent global issues, particularly in science disciplines. Given its alignment with promoting science teacher retention and quality, science teacher identity has gained considerable research attention. Despite this recognition and interest, clear conceptualizations of science teacher identity, its components and their relationships, and how it is constructed and reconstructed over time, especially among more experienced teachers, is lacking. Only a few studies have focused on National Board-Certified Science Teachers (NBCSTs), who have attained the highest level of science teaching certification in the U.S.; yet they do not explore science teacher identity and have been published over a decade ago.Thus, this open-ended qualitative survey study focused on NBCSTs by exploring their views of themselves as science teachers, formative experiences for science teacher identity development, and future aspirations. Findings offer past-present-future trajectory insights into the nature of science teacher identity over time, among more experienced middle and high school NBCSTs, addressing critical literature gaps and adding to theory on science teacher identity by refocusing on the self as meaning-maker, which drives actions and visions for the future.

Stand-Alone Paper

Exploring science teachers' beliefs and practice patterns: a latent profile analysis

Zhao Cao Kan*, East China Normal University, China
Aik-Ling Tan, Nanyang Technological University, Singapore
Xinning Pei, East China Normal University, China

ABSTRACT
This study profiles science teachers based on three constructs: views of scientific inquiry, efficacy of science teaching, and frequency of using inquiry-based instruction, framed by Bandura's social cognitive theory. Latent profile analysis was conducted on a sample of 367 secondary science teachers. Multinomial logistic regression was then used to characterize each group using the variables of gender, teaching experience, academic background, level of academic attainment and school support. Three groups of science teachers were identified– beginning practitioners, competent practitioners and proficient practitioners. Further analysis revealed that gender, teaching experience, academic background, level of academic attainment did not significantly influence profile membership. However, profiles were significantly associated with age and level of school support. Specifically, older teachers were more likely to be beginning practitioners of inquiry, and the level of school support for inquiry significantly influenced teacher subgroups. These findings have implications for the design of tailored professional development programs targeting specific characteristics of science teachers to build an inclusive teacher education system.

Stand-Alone Paper

Raciolinguistic ideologies and formative assessment among middle and high school science teachers: A preregistered replication

Quentin Sedlacek*, Southern Methodist University, USA
Maricela León, Southern Methodist University, USA
Nickolaus Ortiz, Georgia State University, USA
Catherine Lemmi, California State University Chico, USA
Kimberly Feldman, Southwest Academy, Baltimore County Public Schools, USA

ABSTRACT
Language, race, and racism are deeply intertwined. In a recent study of preservice teachers, we found that seemingly race-neutral beliefs about science writing pedagogy (e.g., students should learn to do formal science writing before engaging in creative or informal science writing) were associated with racial ideologies and with ineffective and even racially biased formative assessment practices. To establish the generalizability and reproducibility of these findings, we conducted a preregistered conceptual replication with a larger sample of current middle and high school science teachers from forty-two U.S. states (N= 387). We confirm that most of our previous findings were replicated and identify several additional findings. Implications for science teacher education and science education research are discussed.

Critical Thinking and Argumentation in STEM

Strand 5: College Science Teaching and Learning (Grades 13-20)
24-Mar-25, 8:15 AM-9:45 AM
Location: Magnolia 3

Stand-Alone Paper

Using Model Evidence Link Diagram to Assess College Students' Plausibility Perceptions on Climate Change

Gizem Ozyazici*, Syracuse University, USA
Gaye Ceyhan, Bogazici University, Turkey

ABSTRACT

This study examines the impact of a scaffolding activity on non-science majors' perceptions of global climate change (GCC) in the context of increasing extreme weather events associated with human-induced climate change. Current research, conducted with 62 undergraduate students from a U.S. research university. The study used a pre-post quasi-experimental design. The Extreme Weather (EW) Model Evidence Link (MEL) diagram is used to examine whether students' plausibility perceptions change after the implementation of the EW MEL diagram and students' alternative and scientific explanation results in the EW MEL activity. An updated Plausibility Perception Measure (PPM) scale was used in the current study. The results indicate a statistically significant increase in students' plausibility perceptions after the MEL activity. In addition, results from the explanation task showed that misconceptions about MEL events persist, and students' explanations were categorized and found to be mostly descriptive and erroneous. The study highlights the need for explicit teaching of critical evaluation in higher education to improve students' understanding of evidence-based decision making.

Stand-Alone Paper

University Students Perceptions of a Newly Designed Instructional Framework for Promoting Critical Thinking

Carmella Shahab*, Technion - Israel Institute of Technology, Israel
Miri Barak, Technion - Israel Institute of Technology, Israel

ABSTRACT

Critical thinking is considered a core competency essential for university graduates to compete in the 21st century global economy; yet, much obscurity remains regarding its practical role in science and engineering education, particularly in the context of internationalized teaching and learning practices. This study aimed to examine students' perceptions of a newly designed instructional framework for promoting critical thinking from a sociocultural perspective. Conducted at a research university in Israel and its branch campus in China, the quasi-experimental study involved 308 participants, divided into experimental and control groups. The experimental groups engaged in critical thinking enhanced activities, while the control groups followed traditional teaching methods. Data were collected through pre- and post-intervention questionnaires, analyzing students' perceived experiences with the learning activities. The findings indicate that students who

participated in the intervention perceived to have experienced greater critical thinking engagement than those who studied with traditional methods. Notably, cultural background did not impact the intervention's effectiveness, as both the Chinese and Israeli experimental groups reported similar experiences. The study contributes to theoretical and practical knowledge by presenting a flexible pedagogical model that fosters critical thinking competencies in a multicultural educational context, aligning with global trends in higher education.

Stand-Alone Paper

Assessing Student Scientific Argumentation Using Natural Language Processing

Winter Allen*, Purdue University, USA
Carina Rebello, Toronto Metropolitan University, Canada
N. Sanjay Rebello, Purdue University, USA

ABSTRACT

Scientific argumentation is an important science and engineering practice and a necessary 21st Century work-force skill. Due to the nature of large enrollment classes, it is difficult to individually assess students and provide feedback on their argumentation. The recent developments in Natural Language Processing (NLP) and Machine Learning (ML) may provide a solution. In this study we investigate methods using NLP and ML to assess and understand students argumentation. Specifically, we investigate the use of a fine-tuned BERT (Bidirectional Encoder Representations from Transformers) to analyze student essays of argumentation after solving a problem in the recitation section of an introductory calculus-based physics course. We report on the performance of this model to identify Claim, Evidence, and Reasoning statements and on the model's ability to cluster student argumentation essays to detect emerging themes.

Stand-Alone Paper

Designing Issue-based Instruction in General Education Course to Influence Undergraduates' Argumentation Performances and Learning Interest

Shih-Yeh Chen*, National Taichung University of Education, Taiwan
Shiang-Yao Liu, National Taiwan Normal University, Taiwan

ABSTRACT

Teaching the connection between science, technology, and society is a crucial component of general education. Incorporating socioscientific issues (SSIs) as learning content would enrich this connection byconsidering ethical dimensions, moral reasoning, and emotional development. This study explores the influences of an SSIs film series combined with the argumentation process on undergraduate students' use of the structural elements in arguments and the development of situational and individual interest in the course. Fifty-five students participated in the course, with the intervention beginning in the second half of the semester, following a pre/posttest design. The instructor introduced one issue for argument before and after viewing the SSIs films, with two lessons per week. Results showed that students' performance improved on all structural elements except supportive arguments.

Significant gains were observedin rebuttal, evidence, and qualifier, with medium effect sizes for rebuttal and evidence and a large effect size for qualifiers. Additionally, learning interest increased significantly, with large and medium effect sizes in situational and individual interests, respectively. The study will further elaborate on how the course design influenced argumentation performances and interest development.

Engaging High School Students through Research and Outreach Experiences

Strand 6: Science Learning in Informal Contexts
24-Mar-25, 8:15 AM-9:45 AM
Location: Magnolia 2

Stand-Alone Paper

A Qualitative Analysis of High School Students' Reflections Before and After a University Field Trip

Toluwalase Salako*, North Carolina State University, USA
Tyler Harper-Gampp, North Carolina State University, USA
Margaret Blanchard, North Carolina State University, USA

ABSTRACT

High school students' reflections before and following a university field trip are qualitatively explored. Participants were recruited from six rural, early college and traditional high schools as part of a larger educational study. Students responded to open-ended prompts about their experience prior to (n = 192) and following (n = 223) the field trip. Students' reflections were grouped into nine emergent categories, including evaluative and physically seeing campus. Results revealed that all of the components of the Learning Cycle (active experimentation, concrete experiences, abstract conceptualization, and reflective observation) were present both prior to and following the university field trip. A consistent trend among the items students anticipated and experienced was observed for most classifications, suggesting an alignment between our goals in developing the field trip and the students' expectations. While students anticipated hands-on experiences, a larger portion of them (almost 20% more) identified one of the hands-on activities as the most exciting portion of the field trip, echoing the value of concrete experiences in educational activities. This highlights the importance of not only providing students with the concrete experience of attending a field trip but embedding these opportunities within the experience itself.

Stand-Alone Paper

Measuring High School Student Knowledge of Quantum Information Science and Technology in University-Based Outreach

Robert De La Cruz, Stony Brook University, USA
Angela Kelly, Stony Brook University, USA
Tzu-Chieh Wei, Stony Brook University, USA
Dominik Schneble, Stony Brook University, USA

Michele Darienzo, Stony Brook University, USA

ABSTRACT

With the current growth in quantum information science and technology (QIST), there isan increasing need to prepare precollege students for post-secondary QIST study andcareers. This quantitative, pre-/post-design research focused on students' QISTknowledge outcomes from a one-week, 25-hour summer program for U.S. high schoolstudents in grades 10-12. The theoretical framework for the outreach design was based ona STEM integration model, addressing the counterintuitive, abstract nature of QISTconcepts and promoting QIST interest through multiple representations, careerawareness, and exposure to role models. The program featured lectures, demonstrations,and hands-on experiences in classical and quantum physics and quantum computing.Activities were held at both a research university and an urban informal scienceinstitution. Students (N=77) improved their overall QIST knowledge as well asknowledge in each subdomain of classical physics, quantum physics, and quantumcomputing, all with large effect sizes. Analysis of variance and analysis of covarianceindicated there were no differences in QIST knowledge outcomes when consideringstudent gender, grade level, and prior mathematics and physics preparation. This informalsummer program showed promise in promoting positive student attitudes towards QIST,a critical emerging field in advancing technological solutions for global challenges.

Stand-Alone Paper

URM HIGH SCHOOL STUDENTS EXPERIENCES WITH AUTHENTIC RESEARCH CONDUCTED AT A UNIVERSITY CAMPUS

Maram Alaqra*, Sharjah Education Academy, UAE
Bugrahan Yalvac, Texas A&M University, USA

ABSTRACT

Located in a city in the Southwest US, Latinx students lack quality learning opportunities to be prepared for careers in scientific disciplines. Learning activities that are not contextual do not suffice to catch Latinx students' interest in STEM fields. It is instrumental in engaging Latinx students in contextualized and experiential STEM learning activities to support the efforts to promote social justice and educational equity. Funded by the two major agencies in the US, a team of university faculty and researchers designed and offered contextualized STEM instruction. Students were selected from two high schools and completed the STEM program over the summer. We employed a qualitative study to explore URM's high school students' experiences with contextualized and experiential STEM research on students' STEM perceptions towards science and scientists, life skills, and learning experiences. The findings of our study show that the research experiences inspired students to choose STEM majors after graduation from high school, enhanced students' life skills, helped them gain a deeper understanding of the subject matter, and improved their perceptions of the characteristics of science.

Stand-Alone Paper

Questioning to Facilitate Dialogues between Scientists and High School Students in A Science Internship

Pei-Ling Hsu*, University of Texas at El Paso, USA
Erica Nash*, University of Texas at El Paso, USA

ABSTRACT
Effective questioning is a crucial component of teaching and learning in science contexts. Teachers understanding their role and impact as facilitators of productive discourse through questioning is key to supporting the development of scientific thinking and communication skills in their students. This study aims to understand how questioning may play a role in facilitating dialogues between high school students and scientists in a science internship setting. Throughout the internship, students and scientists conducted cogenerative dialogues to reflect on their internship practice as a way to improve their internship teaching and learning. Drawing on the framework of Solutions Focused Questioning for Coaching, we analyzed and identified ten major questionings used to facilitate the dialogues between high school students and scientists. The frequencies and patterns of these questionings were also illustrated and discussed in this study. These findings can help educators understand how to support and facilitate dialogues through different types of questionings in order to model productive discourse with students.

Computational Thinking in STEM Teaching and Learning

Strand 7: Pre-service Science Teacher Education
24-Mar-25, 8:15 AM-9:45 AM
Location: Baltimore 1

Stand-Alone Paper

Pre-Service Teachers' Reasoning about the Nervous System

Ihsan Ghazal*, Boston University, USA
Hayat Hokayem, Texas Christian University, USA

ABSTRACT
This study explored the impact of a holistic approach to teaching the nervous system on pre-service teachers' (PSTs) reasoning abilities. The research investigated PSTs' reasoning regarding the nervous system and how they evolved after participating in a holistic unit. The study adopted a qualitative approach, employing pre- and post-assessments to gather data. Sixty-eight PSTs engaged in an eight-week unit on the nervous system. Results identified four levels and revealed enhancements in PSTs' reasoning levels. The levels ranged from students not realizing any causal relation or mechanism occurring in the body to the ability to reason a whole nervous mechanism when the receptor organ receives a stimulus that propagates to a nerve center via the sensory nerve and then travels to the effector organ via a motor nerve inducing a response. Intermediate levels included a concealed or incomplete relation between the event and the involvement of a nervous structure (usually the brain), in addition to describing one of the routes: sensory or motor. The findings offered valuable insights for enhancing science education pedagogy, emphasizing the importance of incorporating systems thinking approaches in PSTs' training programs.

Stand-Alone Paper

Challenging Misconceptions: Leveraging Cognitive Conflict to Enhance Pre-service Science Teachers' Understanding

Jingyun Wu*, Indiana University, USA
Adam Maltese, Indiana University, USA
Gholamreza Shamsi Pour Siahmazgi, Indiana University, USA
Arya Karumanthra, Indiana University, USA

ABSTRACT

Persistent misconceptions in science education pose significant challenges for effective instruction. This study investigates the efficacy of cognitive conflict strategies in facilitating conceptual change among pre-service science teachers, focusing on thermal energy and Newton's Third Law concepts. Using a pre-test, intervention, post-test design, we engaged 36 pre-service elementary teachers in targeted cognitive conflict activities. Data analysis revealed significant improvements in understanding, particularly in explaining why metals feel colder than wood at room temperature (37% increase in correct responses) and force interactions between objects of different masses (53% increase). However, some misconceptions, such as the belief that materials retain warmth or cold, persisted. The intervention also enhanced students' ability to apply their understanding more flexibly across different contexts. These findings underscore the potential of cognitive conflict approaches in addressing misconceptions and improving science instruction. By enhancing pre-service teachers' conceptual understanding and ability to address misconceptions, this study contributes to the ongoing effort to bridge the gap between theory and practice in science teacher education, potentially leading to improved student learning outcomes in science education.

Stand-Alone Paper

Empowering Science Pre-service Teachers: Computational Thinking Preparation though SPARC-infused instruction

Jianlan Wang*, Texas Tech University, USA
Yuanlin Zhang, Texas Tech University, USA

ABSTRACT

The importance of K-12 computer science education is increasingly recognized, with integration efforts often focusing on game-oriented, block-based programming languages like Scratch. While these approaches offer a lower learning curve, they lack the authenticity of text-based programming, limiting students' exposure to the practices of professional computer scientists. Additionally, many science educators view computer science as an optional supplement rather than a core component of their curriculum, partly due to a scarcity of successful examples of integrated instruction. This study explores a four-week module aimed at enhancing Computational Thinking (CT) among pre-service science teachers (PSTs) using SPARC, a text-based declarative programming language. The module integrates CT with science through the skills of abstraction, algorithm and programming, with corresponding rubrics developed to assess these competencies. Our findings indicate

that integrating a text-based programming language into science instruction is both feasible and effective in improving PSTs' science content knowledge and CT skills, particularly in abstraction. PSTs' science content knowledge seemed to impact their CT performance. Although PSTs recognized the importance of CT in science education, they expressed concerns regarding the alignment of these skills with existing science curricula at school. Implications for the broader integration of computer science are also discussed.

Stand-Alone Paper

Investigating Preservice Teachers' (PSTs') Conceptions of"Plugged" and "Unplugged" Computational Thinking (CT) via Integrated Robotics

Jeffrey Radloff*, SUNY Cortland, USA
Bridget Miller*, University of South Carolina, USA
Qwynne Lackey, SUNY Cortland, USA

ABSTRACT

As a core science and engineering practice, computational thinking (CT) is crucial for elementary preservice teachers (PSTs) to understand conceptually and pedagogically. This study explores PSTs' conceptions of "plugged" and "unplugged" computational thinking (CT) via integrated robotics activities. This pilot study involved 16 PSTs in a semester-long technology content course who engaged in six scaffolded "plugged" and "unplugged" CT lessons. Data were collected and analyzed via pre-and post-surveys, reflections, and design artifacts to assess PSTs' CT development, self-efficacy, and understanding of "plugged" and "unplugged" instructional approaches. Results showed a significant increase in PSTs' CT knowledge and self-efficacy and yielded critical insights into their understandings of "plugged" and "unplugged" approaches. PSTs articulated discrete enactment and emphasized the importance of balancing "plugged" and "unplugged" activities as an equitable method of introducing CT. This research contributes to learning how integrated CT activities can enhance PSTs' related understandings and emphasizes the need for teacher education classes to include a variety of "plugged" and "unplugged" learning opportunities.

Transformative Professional Development for Equitable STEM Education

Strand 8: In-service Science Teacher Education
24-Mar-25, 8:15 AM-9:45 AM
Location: Annapolis 3

Stand-Alone Paper

Shifts in middle school STEM teachers' conceptions of teacher leadership and equity

Matthew Wilsey*, University of Notre Dame, USA
Michael Szopiak, University of Notre Dame, USA
D'Anna Pynes, University of Notre Dame, USA
Catherine Wagner, University of Notre Dame, USA
Matthew Kloser*, University of Notre Dame, USA
Gina Svarovsky, University of Notre Dame, USA

ABSTRACT
STEM teacher leadership offers a promising solution for elevating the culture of a school by enabling strong classroom teachers to influence broader educational practices and policies with peers, at the school level, and across the field. This study examines how middle school STEM teachers' conceptions of leadership and equity evolve through participation in a longitudinal professional development program that introduced an equity-focused STEM teacher leadership framework. The findings indicate that while teachers frequently adopt leadership roles to support colleagues, their engagement with institutional and systemic levels of leadership is significantly lower. Additionally, evidence from over 100 teachers in this study shows how conceptions of equity can move beyond a sole focus on access to also include more substantive ways that elevate the dignity of students' backgrounds, positions them as problem solvers for the common good, and gives them agency through STEM education to help those in most need. This paper contributes to the field by highlighting the importance of a structured equity framework in fostering comprehensive leadership and equitable practices in STEM education. These insights may benefit future professional development programs aimed at empowering STEM teachers to drive educational equity and innovation.

Stand-Alone Paper

Middle-School STEM Teachers' Collaborative Sensemaking During a Curriculum Planning Workshop

Kristen Wendell*, Tufts University, USA
Geling Xu, Tufts University, USA
Debra Bernstein, TERC, USA
Michael Cassidy, TERC, USA
William Church, CRCS, USA
Ethan Danahy, Tufts University, USA

ABSTRACT
Detailed descriptions of teachers' successful curricular sensemaking can help professional development (PD) facilitators support and sustain it. In this study, we use discourse analysis to unpack a successful episode of STEM teacher sense-making during a curriculum planning conversation about structure/function analysis. This conversation occurred as teachers were working to adapt a set of biomimetic engineering design curriculum materials for use in their own middle-school STEM classrooms. We conducted discourse analysis of the curriculum planning episode for two indicators of collaborative sensemaking: gapsand relations.A gap is a person's expression of the need to make something intelligible, and a relation addresses a gap by building connections between ideas that the people in the conversation already understand in common. We found that over the course of 13 minutes, two teachers and one PD facilitator perceived 20 distinct gaps in their knowledge of how to plan a curriculum piece to support student practice with structure/function analysis. They offered 33 relations to fill those gaps. Our findings demonstrate how engaging in collaborative sensemaking can help teachers adapt curriculum for their students. This work

will be of interest to those who facilitate PD experiences for teachers and want to support teacher sensemaking.

Stand-Alone Paper

(Un)Becoming-STEMM Educator-With Justice-Oriented Professional Development Workshops

Katherine Ayers*, St. Jude Children's Research Hospital, USA
Robyn Pennella, St. Jude Children's Research Hospital, USA
Olayinka Mohorn-Mintah, University of Memphis, USA

ABSTRACT

This study examines the process of (un)becoming-STEMM educator-with a justice-oriented professional development workshops. Through a diffractive analysis of exit interviews with seven STEMM educators participating in a 10-month fellowship, we explore the interplay of human and non-human agents in shaping educators' identities and practices. The study highlights how systemic inequities, such as the segregation of resources within schools, create barriers for marginalized students, particularly in under-resourced schools. By reframing their access to resources through the fellowship, educators gained new strategies and connections, empowering them to advocate for equitable STEMM education. This research underscores the importance of poststructural feminist perspectives in understanding the complex dynamics of identity formation and resource distribution in STEMM education. It calls for professional development programs that not only focus on pedagogy but also address the broader systemic issues that hinder equitable access to quality STEMM education. Through this lens, the study contributes to the ongoing discourse on educational equity, offering insights into how STEMM institutions can support teachers as they navigate and challenge the power dynamics within their schools to better support all students.

Stand-Alone Paper

Extending your Professional Development: Exploring Virtual PLCs as an opportunity for continued teacher support.

Austin Moore*, Boston College, USA
Maria Moreno Vera, Boston College, USA
Katherine McNeill, Boston College, USA

ABSTRACT

While curriculum has shown to assist teachers in achieving the shifts of science reform, professional development (PD) opportunities offer additional support for teachers (Lynch et. al, 2019). These PD programs often require teachers to travel, or are not offered due to the limited number of science teachers in a building or across a district. Therefore we investigated the effectiveness of a virtual professional learning community (VPLC) as a feature of a PD structure (Ford et, al, 2008). This study took place with 90 middle school science teachers as they customized and enacted the OpenSciEd curriculum over the course of the school year. Each teacher engaged in 34 hours of PD: four in-person days and two synchronous virtual sessions. A coding scheme was developed based on our theoretical

framework and through iterative analysis of the data (Miles et al., 2020). Our findings suggest that 42% percent of the participants mentioned benefiting from the VPLC experience. Further analysis presented two major ideas: 1. Teachers value the opportunity to broaden their community 2. Teachers actively search for online learning communities. The results from this study suggest VPLCs have potential to be an effective way to extend the PD by providing teachers meaningful support.

Bridging Theory and Practice: Modeling, Mathematization, and Student Development

Strand 1: Science Learning: Development of student understanding
24-Mar-25, 10:00 AM-11:30 AM
Location: Azalea 3

Stand-Alone Paper

Bridging Equations and Phenomena: Task Design's Role in Promoting Blended Sensemaking

Desi Desi, Sriwijaya University, Indonesia
Anita Schuchardt*, University of Minnesota, USA

ABSTRACT

Studies across disciplines show that students struggle to solve quantitative science problems because they fail to engage in blended sensemaking (make connections between mathematical equations and scientific phenomena). Blended sensemaking has been associated with greater conceptual understanding and improved quantitative problem solving. However, there is limited investigation of student blended sensemaking as they engage in different instructional tasks.This study examined student blended sensemaking elicited by five different tasks: constructing a mathematical model (Build), choosing between existing mathematical models (Comparing Models), practicing using a mathematical model (Present and Practice), recognizing patterns in the mathematical model (Pattern) and modifying mathematical models (Modify). Results showed that when students are discussing mathematics in science in small groups, blended sensemaking occurs regardless of the task set-up. However, the frequency of blended sensemaking and the types of sensemaking that are connected varied by task, indicating that the characteristics of the tasksaffected the types of blended sensemaking that students engaged in. Consideration of how task types may affect blended sensemaking could assist researchers indesigning active learning tasks that are likely to promote the blended sensemaking they are interested in studying and allow instructors to design and select tasks that align with their learning objectives.

Stand-Alone Paper

Evaluating Students' Development of Systems Thinking via Computational System Modeling

Emil Eidin*, University of Wyoming, USA
Jonathan Bowers, Michigan State University, USA

Mark Perkins, University of Wyoming, USA

ABSTRACT
Computational systems modeling has been shown to be a promising avenue for applying Systems Thinking (ST). Despite the significant strides that have been made, there still needs to be a greater understanding of how the application of various ST aspects progresses over time. In this paper, we aim to explore students' progression in applying ST over the course of an NGSS-aligned and project-based six-week unit as the students construct and revise their models using a computational systems modeling program called SageModeler. We analyzed students' models, tagging data, an automatically generated data indicating various parameters in the model. In addition, we developed a rubric to manually evaluate students' models at three time points of the unit. Statistical analysis shows that the model complexity has gradually grown throughout the unit, yet it was only toward the end that non-linear structures, such as feedback and exponential model behavior, were significantly evident. The study highlights the potential of computational modeling, particularly system dynamics modeling, to support ST in science education while supporting students in one of the most challenging aspects of ST.

Stand-Alone Paper

Challenges of Modeling Life Cycles for Lebanese Elementary Students

Christelle Fayad*, Texas Christian University, USA
Hayat Hokayem*, Texas Christian University, USA

ABSTRACT
Elementary students' learning of life cycles has not yet been extensively studied. Available research only focuses on the learning of the life cycles of a couple of model organisms. In this study, we are interested in elementary students' generic ideas about the life cycle and their modeling of the life cycles of various species. We designed a life cycle unit and taught it in a grade 5 classroom in a private school in Beirut, Lebanon. Using scientific modeling as a theoretical framework, we examined students' pre- and post-assessments and interviews, focusing on their life cycle models and ideas. We identified the different challenges students faced in modeling the life cycles of different organisms, such as the apple tree, mealworm, and humans. We also found that these students struggled to distinguish between life and water cycle models. Additionally, the students were unfamiliar with the value and role of life cycles in ecosystems. Accordingly, we provide recommendations for instruction that support the meaningful learning of life cycles for elementary students.

Stand-Alone Paper

Leveraging Mathematization Process to Enhance Automated Scoring of Learning Progression Based Items

Hui Jin*, Georgia Southern University, USA
Cynthia Lima, University of Texas at San Antonio, USA

ABSTRACT
Transformer models have shown promising results in automated scoring, but they also present challenges, such as overvaluing academic vocabulary and low reliability in scoring responses from English Language Learners (ELLs). This study utilizes the mathematization process of transformer models to examine the impact of different scoring rubrics and understand the mechanisms of model mistakes, with the goal of improving the accuracy, fairness, and effectiveness of automated scoring systems. The research question is: How does transformer models' mathematization process affect the accuracy of automated scoring? The automated scoring models are developed and evaluated in three major steps: scoring, fine-tuning, and evaluating. Data from one item was used to pilot various scoring and fine-tuning strategies. Next, best strategies were selected and applied to another three items, which were answered by 809 to 1145 students. The findings indicated that providing additional contextual information enhances the model's ability to interpret student responses. Although models trained by additional contextual information had enhanced performance in scoring response with misspelled and alternative words, they were limited in interpreting scientific terms about complex relationships and nuanced distinctions.

Investigating Strategies for Fostering Social-Emotional Growth in STEM

Strand 2: Science Learning: Contexts, Characteristics and Interactions
24-Mar-25, 10:00 AM-11:30 AM
Location: Annapolis 1

Stand-Alone Paper

Differentiated instruction as a method to influence cognitive and affective learning outcomes in chemistry education

Anna Liskes*, University of Duisburg-Essen, Germany
Helena van Vorst, University of Duisburg-Essen, Germany

ABSTRACT
International research emphasizes students' heterogeneous STEM competencies and different interests in learning science. Differentiated instruction (DI) is a method that addresses classroom heterogeneity by adapting learning content to students' abilities and interests. This study investigates the effects of DI in chemistry education, focusing on performance-based DI through scaffolding and interest-based DI through context-based learning. A quasi-experimental intervention study with a 2x2-design was conducted in secondary schools (N= 738 students). Students were divided into three intervention groups, realizing different forms of DI, and one control group. The study measured among other instruments prior knowledge, content knowledge, and engagement in chemistry both before and after the intervention. Results show that student performance and engagement increase significantly over time across all groups. A significant effect of time on performance and engagement can be observed. However, there was no significant intervention group × time interaction for performance or engagement. Situational interest also increased significantly. Further analyses, including linear mixed models and structural equation

modelling, will be conducted to provide a more detailed understanding of the data. These results and their implications further research and school practice will be presented in detail at the NARST-conference.

Stand-Alone Paper

A Framework for Examining the Interconnectedness of STEM and SEL

Cory Susanne Miller*, Michigan State University, USA
Kathryn Bateman*, Museum of Science, USA

ABSTRACT

This paper introduces a framework for examining the connections between STEM practices and social and emotional learning. In the post-COVID era, there is a growing emphasis on SEL in elementary classrooms as students recover from the mental health impacts of a global pandemic. Traditionally, SEL has been treated as an independent curriculum in classrooms, but this paper argues for a more integrated approach within science and engineering. Using the CASEL SEL framework and the NGSS science and engineering practices, the paper illustrates how SEL and STEM practices can be intentionally aligned to create mutually beneficial learning environments. We developed a theoretical model based on evidence from two separate studies of science and engineering curricula conducted in K-8 school classrooms. By analyzing STEM practices alongside social and emotional competencies, the model highlights connections across five strands: self-awareness, self-management, responsible decision making, relationship skills, and social awareness. We argue that embedding SEL with STEM fosters the development of socially and emotionally intelligent, scientifically literate students while alleviating the perceived competition for time in elementary classrooms. Recommendations for professional learning are discussed alongside educative curriculum design that supports teachers in fostering both pedagogical skill sets.

Stand-Alone Paper

Facilitating productive affective transitions during a physics inquiry

Lulu Garah*, Technion - Israel Institute of Technology, Israel
Shulamit Kapon, Technion - Israel Institute of Technology, Israel

ABSTRACT

Students' enactments of epistemic agency in research apprenticeships requires going through affective transitions to resolve emotional challenges related to epistemic practice and actions. This study unpacks these transitions at different temporal scales to uncover how they are facilitated and nurtured through interactions with the research mentor. We followed an 11th grade student working on an individual open inquiry project in physics and the teacher research mentor who guided her study. The data included videotaped participant observations of the working sessions overthe full duration of the project (two years), complemented by interviews.The analysis includedfine-grained discourse analysis of selected episodes, longitudinal comparisons across episodes, and triangulation with interview data.The findings illustrate how epistemic affective transitions occurred gradually throughaccumulated in-the-moment series of micro-affective transitions,and how the teacher research mentor's epistemic empathy unfolded and transformed into specific and

coherent in-the-moment discursive moves and pedagogical decisions that facilitated these transitions.This work contributes to scholarship on learning in research apprenticeships through its analysis of authentic student-mentor interactions, rather than relying solely on retrospective data. It enhances the literature on epistemic affect through its examination of thementor's in-the-moment discursive moves and pedagogical decisions that facilitated the student's affective transitions.

Enhancing strategies for boosting elementary student scientific literacy

Strand 3: Science Teaching — Primary School (Grades preK-6): Characteristics and Strategies
24-Mar-25, 10:00 AM-11:30 AM
Location: Camellia 1

Stand-Alone Paper

The Impact of Organizing and Addressing STEM-practices in a STEM-circle in 2ndgrade STEM leaning environments

Kara-Sophie Köhler*, University of Hamburg, Germany
Karl Wollmann, University of Leipzig, Germany
Annett Steinmann, University of Leipzig, Germany
Kim Lange-Schubert, University of Leipzig, Germany
Maike Hagena, Leibniz University of Hannover, Germany
Marcus Schütte, University of Hamburg, Germany
Mirjam Steffensky, University of Hamburg, Germany

ABSTRACT

Studies show that children can develop an initial understanding of science practices and epistemological knowledge if they receive suitable support (Zimmermann Klahr, 2018). In particular, explicit reflection on the research process supports children's understanding of science as a creative process (Akerson et al., 2011), of the provisional nature of scientific knowledge (Quigley et al., 2010) and the development of epistemic beliefs (Schiefer et al., 2021). Research concerning an understanding of integrated STEM practices is missing. In the project DearH_MINT, a learning environment was developed that aims to promote STEM-specific practices and epistemological knowledge in second graders. This learning environment was tested in a comparison group design with n=308 children. The degree of explication of procedural and epistemic knowledge (incl. knowledge about science, engineering and mathematical practices) was systematically varied (IG explicit addressing n=122; CG implicit addressing n=130, BG business as usual n=56). Learning progress in content knowledge (STEM) and knowledge of STEM was determined using paper-pencil tests. The results show that the explicit addressing improves student's knowledge of corresponding STEM practices the short and long term (4-week follow-up). Furthermore, the results indicate that the promotion of STEM practices is not at the expense of of content knowledge.

Stand-Alone Paper

Understanding Discrepancies in Science Identity by Gender and Grade among Chinese Students

Bing Feng, Beijing Normal University, China
Yangdan Liu, Beijing Normal University, China
Jing Lin*, Beijing Normal University, China

ABSTRACT

Science identity is crucial for students' sustained interest in science and their career aspirations. While few studies have focused on gender and grade differences in science identity among elementary students, this research on grades 5 to 7 students from China found that males generally have a stronger science identity than females, potentially due to females being more susceptible to stereotypes. Both genders' science identity improves with higher grades. Educators are advised to adopt tailored educational strategies that account for grade and gender to ensure inclusive and fair science education.

Stand-Alone Paper

The Impact of Engineering DesignBased Instruction on Urban Elementary Students Nature of Engineering Views

Emine Sahin Topalcengiz*, Mus Alparslan University, Turkey

ABSTRACT

The study aimed to assess the effects of engineering design-based instruction (EDBI) on the views of 5th-grade urban students about the nature of engineering (NOE). Changes in students' NOE views were examined using a questionnaire called "Views for Nature of Engineering - Elementary School Version (VNOE-E)" as a pre- and post-test. The study included 31 students (21 women and 10 men) from urban elementary public schools in the northwest part of Turkey, selected through purposeful sampling. Over three weeks, students completed 12 hours of two design challenges. The first challenge, "Learning Woolen Gloves and Designing One," involved students learning about woolen gloves and designing insulated winter gloves as textile engineers. In the second challenge, "Let's Learn the Hippodrome of Constantinople and Design a Racetrack," students learned about the historic site, its use and designed a racetrack as civil engineers. The results of the Wilcoxon signed-rank test demonstrated that the NOE perspectives of the students were influenced by EDBI, leading to an increased prevalence of partially informed and informed NOE perspectives following the EDBI instruction. This study highlights the importance of the inclusion of more explicit and reflective strategies to teach NOE aspects during engineering design experiences.

Stand-Alone Paper

Investigating Mechanistic Reasoning in Modeling-Based Learning in Kindergarten Science: The case of Melting And Freezing

Loucas Louca*, European University Cyprus, Cyprus
Maro Michaelidou, Ministry of Education and Culture, Cyprus

ABSTRACT
Following research on using Modeling-based Learning (MbL) in kindergarten, this case study provides detailed descriptions of the implementation of MbL with a group of 21 kindergarten children studying (a) ice cube melting and (b) water freezing. Data included transcribed lessons and child-developed models. We coded the discourse data for mechanistic reasoning and child-constructed models using artifact analysis. Findings suggest that participating kindergarten children (a) can think productively across various scalar levels of mechanistic reasoning, although support to move across these levels is necessary; (b) working in step-by-step process of progressive MbL is crucial for children before moving to lower scalar levels of reasoning; and (c) multiple ways of analyzing the data provide better insights into the MbL process.

NARST Connects

24-Mar-25, 10:00 AM-11:30 AM
Location: Camellia 2

Discussion Session
This is a time for conference attendees to connect and discuss professionally related topics of their choosing. There are no designated presenters or moderators.

Examining the transformative potential of systems thinking, technology, and teacher agency in modern education

Strand 4: Science Teaching — Middle and High School (Grades 5-12): Characteristics and Strategies
24-Mar-25, 10:00 AM-11:30 AM
Location: Baltimore 4

Stand-Alone Paper
Improving high school student's scientific competencies through systems thinking inquiry
Yu-Jan Tseng*, Institute of Professional Development for Educators, National Chung Hsing University, Taiwan
Huann-shyang Lin, Centre for General Education, National Sun Yat-sen University, Taiwan

ABSTRACT
Existing literatures revealed the students' scientific competencies can be promoted through structured inquiry. Additionally, systems thinking plays an important role to enhance students' understandings of science. However, how systems thinking help students learning in structured inquiry is still worth exploring. This study aimed to compare student performance of the scientific competencies after conducting the different types of

structured inquiry teaching intervention. A total of 54 11th-grade students engaged in this quasi-experiment study. The 10-week teaching intervention for students inexperimental group (EG, n = 23) participated in systems thinking inquiry and the comparison group (CG, n = 31) participated in structured inquiry. Both groups of students took scientific competencies assessment on the pre-test and post-test. The analysis of covariance (ANCOVA) results indicated that EG significantly outperformed the CG in the post-test. In addition, students' feedbacks revealed that the practice of systems thinking can reduce the difficulties of learning science. The findings suggested that systems thinking inquiry had benefits to improve high school students' scientific competencies.

Stand-Alone Paper

Enhancing Self-Regulated Problem Solving Through a Web-based Metacognitive Tool

Leonie Jasper*, TU Dortmund University, Germany
Insa Melle, TU Dortmund University, Germany

ABSTRACT

The ability to self-regulate the acquisition of knowledge and skills is considered a key competence in today's society (Foster Piacentini, 2023). Problem-solving processes offer an opportunity to promote self-regulation and, in particular, metacognitive strategies by designing them in a way that students set goals independently, develop strategies to achieve these goals, and critically reflect on their own learning (Zumbach et al., 2020).To support students in these metacognitive processes, we have developed a content-independent, web-based tool that can be used flexibly in chemistry lessons and evaluated it as a part of a pilot study and a main study. In the main study, the tool will be used over several weeks with N ≈ 250 participating students (age 15-18) in grades 10 and 11. Among other things, the study focuses on the students' approaches in the problem-solving process.The initial results of the pilot study (N = 46) indicate that students particularly struggle with three specific steps in the problem-solving process namely 'Execute your plan and check it', 'Evaluate your work', and 'Connect content'. Further results especially from the main study, e.g. on the tool's impact on students' approaches in the problem-solving process will be presented at the conference.

Stand-Alone Paper

The Alchemy of Teacher-Driven Adaptations in the Age of Digital Curricula

Brandin Conrath, Virginia Commonwealth University, USA
Scott McDonald, The Pennsylvania State University, USA

ABSTRACT

With calls for innovative curriculum materials and those that leverage affordances of technology, there is a rise in digital curricula as a means to support complex science learning. However, the work of teaching with digital curricula is complex and understudied. There lie implicit assumptions of online and digital curricula as standalone sources of instruction in which teachers act solely as proctors. We draw on elements of digital curricula (e.g., Choppin, 2014; Mutch-Jones et al., 2018) and curricular adaptations (Remillard, 2005) to investigate the ways in which a teacher implements digital curricula and how they seek to make learning

meaningful and coherent in response to complex geoscience tools and practices. In the instances described in this study, the teacher adapted the existing digital curriculum in various forms. For the purpose of this proposal, we highlight one adaptation theme of leveraging correspondence between digital models and the real world. We expand on the teacher's reasoning for these adaptations to highlight how these each of these adaptations contribute to student sensemaking of complex geoscience phenomena with respect to professional geoscience practices.

Stand-Alone Paper

Insights into Co-designing Teaching NGSS-aligned Computational Agent-based Modeling Units in High School Science Classrooms

Elroy Murray*, DCPS, USA
Aditi Wagh, MIT, USA
Luke Conlin, Salem State University, USA

ABSTRACT

Computational modeling has been found to simultaneously support science learning and computational practices. There is much alignment between computational modeling and the Science and Engineering Practices in the Next Generation Science Standards (NGSS). However, integrating computational modeling practices with NGSS instruction may not be a straightforward task for teachers. First-authored by a high school Science teacher, this paper reports from a Research-Practice Partnership in which high school teachers from a large urban school district and university-based researchers are co-designing NGSS-aligned CM units for high school science classes. Drawing on discussions from co-design sessions and classroom implementations of the designed unit over 2 years, we ask: How did the RPP's adopted instructional values inform unit design and students' work in these ABM units? We use an existing framework of NGSS-aligned instructional elements to examine how three elements - phenomenon-based instruction, coherent for students and collaborative equitable - informed co-design of the units and classroom instruction. In the findings, we draw on decisions made through co-design and snapshots of student work to illustrate how these elements helped reconcile NGSS instruction with CM practices.

Epistemic Practices, Beliefs, and Agency in STEM

Strand 5: College Science Teaching and Learning (Grades 13-20)
24-Mar-25, 10:00 AM-11:30 AM
Location: Magnolia 3

Stand-Alone Paper

Exploring effective strategies of developing student systems thinking and epistemic beliefs about science

Huann-shyang Lin*, National Sun Yat-sen University, Taiwan
Zuway-R Hong, Chung Shan Medical University, Taiwan
Hsin-Hui Wang, National Tsing Hua University, Taiwan

Ming-Yeng Lin, National Cheng Kung University, Taiwan

ABSTRACT

This quasi-experimental study is intended to explore the effectiveness of integrating history of science and contextual inquiry activities into teaching on college students' systems thinking and epistemological belief about science (EBS). Group A students engaged in the discussions of cases history of science and hands-on activities of contextual science inquiry. Group B students' learning activities include more cases history of science, and hands-on confirmation experiments. The students engaged in typical lectures and hands-on confirmation experiments without containing history of science and inquiry activities were selected as the comparison Group C. The three courses were taught by the same instructor for one semester. The analysis of covariance (ANCOVA) on pre- and post-test of systems thinking along with qualitative analysis of student feedback in the interview found that students in the experimental group A and B outperform the comparison group students on systems thinking and EBS. Students in group A and B identified that "writing learning sheets related to inquiry experimental procedures" and "questioning/discussions after reading the history of science" effectively develop their systems thinking skills. Potential benefits of how specific teaching strategies trigger student cognitive thinking are discussed.Keywords: systems thinking, history of science, epistemological belief about science

Stand-Alone Paper

EPIC-Quest: Characterizing Epistemic Messages in Chemistry Lectures

Nicole Graulich*, Justus-Liebig University Giessen, Institute of Chemistry Education, Germany
Elias Heinrich, Justus-Liebig University Giessen, Institute of Chemistry Education, Germany

ABSTRACT

Science is a dynamic and ongoing process of inquiry, and experiencing the epistemology of science helps students understand how scientific knowledge is constructed, evaluated, and refined over time. This understanding helps students develop a more sophisticated view of scientific knowledge and grasp the inherent uncertainty of scientific knowledge. Many complex social, environmental, and technological issues, such as climate change, vaccines, and artificial intelligence, dominate the discourse and require future students to navigate these issues, understand the scientific consensus, and evaluate competing claims. Fostering the epistemology of science and uncertainty can help foster scientific literacy, which is essential for informed decision-making and responsible citizenship. Thus, students need to experience not only what scientists,e.g., chemists or biologists, know but how they know what they know. Although former and ongoing work has focused on how students develop epistemic beliefs as well as how epistemic aspects of student-teacher discourse in the science discipline unfold, it is quite unknown to what extent epistemic messages are sent in university science lectures. This work provides first insights into how epistemic messages are communicated in traditional lecture courses in chemistry and sheds light on this not-yet unpacked black box of epistemologies in teaching and learning in sciences.

Stand-Alone Paper

Scientific Writing in English in Higher Education and Non-Anglophone Students' Participation in Epistemic Practices

Luciana Milena*, Universidade Federal do ABC, Brazil
Danusa Munford, Universidade Federal do ABC, Brazil

ABSTRACT

This proposal investigates how non-native English-speaking university students engage in epistemic practices (EP) as they write scientific texts in English for an introductory science course at a public university in Brazil, taught through English as a Medium of Instruction (EMI). Using Qualitative Research methodologies and Research in Writing principles, we present the analysis of a scientific article written by higher education students in the Experimental Fundamentals of Natural Sciences (EFNS) course. The analysis focuses on epistemic levels (EL), rhetorical moves (RM), code-switching (CS), and epistemic practices (EP). Our study introduces an analytical framework for characterizing EP in university students' writing, contributing to Science Education research. The characterization of EP is enriched by examining EL, RM, and CS, which help us infer how students connect empirical and theoretical data and construct what counts as scientific discourse, while also allowing us to understand cultural practices within the group, including contextual characteristics, social roles, and relationships among members. Importantly, the use of English for writing did not impede non-anglophone participants' engagement in EP. Instead, scientific writing in English in the EFNS course proved to be an epistemically rich activity, offering students valuable opportunities to engage in the construction and communication of scientific knowledge.

Stand-Alone Paper

Biological reasoning and epistemic agency: A case of undergraduate biology teaching and learning

Greta Etherton*, University of Maryland, USA
Daniel Levin*, University of Maryland, USA
Julia Gouvea*, Tufts University, USA

ABSTRACT

Our purpose is to explore how students reason about evolution when given opportunities to assert epistemic agency. We describe a case from a lesson sequence on the evolution of the giraffe's neck in a history and philosophy of science class for undergraduate future STEM teachers. We analyzed classroom discussions, student work, and interviews with students to describe how the instructor positioned students to assert their epistemic agency and how the students were able to make choices about what and how to construct explanations that showcase a range of ideas and forms of productive reasoning. We found that students took up the opportunities to assert their epistemic agency in answering questions about evolutionary phenomena in a variety of ways including: by making claims and supporting them with evidence and reasoning, by pushing back on dominant ideas, by filling missing pieces of explanation with relevant knowledge, and by flexibly exploring a variety of ways of

explaining evolutionary phenomena. We discuss implications for instructors and curriculum developers.

Centering Equity, Agency, and Diverse Epistemologies in Informal STEM Education

Strand 6: Science Learning in Informal Contexts
24-Mar-25, 10:00 AM-11:30 AM
Location: Magnolia 2

Stand-Alone Paper

Negotiating Power: Minoritized youth instructors' enactments of critical agency in outreach activities in their community

Wisal Ganaiem*, Technion - Israel Institute of Technology, Israel
Fadia Nasser-Abu-Alhija, Tel Aviv University, Israel
Shulamit Kapon, Technion - Israel Institute of Technology, Israel

ABSTRACT

What are the pathways operationalized by minoritized youth to enact their critical agency in their own community? We present an ethnographic study that followed 31 Young Arab Instructors (YAIs) during their work as science outreach facilitators in Arab schools in Israel. These outreach activities were organized by a grassroots non-profit Arab organization in Israel whose aim is to enhance STEM education in the Arab community, andcontribute to raising this community's socioeconomic status and social mobility. The YAI (aged18-19) also participated in an extensive professional development course that focused on science content, pedagogy and social activism.The study followed the YAIs during their fieldwork in the schools. The findings show that the YAIs often had to navigate complex power relations with teachers as a result of different interpretations of student behavior that stemmed from a mismatch between the teachers' and the YAIs' figured worlds of teaching and learning.Three pathways to the enactment of the YAIs' critical agency in response to what they interpreted as injustice are discussed: defiant resistance, insistent resistance, and inclusive resistance. Whereas defiant and insistent resistance alienated the teachers and threatened their face, inclusive resistance acknowledged the teachers' role and made them part of the activity.

Stand-Alone Paper

STEM Outreach as Academic Imperialism: A Critical Discourse Analysis

george schafer*, Drexel University, USA

ABSTRACT

STEM outreach is a term commonly used to describe programming that seeks to educate K-12 youth. While there is an abundance of literature about STEM outreach, there is little work examining discourses around the purpose of such programs. Many scholars highlight the dominant emphasis of neoliberal rationale for STEM education in the U.S. such as preparing

students for the workforce and maintaining global competitiveness, yet few have explored these ideas in STEM outreach. The present study describes a critical discourse analysis conducted of 45 recently published research articles (from 2019-2023) to analyze the reasons given for engaging youth in STEM outreach. The framework of academic imperialism is used to describe and analyze Western dominance over scientific knowledge and ways of thinking which perpetuates the belief that STEM education is most important to national, economic, and societal interests. The study found that a large majority of articles used rationale in alignment with academic imperialism, with few taking human-centered approaches. These findings build the case for STEM educators to more critically reposition their approaches to and reasons for engaging in STEM outreach. By shifting our own rationale, we can create more equitable and meaningful spaces for engagement with and for youth.

Understanding Preservice Teachers' Teaching and Learning practices

Strand 7: Pre-service Science Teacher Education
24-Mar-25, 10:00 AM-11:30 AM
Location: Baltimore 1

Stand-Alone Paper

Understanding Stress and Coping Strategies of Pre-Service Science Teachers in a Teacher Preparation Program

Anne Levendusky*, University of Florida, USA
Kent Crippen, University of Florida, USA

ABSTRACT

Emotional exhaustion is exhibiting a widespread effect on the field of education not only as a key factor in influencing in-service teachers to leave the profession but also in influencing pre-service teachers' (PSTs) commitment to and perception of teaching in general. As the Transactional Theory of Stress and Coping (TTSC) postulates that stress is unique to each individual and to each situation, this study sought to understand how PSTs perceive stress in their teacher preparation program, discern specific sources of stress and identify the main stress coping mechanisms utilized. Data were obtained with a self-report questionnaire completed three times during the semester by 33 elementary science PSTs and analyzed using repeated measures ANOVA and thematic analysis. Results showed that preservice teachers exhibit higher stress levels compared to the national average, perceived stress increases significantly over the semester, main sources of stress include school, finances, and personal issues, and negative coping mechanisms were mainly utilized.

Stand-Alone Paper

Battling the Clock: P-2nd Clinical Educator Dilemmas Regarding Time for Science

Jennifer Gallo-Fox, University of Delaware, USA
Sothera Veng, University of Delaware, USA
Rosa Mykyta-Chomsky*, University of Delaware, USA

ABSTRACT
Early childhood science/engineering education is essential for fostering cognitive development and future academic success (Trundle Sackes, 2015). However, disparities in science/engineering achievement exist, from early education through later years. This pilot study surveyed 101 clinical educators (51% response rate) to examine the science/engineering teaching practices, perceptions, and preparedness of one state university's early childhood clinical educators from preschool to second grade. Data were compared to the national averages. Findings reveal that science/engineering subjects are less frequently taught among the ECE CEs in the sample than the teachers in national studies. Barriers to effective instruction include limited resources, time constraints, and insufficient teacher training. The study highlights the need for targeted professional development to enhance science/engineering instruction and education.

Stand-Alone Paper

Personal Characteristics Impacting Teachers' Effective Argumentation Teaching in science classrooms: A Literature Review

Nannan Fan*, University of north carolina at chapel hill, USA

ABSTRACT
Recognized as one of the eight core scientific practices of science education in the Next Generation Science Standards (NGSS Lead States, 2013), argumentation in science is a social practice wherein learners build and validate knowledge claims through constructing, critiquing, and justifying arguments supported by evidence. While argumentation is widely recognized by science education researchers as an essential and promising scientific practice that benefits students' science learning, incorporating it into science classrooms remains challenging for teachers. This review aims to identify factors necessary for teachers to successfully implement argumentation practices in their classrooms. Using construct personal professional characteristics derived from Clarke and Hollingsworth's (2002) Interconnected Model of Teacher Professional Growth (IMTPG), this review searched and analyzed 44 empirical studies. Through systematically reviewing these articles, I identified two categories of personal factors (knowledge and beliefs) necessary for effective argumentation instruction. These include knowledge on argumentation, pedagogical content knowledge of argumentation, and teachers' beliefs toward argumentation and its teaching.

Stand-Alone Paper

Reimagining Science Education: A Culturally Sustaining, Health-Centric Approach Addressing Type 2 Diabetes

Miriam Ortiz, University of Texas Rio Grande Valley, USA
Angela Chapman*, University of Texas Rio Grande Valley, USA

ABSTRACT
In response to the global crisis of type 2 diabetes prevalence, this inquiry investigated the impact of a culturally sustaining, health-centric science curriculum contextualized in type 2 diabetes. Using a case study methodology, it explored how the curriculum shaped secondary

math and science preservice teachers' (PSTs) perceptions of science and how it can be taught and how prepared they felt to design and implement culturally sustaining, health-centric lessons. Four themes that emerged across both cases included: 1) connecting health, nutrition, everyday science, and culturally sustaining pedagogy through the CBSS curriculum, 2) connecting science to health and wellness concepts through the CBSS curriculum, 3) connecting the importance of teaching as an act of love for humanity through culturally sustaining pedagogy and health and wellness, and 4) PST's feel prepared to design and implement culturally sustaining, health-centric lessons. The findings presented highlighted the pivotal need to bridge the existing divide between health and science education in a culturally sustaining way. This integration promises to cultivate a more nuanced, meaningful understanding of both disciplines, enabling students to apply scientific knowledge pragmatically to enhance their own health and their community's health.

Research Experiences for Teachers (RETs) Through the Lens of Rightful Presence

Strand 8: In-service Science Teacher Education
24-Mar-25, 10:00 AM-11:30 AM
Location: Annapolis 3

Related Paper Set

Science teachers in research experiences: Learning from 25 years of RETs to inform future programs

Karen Woodruff*, Kean University, USA
Suzanne Patzelt*, Touro University, USA

ABSTRACT

Not available

Related Paper Set

Understanding Science Science Teaching as Political Domains: RET Teachers Enactment of Justice-Centered Pedagogies

Shannon Davidson*, University of Alabama, USA
Roxanne Hughes, Florida State University, USA
Stacey Hardin, University of Washington, USA

ABSTRACT

K-12 science teachers are often students' first exposure to the world of science and are responsible for translating the content, practices, and understandings of science and the scientific community to their students. However, K-12 science teachers are situated within and affected by the same systems of oppression and bias that apply to the disciplinary fields of science, and thereby may inadvertently reify, maintain, or be unaware of harmful and exclusionary stereotypes that often dictate who belongs in the disciplines and whose ideas and experiences count in science. While Research Experience for Teachers (RET) programs are largely understood to be productive professional development for teachers by providing

firsthand experiences within the science community of practice, RETS have not often attended to the importance of explicitly interrogating and addressing injustices within science disciplines with teachers--and relatedly supporting their uptake of anti-racist and justice-centered pedagogies. To this end, we draw on the framework of 'rightful presence' to examine the learning and experiences of teacher participants who took part in a RET program that supported teachers' science pedagogy and experiences within the community of science, while also bridging and critically interrogating their teaching through justice-centered pedagogical frameworks.

Related Paper Set

Exploring Power Dynamics in Teacher Research Experiences: Insights from bacteriophage discovery in K-12 classrooms

Chris Pavlovich*, Montana Technological University, USA
Rayelynn Brandl, Montana Technological University, USA
Marisa Pedulla, Montana Technological University, USA

ABSTRACT

This paper examines the transformative impact of teacher research partnerships on educators' professional development. The BRIC and PHAGES projects provided teachers with authentic STEM research experiences, enhancing their teaching skills and positioning them as respected scientific experts. Findings reveal that these partnerships not only empower teachers but also elevate their professional status within their schools. By engaging in meaningful research, teachers gain a deeper understanding of scientific inquiry, develop critical thinking skills, and become more confident in their ability to facilitate authentic learning experiences. The projects also foster a supportive community among teachers, promoting collaboration and professional growth. While challenges like workload and resource disparities persist, the overall impact of these partnerships is significant in elevating teachers as respected professionals and fostering a culture of innovation and inquiry within education.

Related Paper Set

Developing Dispositions for Indigenous Science and Engineering Knowledge in Elementary Science Teachers through a RET

Linda Rost, Baker High School, USA
Rebecca Hite*, Texas Tech University, USA
Gina Childers*, Texas Tech University, USA
Sweeney Windchief, Montana State University, USA

ABSTRACT

Not available

Biological Phenomena and Their Roles in Designing and Evaluating Assessments of Student Understanding and Learning

Strand 10: Curriculum and Assessment
24-Mar-25, 10:00 AM-11:30 AM
Location: Magnolia 1

Related Paper Set

Characterizing the diversity of evolutionary phenomena in curricula and their relationships to causal-mechanistic explanations

Evan Abreu*, Stony Brook University, USA
Ross Nehm, Stony Brook University, USA

ABSTRACT

Biology textbooks play a crucial role in introducing undergraduates to biological phenomena and the mechanisms that explain them. However, there is limited understanding of how these textbooks represent evolutionary phenomena and link them to causal mechanisms. This study analyzed two widely used biology textbooks to examine the types of evolutionary phenomena presented and the causes/mechanisms (CMs) used to explain them. Using a multidimensional coding framework, we identified 42 distinct phenomenon types across two chapters and assessed the frequency and diversity of CMs associated with each type. Our findings reveal an uneven representation of phenomena, with a small subset dominating the content. Additionally, while certain CMs like natural selection and genetic inheritance were frequently used, others, such as genetic drift, were underrepresented or absent. The overuse of trait function as a primary explanatory mechanism raises concerns about reinforcing misconceptions about trait origins. The study highlights a need for more coherent and balanced integration of phenomena and CMs in biology textbooks to support effective teaching and learning of evolutionary concepts. These insights can inform the development of curricula that better align with scientific practices and enhance students' understanding of evolutionary processes.

Related Paper Set

The structure and magnitude of novice evolutionary knowledge across phenomena using the CANS instrument

Gena Sbeglia*, San Diego State University, USA
Austin Zuckerman, University of California - San Diego, USA

ABSTRACT

Novice evolutionary reasoning is impacted by the features (e.g., taxon, trait polarity) of evolutionary phenomena and thus lacks cognitive coherence. Improving evolution education necessitates assessment tools that can measure the progression from novice-like thinking (incoherent with low knowledge magnitudes) to expert-like thinking (coherent with high knowledge magnitudes). To capture this progression, instruments must intentionally tap into the incoherent structure of student thinking by systematically integrating salient features of the phenomenon into its design. Kalinowski et al. (2016) developed the Conceptual Assessment of Natural Selection instrument (CANS) to include phenomena that vary in two

features –taxon and trait polarity– possibly allowing measurement of natural selection knowledge in alignment with the incoherent structure of novice reasoning.In this study, we measure knowledge and learning of natural selection in a large (N 6000) sample of undergraduate students to investigate the suitability of the CANS to tap into novice evolutionary thinking. Using Rasch analysis,we report low pretest magnitudes of natural selection knowledge and several problematic aspects of the instrument's functioning. Unfortunately, we were unable to investigate the structure of natural selection knowledge due to a lack of balance among phenomena within the instrument's items. We conclude with recommendations to improve this instrument.

Related Paper Set

Assessing student reasoning about matter and energy across biological phenomena using the MOMO

Austin Zuckerman*, San Diego State University, USA
Gena Sbeglia, San Diego State University, USA
Ross Nehm, Stony Brook University, USA

ABSTRACT

The pathways and transformation of matter and energy (PTEM) is a central organizing principle for systems-level thinking in biology, yet students show many challenges with this topic. In this study, we use the Movement of Matter in Organisms instrument (MOMO) to measure undergraduate students' (N =895) understanding and coherence of PTEM across biological phenomena situated in animals, plants, and fungi– at two institutions. We use Rasch analysis to establish preliminary construct validity evidence for the MOMO and linear mixed models and dimensionality analyses to examine the magnitude and coherence of PTEM knowledge. We report that the MOMO largely adhered to well-established criteria of robust measurement. There were also significant and large gains in PTEM knowledge from pre to post-test, and students of all backgrounds had similar incoming knowledge and learning gains. PTEM reasoning was coherent across the three phenomena, but the unexplained multidimensionality at the pre-test indicates possible fragmented reasoning for other features of the phenomena that were not systematically studied. These findings offer insights about the magnitude and coherence of PTEM knowledge across phenomena, patterns of disparities in incoming knowledge and learning at multiple institutions, and the potential of the MOMO to measure progress toward PTEM proficiency.

Related Paper Set

Evaluating undergraduate student's Perceptions of the Magnitude of Variation (PMoV) across biological phenomena

Cecylia Quintero*, San Diego State University, USA
Gena Sbeglia, San Diego State University, USA

ABSTRACT

Understanding student perceptions of evolution remains a challenge, particularly regarding the plausibility of evolutionary theory and the role of biological variation. This study introduces and evaluates a novel instrument designed to measure students' perceptions of

the magnitude of biological variation (PMoV) across different phenomena. The instrument evaluates perceptions of variation at different biological scales (eg.,DNA, protein, phenotype) and across multiple taxa (eg., plants, animals, humans). The instrument was administered to undergraduate non-majors (N=263) to explore its effectiveness in assessing PMoV and its relationship to biological phenomena. Utilizing Rasch analysis we were able to determine that students perceived the greatest amount of DNA variation in animals and the least in plants. The PMoV fulfilled the criteria of robust measurement. We report that the analysis of a unidimensional model with the biological phenomena independent of another was supported. Additionally, the multidimensional Rasch model showed a better fit than the unidimensional model, suggesting that perceptions of variation are influenced by the specific biological phenomena. These findings highlight the importance of considering how students' understanding of biological variation in the contextualization of biological phenomena might impact their acceptance of evolutionary theory and provide a foundation for further investigation into this relationship.

Navigating Identity and Resilience in STEM Higher Education

Strand 11: Cultural, Social, and Gender Issues
24-Mar-25, 10:00 AM-11:30 AM
Location: Azalea 1

Stand-Alone Paper

Community college transfer students' navigations of boundary experiences through a storied science identity lens

Paul Le*, University of Colorado Denver, USA
Sarah Hug, Colorado Evaluation and Research Consulting, USA
Laurel Hartley, University of Colorado Denver, USA

ABSTRACT

Many students in the United States begin higher education at two-year institutions (community colleges) and transfer to four-year institutions. However, transfer students often have lived experiences that prevent successful completion of a four-year degree. Through the lens of science identity and boundary experiences, we completed multiple interviews with two community college transfer students at a four-year higher education institution. The students imparted stories over the course of their lifetime that impacted their (dis)engagement with science and explained their pathway through higher education. We noted that navigating these boundary experiences to strengthen their own science identity production required that these students purposefully pursued spaces where they could thrive, sought meaningful others who would positively recognize them, and completed internal work that required them to continually rethink who they are and how they participate in science. These constant negotiations throughout their lives allowed for a continuous science identity production that resulted in persistence in science even with interruptions.

Stand-Alone Paper

The Role of Socialized Assumptions in Shaping Identities of Women in Mathematically Intensive STEM Majors

Terrie Galanti*, University of North Florida, USA
Nancy Holincheck*, George Mason University, USA
Tiffany Butler*, George Mason University, USA

ABSTRACT

This study applies a framework of socialized assumptions about what it means to be good at mathematics to understand how cultural norms influence the development of STEM identity for ten undergraduate women in mathematically intensive STEM college majors. We analyzed semi-structured interviews using collaborative coding methods in our application of frameworks for socialized assumptions and STEM identity. Our initial analysis of interviews revealed that the majority of the participants in our study had robust STEM identities. Our secondary analysis of data allowed us to make explicit connections between the socialized assumptions and dimensions of STEM identity.Implications for K-16 science teachers and teacher educators are discussed.

Stand-Alone Paper

Understanding Differences in Perceived Viability by Physicists in Careers for Academia, Government and Private Industry

Daniel Oleynik*, University of Central Florida, USA
Erin Scanlon, University of Connecticut - Avery Point, USA
Constance Doty, University of Central Florida, USA
Jacquelyn Chini, Ohio State University, USA

ABSTRACT

As researchers, we should use the results of our research to create change at institutions, rather than focus on underrepresented individuals. To do this, this study focuses and reports on ableist beliefs held by practicing physicists to create an opportunity for others to interrogate their own preconceptions. We administered the Disability and Physics Career Survey (DPCS) through physics-specific listservs and at physics-specific conferences to measure practicing physicists' knowledge about disability and their beliefs about the viability of physics careers for individuals with a variety of disability diagnoses. This study uses Cochran's Q and McNemar's R to compare how practicing physicists' perceptions of the viability for careers in the public sector, private industry and academia depend on the impairment that an individual is diagnosed with. We find that physicists hold the most negative views about the viability of professor and the most positive views about the public sector compared to the other careers.

Stand-Alone Paper

Graduate Student Resilience: Using Survey Analysis to Explore Influential Factors in U.S. Graduate Education

Karen Collier*, Augusta University, USA

Margaret Blanchard*, North Carolina State University, USA

ABSTRACT

Graduate education holds the potential to provide individuals with stimulating personal growth and economically viable career opportunities. First-generation college students, underrepresented minorities (URM), and females often face unique obstacles that can undermine their progress in graduate programs. These obstacles may be more pervasive in fields where these students have lower enrollment: STEM graduate programs. The Graduate Student Success Survey+ (GSSS+) was broadly distributed to a national population of graduate students, with a particular focus on seeking the participation of students from universities that serve first-generation, URM, and female graduate students, capturing both STEM and non-STEM programs. Exploratory and confirmatory factor analyses were used to test the survey's validity and reliability, with 648 participants from 23 universities. A 7-factor, 40-item model was determined with the following subscales: mentor support, imposter phenomenon, financial support, microaggressions (race and gender), access and opportunity, resilience, and peer support. Regression analysis revealed a positive impact on students' sense of resilience with greater perception of mentor support and financial support, and a negative impact on resilience with a greater perception of imposter phenomenon. Findings lead to recommendations for financial support, mental health counseling, and access and opportunity to enhance graduate student success.

Stand-Alone Paper

Identity Development of Scientists with (dis)Abilities

Jonathan Hall*, California State University, San Bernardino, USA
Mila Rosa Carden*, University of North Texas, USA
Sarah Losoya*, University of North Texas, USA

ABSTRACT

Students with (dis)Abilities (StWDs) who identify as scientists can experience lifelong positive impacts in their academics, careers, and social lives. However, StWDs often navigate figured worlds that are detrimental to their STEM identity development. StWDs experience ableist perspectives and low expectations from actors of their STEM figured worlds. StWDs and actors of STEM figured worlds should be aware of the experiences of influential scientists with (dis)Abilities (ScWDs) to facilitate positive STEM identity development and disrupt ableist perspectives. The experiences of seven influential ScWDs were explored through an identity development and intersectionality conceptual framework. Participants engaged in three interviews and explored their life histories, current experiences, and reflections on STEM. The following three themes emerged from the data analysis: STEM figured worlds were rooted in ableist perspectives; the world of science was a world of curiosity; and identity work adjustments were made due to (dis)Abilities. Theoretical implications for identity development models and practical implications for science educators to strategically facilitate positive STEM identity development are discussed.

Powered decision-making for equity in science education: Beyond access and inclusion

Strand 11: Cultural, Social, and Gender Issues
24-Mar-25, 10:00 AM-11:30 AM
Location: Annapolis 2

Symposium

Powered decision-making for equity in science education: Beyond access and inclusion

Elizabeth Davis*, University of Michigan, USA
Sage Andersen, University of Texas, USA
Jessica Bautista, University of Michigan, USA
Terrance Burgess, Michigan State University, USA
Heidi Carlone, Vanderbilt University, USA
Symone Gyles, University of California, USA
Stefanie Marshall, Michigan State University, USA
Veronica McGowan, University of Washington, USA
Jordan Sherry-Wagner, University of Washington, USA
Michele Williams, University of Illinois, USA
Carrie Tzou, University of Washington, USA

ABSTRACT

Over the last three years, two important reports have been published from the National Academies of Sciences, Engineering, and Medicine (NASEM, 2022, 2024). Together, these reports provide powerful and coherent frameworks for conceptualizing issues of equity and justice in science education, including a set of approaches to equity and frames for decision-making about equity. Through discussion among nine poster presenters, a discussant, and the audience participants, in this structured poster symposium we aim to explore how science educators can move beyond a vision of access and inclusion, toward a much richer perspective of what working toward equity in science education can look like. Through the posters and discussion, we will put the frames in conversation with each other and explore their interconnectedness, the tensions among them, and the need for concretizing them in research methods, design, and practice. The posters collectively span actors, participants, and designs across the educational ecosystem, including children and youth, preservice and inservice teachers, school and district leaders, and instructional designers. Collectively, the work represented in this session will help the field make important progress in moving toward equity and justice in science education.

Innovative Exploration in STEM Evaluation

Strand 12: Technology for Teaching, Learning, and Research
24-Mar-25, 10:00 AM-11:30 AM
Location: Baltimore 5

Stand-Alone Paper

Design and Usability Evaluation of an Innovative Educational App for Inquiry-Based Education

Iraya Yánez-Pérez, University of Burgos, Spain
Radu Bogdan Toma*, University of Burgos, Spain

ABSTRACT

Teachers often face challenges in implementing inquiry-based science teaching. To address this, IndagApp—a 3D educational app offering curriculum-aligned, inquiry-based lesson plans—was developed. The app is based on inquiry phases recommended by best-practices literature, aligning with most international standards. This study presents the development of the app and results from three independent usability tests involving university and in-service teachers, pre-service teachers, and elementary school students. The findings showed that IndagApp received high usability ratings, exceeding established benchmarks. These results suggest that IndagApp is a valuable tool for inquiry-based education, with significant implications for science teaching and learning.

Stand-Alone Paper

Developing an instrument to explore junior high school students' online science capital

Wei-Shou Chen*, Graduate Institute of Information and Computer Education, National Taiwan Normal University, Taiwan
Chin-Chung Tsai, Program of Learning Sciences, National Taiwan Normal University, Taiwan
Min-Hsien Lee, Program of Learning Sciences, National Taiwan Normal University, Taiwan
Jyh-Chong Liang, Program of Learning Sciences, National Taiwan Normal University, Taiwan

ABSTRACT

This study built on the concept of science capital proposed by Archer et al. (2015) [Archer et al., (2015) Journal of Research in Science Teaching, 52, 922-948] by shifting the focus of science learning to an online context and introducing the concept of "online science capital." The research developed an online science capital scale suitable for junior high school students to assess the resources they might possess during online science learning. This scale included science-related online cultural capital, science-related online behavioral capital, science-related online economic capital, and science-related online social capital. Through t-tests, the study found that online science capital differs between genders, with males scoring higher than females in multiple aspects. Furthermore, correlation analysis revealed that all aspects of online science capital were positively correlated with students' aspirations for studying science and pursuing scientific careers in the future.

Stand-Alone Paper

Enhancing Chemistry Learning by Providing Formative Feedback and Assessment in Interactive Digital Learning Units

Florian Trautem*, University of Duisburg-Essen, Germany
Carolin Eitemüller, University of Duisburg-Essen, Germany
Maik Walpuski, University of Duisburg-Essen, Germany

ABSTRACT

Freshmen in chemistry study programs show heterogeneous levels of content knowledge (Heublein et al., 2017). Those learners who lack fundamental concepts and corresponding competences can hardly improve their chemistry skills because chemistry knowledge shows a cumulative and hierarchical organized structure. Plus, students vary in the ability of self-regulated learning , because they often underestimate the amount of time needed to study efficiently (Thibodeaux et al., 2017). In fact, self-regulation of learning is a major problem at the beginning of study entry phase especially for students with low prior knowledge (Winters et al., 2008).To combine the advantages of multiple digital resources of information presentation and formative feedback and assessment we developed interactive digital learning units to address content knowledge deficits in important subtopics of chemistry. Since self-regulation of learning is a major problem for many students, we tested two implementation conditions (1) free use of the material and (2) mandatory use of the material with a total of N = 124 chemistry students during the winter semester 2023/2024 concerning the impact on exam performance as well as acceptance and perceived usability. The results show significant advantages for students with low prior knowledge in terms of exam performance under condition 2.

Stand-Alone Paper

Empowering students' digital literacy in the AI era through the creation of Innovation Centers

Zacharoula Smyrnaiou*, Computer Technology Institute and Press "Diophantus", Greece
Eleni Georgakopoulou, National and Kapodistrian University of Athens, Greece
Martha Georgiou, National and Kapodistrian University of Athens, Greece

ABSTRACT

Nowadays, all educational systems deal with the big issue of digital transformation, including the impact of Artificial Intelligence in students' life. Digital literacy does not only refer to students' digital skills, but also to their ability to think and use critically the new power of Artificial Intelligence. The big question "What do students finally learn by the use of ICT Tools?" is still at the heart of educational design, which seeks to combine new educational policies with recent scientific directions of students' learning. In Greece, the Research project "Innovation Centers in the 13 regions of Greece"- attempts to combine new advanced educational technologies to the main principles of Innovative Pedagogy and Digital Transformation worldwide in the light of science. These are essentially physical, modern infrastructures equipped with cutting-edge educational technology designed to enhance and develop the skills of 21st century learners. At the same time, the innovation centers apply

modern educational methods so that students can interact with AI educational scenarios and different semiotic systems, including the digital world, giving the opportunity to study how these affect their cognitive skills. This paper presents the principles and pillars for the development of Innovation Centers and their design methodology.

Teaching to Develop Competent Outsiders: Preparing Students to Engage With Socioscientific Issues in Daily Life

Strand 13: History, Philosophy, Sociology, and Nature of Science
24-Mar-25, 10:00 AM-11:30 AM
Location: Baltimore 2

Related Paper Set

Promoting Motivation for Environmentally Responsible Teaching of Science Practices in Pre-Service Elementary Teachers

Benjamin Janney*, University of Utah, USA
Lynne Zummo, University of Utah, USA

ABSTRACT

Science education that equips students to become competent science outsiders, capable of engaging with personal and societal science matters, is a key priority for educators and scholars. This education should begin in the earliest years of formal learning. However, many elementary educators struggle to meaningfully integrate science and social issues into their classrooms, often due to low intrinsic motivation or interest. This study examines the impacts of an environmentally-based elementary science methods course designed to address three key factors that influence motivation to teach science. By incorporating locally relevant science and environmental issues, as well as strategies for integrating these issues into the classroom, the course aims to develop environmentally responsible teachers who are committed to science. Although analysis is ongoing, this proposal presents initial findings that suggest promising and desirable outcomes. We then conclude with implications and recommendations on how pre-service teacher education can foster motivation to teach science and ultimately support the development of competent science outsiders.

Related Paper Set

'Science is... communication across the board": A biology teacher's conceptions of science media literacy

Daniel Pimentel*, The University of Alabama, USA

ABSTRACT

Contemporary concerns about the spread of mis- and disinformation on the internet have renewed discourse about the role that science education plays in preparing a scientifically literate citizenry.This exploratory case study examined how one high school biology teacher's ideas about science media literacy (SML) developed after participating in a study focused on integrating SML into his high school biology lessons. Transcripts and observer notes from

lesson-planning meetings and reflection interviews were analyzed for emergent themes regarding the focal teacher's ideas about SML. Three themes emerged from the analyses:1) SML as deeply intertwined with the nature of science,2) SML as bridging the internalist and contextualist practices of ''doing research'' and3) Multiple opportunities to integrate SML throughout the curriculum.This study demonstrates how engaging in the process of co-planning, co-teaching, and reflecting on SML, enables science teachers to connect SML to their content area and make adaptations to their instruction to foster connections between science and everyday life.This study has implications for science teacher learning and professional development by providing insights into how teacher educators and professional development facilitators can support science teachers working to incorporate SML into their instruction.

Related Paper Set

Science civic engagement self-concept and experiential learning in an introductory college course

Jenny Dauer*, University of Nebraska-Lincoln, USA
Jennifer Teshera-Levye, University of Nebraska-Lincoln, USA
Lisa Corwin, University of Colorado Boulder, USA
Christine Haney-Douglass, University of Nebraska-Lincoln, USA

ABSTRACT

The field of science education currently lacks clear conceptual frameworks to describe the ways that students develop a recognition of the relevancy of classroom science learning to their lives, and models of classroom instruction with this orientation as a primary learning goal. We describe science civic engagement self-concept (SCE-SC) which describes how students envision their ability to use their science knowledge and skills to strengthen their communities and enact positive change. We describe a large-enrollment postsecondary course with students' SCE-SC as a learning goal, though a focus on socioscientific issues decision-making and experiential learning. The results of evaluative mixed-methods research suggest that students increase in the dimension of SCE-SC civic knowledge, though dimensions of civic value, civic confidence, and civic action did not change. Qualitative analysis indicated the ways in which students view science knowledge and skills to be relevant to their communities. We discuss ways in which this concept and the research on the course point to possible instructional interventions that support students' ideas about science relevance to their lives.

Related Paper Set

Preparing Undergraduate Students to Resist Socioscientific Issues Mis/disinformation Through Collaboration with University Scientists

Sarah Poor*, University of Missouri, USA
Benjamin Herman, Texas A&M University, USA
Tamara Powers, Texas A&M University, USA

ABSTRACT
Addressing socioscientific issues (SSI) such as climate change and the COVID-19 pandemic necessitates that the public become "competent outsiders" who can knowledgeably differentiate between mis/disinformation and valid scientific facts when making decisions. College students can hold pseudoscientific beliefs regarding SSI and are especially vulnerable to mis/disinformation due to their frequent use of technology-based media, such as the Internet and TV, which often encourage uncritical information consumption through oversimplified and emotionally charged messages. Despite this, college science courses typically adhere to deficit models of science education and rarely focus on NOS or students' sociocultural backgrounds and emotive reasoning. To address these gaps, the author collaborated with university scientists to conduct a mixed-methods investigation on how an SSI mis/disinformation detection-focused course could improve college students' ability to navigate mis/disinformation. The investigation included modifying a large undergraduate science course for non-science majors to include NOS, mis/disinformation resistance, and SSI-based instruction. This paper focuses on how the course was designed, student outcomes from the course, and why collaboration between science education scholars and scientists is important for developing competent outsiders at the undergraduate level.

Related Paper Set

How Science Teachers Negotiate Identities to Manage Disconnects Between Science Inside and Outside the Classroom

Sam Evans*, University of Wisconsin, USA

ABSTRACT
Efforts to imagine science-literate people as 'competent outsiders' have led researchers to suggest new learning outcomes for science classrooms – e.g., capacities like judging scientific expertise and recognizing scientific misinformation. Research suggests that how teachers integrate these capacitiesinsidetheir classrooms and personally engage with scienceoutsidethe classroom will be shaped by their identities. This means that science teachers are likely to 'judge scientific expertise' and 'recognize scientific misinformation' in diverse ways based on who they are and what they care about, shaping how they teach these capacities. Therefore, teachers' identities will be central to advancing the competent outsider initiative. The goal of this study was to understand how science teachers in a small professional learning community engaged in identity negotiations as they reflected on how science is taught in schools and how people use science outside of schools to solve problems. Drawing from group discussions and interviews, my analysis suggests that teachers tended to view issues outside of schools from a science perspective in ways that resonated with their identities as science teachers. However, outside of schools, teachers' leveraged science in diverse ways based on their social relationships, personal priorities, and unique aspects of the issues they cared about.

Climate Literacy 2

Strand 14: Environmental Education and Sustainability
24-Mar-25, 10:00 AM-11:30 AM
Location: Baltimore 3

Stand-Alone Paper

A Systematic Review of Intervention Studies on Climate Literacy in K-12 Science Classrooms

Ayça Fackler*, University of Missouri, USA
Madeline Good, University of Missouri, USA
Ricardo Rojas Calderon, University of Missouri, USA
Emily Adah Miller, University of Georgia, USA

ABSTRACT

The global climate crisis necessitates urgent educational responses to foster climate literacy among future generations. This systematic review examines intervention studies in K-12 science teaching and learning spaces, focusing on the integration of knowledge, skills, and attitudes central to climate literacy. The review covers studies conducted post-2013, following the release of the Next Generation Science Standards, and seeks to identify how climate change education has been framed and implemented in science classrooms. Our analysis, guided by placemaking and futures thinking pedagogies, explores the constructs guiding interventions, the science content taught, and the skills and attitudes developed. The review highlights significant progress in teaching comprehensive climate science but identifies gaps in fostering critical skills, science practices, and adaptive behaviors. By addressing these gaps, this review aims to contribute to ongoing discussions in the field and promote more holistic approaches to climate change education that empower learners to become proactive climate citizens.

Stand-Alone Paper

Towards a Unified Framework for Climate Change Literacy in Science Education: A Systematic Literature Review

Helin Semilarski*, University of Tartu, Estonia
Helen Semilarski, University of Tartu, Estonia

ABSTRACT

Climate change is one of the important and critical topics of science education. Emphasizing climate change literacy is important because it will help society adapt to a complex and fast changing world and provide people the power to make decisions that are well-informed when they consider the climate to be a major factor. This theoretical article aims to reach a consensus and conceptualise climate change literacy more clearly. It also presents a theoretical concept of climate change literacy based on systematically analysed articles. This theoretical concept includes three domains of climate change literacy: (1) knowledge and skills domain, (2) affective domain, and (3) action domain.

Stand-Alone Paper

Concerns, Methods, Grade Bands that Allow the Teaching of Ecoliteracy

Peter Oyewole*, Kent State University, USA

ABSTRACT

The urgency of addressing environmental challenges has intensified the call for integrating ecoliteracy into education systems globally. This theoretical position paper advocates for prioritizing ecoliteracy education within early childhood (P-5) as a foundational step in cultivating environmental awareness and sustainable practices. While current educational frameworks often focus on older students, this paper argues that early intervention is crucial for fostering a deep, lifelong connection to the environment. Through a review of existing literature, the paper explores various methods, such as nature-based, place-based, and outdoor learning, as effective approaches to teaching ecoliteracy to young children. Additionally, it examines the role of interdisciplinary teaching, critical pedagogy, and common-world perspectives in creating a holistic educational experience. By proposing a curriculum that integrates ecoliteracy across all subjects, this paper underscores the importance of developing an educational system that not only imparts knowledge but also instills a sense of responsibility and stewardship towards the environment from an early age. The ultimate goal is to equip young learners with the skills, attitudes, and understanding necessary to navigate and contribute positively to a complex, interconnected world.

Awards Luncheon

24-Mar-25, 11:30 AM-1:15 PM
Location: Woodrow Wilson Ballroom
Social Event

Through the Lens of Leadership: Charting NARST's Growth and Impact with the Work of Its Fellows

24-Mar-25, 1:30 PM-3:00 PM
Location: Annapolis 4

Administrative Session

Organizer

Amelia Gotwals, Michigan State University, USA

Distinguished Contribution Through Research Award:
Dr. Sherry Southerland

Early Career Research Award:
Dr. Marcus Kubsch

Outstanding Doctoral Research Award
Dr. Daniel R. Pimentel
Dr. Sam Lee

NARST Fellows:
Dr. Janet Carlson
Dr. M. Gail Jones

Basu Scholars Symposium: Presentation of the 2024 Basu Scholars

24-Mar-25, 1:30 PM-3:00 PM
Location: Annapolis 2

Symposium

Regina McCurdy, Georgia Southern University, Statesboro, USA
Marsha Simon, Valdosta State University, USA
Khanh Tran, Purdue University, USA
Ilana De La Cruz, Texas A & M University, USA
Carol Waters, University of Houston-Clear Lake, USA
Alexandrea Muller, University of California - Santa Barbara, USA

ABSTRACT
This session provides an opportunity for the 2024 Basu Scholars to present their original research. In line with the intention of this scholarship program, this presentation offers scholars a space to engage with, network, and receive feedback from peers and senior scholars in the field. The 2025 Basu Scholars are also encouraged to attend this symposium in order to understand what will be expected of them in the 2025 NARST conference. To accommodate all of the scholars and to encourage generative dialogue, this 90-minute symposium is designed as an interactive poster session.

Cognitive Load and Mechanistic Reasoning: The Role of Errors and Black Box Explication in Learning

Strand 1: Science Learning: Development of student understanding
24-Mar-25, 1:30 PM-3:00 PM
Location: Azalea 3

Stand-Alone Paper

Highlighting errors is worth it! - Erroneous examples foster learning gains and cognitive load in chemistry

Sonja Dieterich*, University of Duisburg-Essen, Germany
Stefan Rumann, University of Duisburg-Essen, Germany
Marc Rodemer, University of Duisburg-Essen, Germany

ABSTRACT
Due to complex concepts such as chemical bonding, chemistry is susceptible to student misconceptions, which may inhibit the learning process (Hunter et al., 2022). Knowledge of errors can be conducive to learning if they are explicitly instructed in the form of erroneous examples (ErrEx). Our systematic literature review on ErrEx confirms beneficial effects of ErrEx in general, however, much uncertainty still exists about the influence of cognitive load (CL) and prior knowledge (PK). Hence, the present intervention study investigates the effectiveness for learning and CL of an instruction based on either correct examples (CorrEx), ErrEx, or a combination of both (CorrEx + ErrEx) depending on PK using the content of ionic bonding in German high schools. Results show significant learning gains, particularly for CorrEx + ErrEx. A significant decrease of extraneous CL (ECL) and intrinsic CL (ICL) and an increase of germane CL of CL for CorrEx + ErrEx were observed. Analysis of PK showed no significant effect on learning gains. Our results are consistent with the empirical findings of our review and may replicate the positive effects of ErrEx in the unstudied area of chemistry education.

Stand-Alone Paper

The effect of black boxes on understanding mechanistic information

Michal Haskel-Ittah*, Weizmann Institute of Science, Israel
Shanny Mishal-Morgenstern, Weizmann Institute of Science, Israel

ABSTRACT
Mechanistic reasoning involves understanding phenomena by identifying and unpacking the underlying entities and activities. While many challenges in unpacking were identified in mechanistic reasoning less is known about the effect of explanatory black boxes - parts of explanations where processes are missing or masked by filler terms.Black boxes create gaps in mechanistic explanations, which can hinder understanding and lead to misconceptions or an illusion of explanatory depth. To explore the effect of black boxes on understanding, we conducted a study with 18 undergraduate students from non-biological fields. Participants read sections on COVID-19 mechanisms containing black boxes and evaluated their understanding. They were also asked to draw causal diagrams and think aloud during the process.Our findings revealed that initially, students did not address black boxes and relied on familiarity with terminology to assess their understanding. However, when prompted to explain mechanisms, they shifted to mechanistic criteria, recognizing gaps outlined by black boxes. We also found that when black boxes were masked by filler terms, fewer students perceived them as gaps in their understanding than hidden black boxes. This study highlights the importance of teaching students to identify and navigate black boxes in mechanistic explanations.

Stand-Alone Paper

Into the Black: The Effect of Black Box Explication on Biology Students' Mechanistic Reasoning

Gur Livni Alcasid*, Weizmann Institute of Science, Israel
Michal Haskel-Ittah, Weizmann Institute of Science, Israel

ABSTRACT
Mechanistic reasoning, crucial for scientific explanation and understanding, inherently involves "explanatory black boxes"—gaps in mechanistic knowledge. This study investigates the impact of black-box explication (i.e., emphasizing the existence of such knowledge gaps) on high school biology students' mechanistic reasoning. To explore how students understand and use the concept to reflect on their explanations, an online module on cancer mechanisms was introduced to 23 10th-grade biotechnology students, focusing on identifying and discussing explanatory black boxes. Data were collected from students' justifications for unpacking or black boxing mechanisms while creating informational posters. Analysis revealed that students prioritized clarity and depth in their justification, engaging with epistemic criteria while recognizing the productive role of black boxes. We also identified two perspectives by which students discussed such criteria: focusing on a single black box or comparing black boxes while using an interconnected black boxes perspective. The latter was found more in discussions concerning black boxing. Results suggest that explicating black boxes enhances students' mechanistic reasoning by fostering critical assessment and articulation of the inclusion and exclusion of mechanistic details. This research contributes to mechanistic reasoning frameworks by highlighting the educational value of black-box explication in science teaching.

Exploring In Situ Engagement and Decision-Making in Science Education

Strand 2: Science Learning: Contexts, Characteristics and Interactions
24-Mar-25, 1:30 PM-3:00 PM
Location: Annapolis 1

Stand-Alone Paper

Field Study Science Observations in K-12 Settings: An Investigation of Pedagogical Strategies

Steph Dean*, Clemson University, USA
Devan Jones*, Clemson University, USA

ABSTRACT
K-12 students in the United States have limited exposure to field study science, leading to inadequate nature-based experiences and lagging biological literacy. Field study science offers an opportunity for meaningful outdoor learning and ecological observation, but the Next Generation Science Standards (NGSS) do not prioritize such experiences. This study aims to enhance understanding of field study science's benefits by investigating the strategies teachers use to facilitate scientific observations outdoors. Using qualitative content analysis, we explored the strategies of six K-12 teachers who regularly implement field study science. Data were collected through semi-structured interviews and analyzed in two stages: condensing and expanding, using in vivo coding to generate themes. Three key themes emerged: fostering a safe and supportive environment, nurturing a learning community, and creating space for diverse learners. Teachers emphasized gradual release strategies to build

comfort, promoted shared learning experiences, and utilized student knowledge to support diverse learners. This research contributes to the discussion on the role of nature in science education, emphasizing the untapped potential of school grounds for contextualized science learning. It advocates for a broader approach to science education that values experiential learning and the diverse knowledge students bring from their interactions with the natural world.

Stand-Alone Paper

Engagement development of junior high school students during the enactment of Grand Challenges units

Shira Passentin*, Weizmann Institute of Science, Israel
Troy Sadler, University of North Carolina at Chapel Hill, USA
David Fortus, Weizmann Institute of Science, Israel

ABSTRACT

Science education too often fails to connect meaningfully with students' lives, interests, and concerns. Numerous decades of research indicate a significant decline in students' motivation to engage with science and their attitudes towards it, particularly during late elementary and junior high school. A new socio-scientific instructional approach called, the Grand Challenges (GCs), which structures science instruction around global socio-scientific issues, may be able to interest and engage students who have typically been under-engaged when learning from more traditional curricula. This study is the first step in investigating how GC instruction may foster engagement of typically under-engaged junior high school students.

Stand-Alone Paper

Unraveling the Association between Perceptions of Science Instructions and Student Engagement across Grades

Xin Xia*, University of Virginia, USA
Robert Tai, University of Virginia, USA

ABSTRACT

Previous research has consistently shown higher learning interests, attitudes, and motivation toward science in elementary compared to middle and high school. However, the predictors behind these differences remain unclear. This study aims to identify the association between students' perceptions of science instruction and their emotional engagement across educational stages. A multilevel random effect model was employed with a sample of 6465 students from 25 schools. Findings reveal significant associations between perceptions of interesting and understandable science instruction and emotional engagement. Emotional engagement decreases in higher grades, with significant variations in perceptions of interesting science instruction, particularly in 6th grade. Future studies should explore science instruction during transition grades to address emotional engagement differences.

Stand-Alone Paper

Who Shapes Science?: Elementary Students' Bids for Emergent Authentic Science with a University Entomologist

Sinead Brien*, University of South Carolina Upstate, USA
David Stroupe*, University of Utah, USA

ABSTRACT

One way teachers have supported students in participating in science practices is through collaboration with professional scientists (Flick, 1990; Glynn, LaMarche, Poulos, Willardson, 2017; Hopwood, 2012; Buck, Leslie-Pelecky, Kirby, 2002; McCombs, Ufnar, Shepherd, 2007; Owens, 2000). However, while these partnerships can offer students a learning pathway based on what adults/professional scientists deem important, or a version of science Rahm et al. (2003) refer to as "pre-authenticated science", this can also bound participation in ways that exclude student ways of knowing and ways of doing science beyond the particular old-timer's experience. Drawing on Communities of Practice Theory (Wenger, 1998) and Rahm et al.'s (2003) notion of emergent authentic science, we analyzed student and adult practices and interactions during a 4-week moth science unit in a second grade classroom. We found that students made bids for authentic participation in science, adult responses to these bids could support or constrain student participation in science practices, and one student creatively circumvented adult preauthenticated science and co-opted adult expectations to engage in his own science practice. This case study provides insights into how teachers and professional scientists might intentionally support emergent authentic science and thus recognize and include more student science practices.

Reforming STEM Education: Culturally Responsive and Inclusive Practices in Physics and Chemistry Teaching

Strand 4: Science Teaching — Middle and High School (Grades 5-12): Characteristics and Strategies
24-Mar-25, 1:30 PM-3:00 PM
Location: Baltimore 4

Related Paper Set

Fostering Inclusivity: Transforming Physics and Chemistry Curricula for Diverse Classrooms

Clausell Mathis*, Michigan State University, USA
Joseph Krajick, Michigan State University, USA
Ehud Aviran, Michigan State University, USA
Ozlem Akcil Okan, Michigan State University, USA
Lucky Nonyelum, Michigan State University, USA
William Van Luven, Michigan State University, USA
Angie Valbuena Rojas, Michigan State University, USA
Barbara Schneider, Michigan State University, USA

ABSTRACT
Many scholars argue that traditional methods of teaching physics and chemistry are outdated and hinder student learning (Mathis & Southerland, 2022). These subjects often depend on didactic lectures and use examples that fail to resonate with students from diverse backgrounds. Consequently, these students find it difficult to relate to the cultural norms presented in the course materials, resulting in lower performance compared to peers who are familiar with these norms. To tackle the issue of outdated teaching methods and materials, we are currently conducting a study that builds on prior work to transform the cultural norms and materials in the existing physics and chemistry curriculums. We are implementing a reformed-based curriculum design process that embraces a culturally responsive, project-based approach to Developing Next Generation Science Standards-Aligned culturally responsive, project-based learning curriculum materials for physics and chemistry (Morrison et al., 2008; Krajcik & Shin, 2016 & 2022: Ladson-Billings,1995. This paper details the process for crafting curricula that immerse students in using disciplinary-core ideas, scientific practices, and crosscutting concepts to make sense of culturally relevant phenomena and complex problems. Instead of passively listening to lectures, students actively engage in making sense of physics and chemistry tasks, fostering a more inclusive learning environment. The research question for our study is: What is the process for developing a culturally responsive project-based instructional unit?

Related Paper Set

Cultural Resources in Physics Education: A Study of Culturally Responsive Curriculum Development among Secondary Teachers

Ozlem Akcil Okan*, Michigan State University, USA
Clausell Mathis*, Michigan State University, USA
Lucky nonyelum, Michigan State University, USA

ABSTRACT
Despite ongoing efforts to enhance diversity in physics education, significant challenges remain, particularly in the underrepresentation of certain groups across all educational levels. Schools in the United States, characterized by their cultural diversity, present unique opportunities and challenges for educators. Effectively leveraging these cultural resources to optimize learning outcomes has become a central focus of scholarship on culture-based pedagogies, emphasizing the importance of integrating students' cultural backgrounds into instructional practices (Gay, 2013; Ladson-Billings, 1995). This study investigates the work of a professional learning community (PLC) of secondary physics teachers who are developing culture-based curricula. Specifically, it examines the methodologies employed by these educators as they identify and incorporate their students' cultural resources into the physics curriculum. The study addresses two key research questions: (1) How do physics teachers recognize their students' cultural resources? (2) How do secondary physics teachers in a PLC integrate local cultural knowledge and practices into their physics curriculum? To answer these questions, the study employs video analysis of the teachers as they collaboratively develop instructional units. The findings aim to contribute to the broader understanding of

culturally relevant pedagogy in physics education, providing insights into the practical application of these principles in diverse classroom settings.

Related Paper Set

Politicized Care Dimensions in Physics Education: Pedagogical Practices and Engagement Case Study for Underserved Students.

Clausell Mathis*, Michigan State University, USA
Lama Jaber*, Florida State University, USA
Sherry Southerland*, Florida State University, USA

ABSTRACT

This study explores politicized care in a physics class, focusing on African American teacher Sarah's unique pedagogical approach. Sarah's success in increasing physics enrollment among predominantly African American students prompted investigation into her methods. The study, rooted in Noddings' ethic of care and Parsons' culturally relevant caring, uses a naturalistic qualitative case study to examine how Sarahs care practices support and sometimes contradict each other in an urban high school setting. Data from observations, video recordings, and reflective sessions with Sarah reveal dimensions of care: social, epistemic, and academic. These dimensions demonstrate Sarah's commitment to understanding her students' social identities, addressing their academic struggles, and preparing them for real-world challenges. The findings underscore the need for a politicized, multidimensional approach to care in science education, particularly for students in marginalized communities, and highlight the potential for such pedagogies to foster significant engagement and learning in physics. This study contributes to the broader discourse on integrating social justice and care ethics in educational practices, suggesting that caring must be seen as an active, political act that confronts institutional and systemic inequities.

Related Paper Set

Perspectives of Critical Care of Minoritized Students: One Teachers Leveraging of Care for Science Learning

Sierra Morandi*, Florida State Univeristy, USA
Sherry Southerland, Florida State Univeristy, USA

ABSTRACT

As the reform efforts continue in science education, there is a call for attention to the lens of critical care. Many argue that care is necessary so that we might not only focus on science practices and big ideas of science, but also support the development of the entire student as they engage in this work. This case study focuses on illuminating the perspective of critical care held by one cis-gendered, White science teacher who served a multi-ethnic student population. Through a three-part series, Ms. Valentine engaged in scenarios of minoritized learners in science classrooms to reflect on her own experiences. She was driven to build authentic relationships with her students and value their experiences and identities, while she fostered a safe place to do meaningful science with her students. We present one of her major themes in this work: focusing on her role of setting and maintaining high expectations

through communication with each of her students required that she valued them as whole individuals, aside from their role as students. This work uses a critical narrative perspective to explore her perspective and its ramifications for science learning.

Taking a Critical Look at Graduate Education in Physics

Strand 5: College Science Teaching and Learning (Grades 13-20)
24-Mar-25, 1:30 PM-3:00 PM
Location: Magnolia 3

Related Paper Set

Investigating the Landscape of Physics Graduate Program Requirements

Bill Bridges*, Kansas State University, USA
Daniel Sharkey, Ohio State University, USA
Jacquelyn Chini, Ohio State University, USA
Rachel Henderson, Michigan State University, USA
James Laverty, Kansas State University, USA

ABSTRACT

As physics graduate programs adapt to an ever-changing world, it is important to update outdated and problematic practices. We are interested in the variety of ways that physics graduate students' comprehension and progress are evaluated. We conducted a landscape study of university handbooks and websites documenting and categorizing each program's requirements. These practices were compared among departments to determine how diverse department assessments are. This work will help to better understand what the numerous institutions across the country consider as necessary practices and requirements for graduate students. Understanding this landscape can provide a resource for graduate programs looking to update their practices and a foundation for further investigations into graduate education within physics programs.

Related Paper Set

Why they stay: Counternarratives of women PhD students in physics

R Strain, Auburn University, USA
Eric Burkholder*, Auburn University, USA

ABSTRACT

Though the representation of women in physics was steadily increasing in the latter half of the twentieth century, this representation has plateaued and remains at about 20% of bachelor's degree recipients. Persistent sexism and harassment continue to impact women in physics, manifesting as a lack of recognition of their competence and contributions, deliberate exclusion, and in some cases assault. Though there has been a great deal of research characterizing the experiences of women in physics at the undergraduate level, there is much less data at the graduate level. Curiously, despite the well-documented negative experiences of undergraduate women in physics, their representation in doctoral

programs is similar to that in undergraduate programs. Our aim for this study was thus to investigate why women might choose to stay in physics in the face of its hostile culture towards them through interviews with three women in a physics doctoral program. A common theme among these women was defiance – of low expectations for success, external pressures to pursue other careers, and negative treatment by male peers and faculty. These stories showcase how women assert agency over their pathways in physics and may be able to serve as useful counternarratives for future belonging interventions.

Related Paper Set

Study of a nontraditional physics doctoral student's program departure

Eric Burkholder*, Auburn University, USA
Steven Cortez, Auburn University, USA

ABSTRACT

A substantial fraction of physics PhD students do not go directly from their undergraduate degrees into a PhD program. Indeed, 8% of physics PhD recipients are over the age of 35. Like nontraditional students in undergraduate programs, these students face different challenges like raising children, being able to take a substantial pay cut to pursue their degrees, and integrating socially into their programs. The persistence literature at the graduate level is sparse, particularly for nontraditional students. Though some studies do characterize nontraditional students' characteristics and motivations for pursuing doctoral degrees, we could find no studies that investigate how they decide to leave their programs. Our focus for this study was to understand how a nontraditional physics doctoral student decided to leave their program and the impact that this decision had on her peers. The student who departed experienced racism, sexism, insufficient support, and imposter syndrome, all of which took a substantial toll on her mental health. Despite being strong academically, the student chose to leave for the good of her health and her family. Her peers were frustrated and saddened by her departure but supported her decision, underscoring the ripple effects that occur when a student leaves a doctoral program.

Related Paper Set

A Change Agents' Experience Reforming Physics Candidacy Exams

Daniel Sharkey*, The Ohio State University, USA
Bill Bridges, Kansas State University, USA
James Laverty, Kansas State University, USA
Rachel Henderson, Michigan State University, USA
Jacquelyn Chini, The Ohio State University, USA

ABSTRACT

While research has been done surrounding the assessments students take to apply to graduate school in physics, there is a gap in the literature surrounding assessments post-matriculation, such as qualifying or candidacy exams. This project seeks to understand these graduate assessments and the process for physics departments attempting to modify these assessments. To do this, we have conducted interviews with faculty, students, and staff at three institutions that have recently modified their candidacy process. This presentation

focuses on one interview with a key change agent at one of the institutions and their experience. We implemented an emergent coding process guided by pragmatic grounded theory methodology to understand how various factors impacted the process of modifying assessments in a physics graduate program. The theory was then considered in the context of the Four Frames, a framework designed to understand institutional change. We found a variety of ways in which the different frames of structures, symbols, people, and power influenced the change agents' experience, and highlighted these examples to better understand what departmental change looks like when modifying a long-established tradition and to provide advice for departments interested in modifying their candidacy exams.

Building Reflective and Supportive Pathways in Preservice Teacher Education

Strand 7: Pre-service Science Teacher Education
24-Mar-25, 1:30 PM-3:00 PM
Location: Baltimore 1

Stand-Alone Paper

The Noyce Pre-Residency: Early field experiences used to recruit individuals to become science teachers

Sarah McCorrison*, University of South Alabama, USA
André Green, East Carolina University, USA
Susan Ferguson, University of South Alabama, USA

ABSTRACT

The National Assessment of Educational Progress (NAEP) science assessment results suggest that science scores are declining for the lowest performing eighth graders in all three content areas compared to 2015 NAEP results (National Center for Education Statistics, 2019). Research shows that the lack of certified science teachers is a major cause of poor achievement for high-risk students (Darling-Hammond, 2000; Ekmekci Serrano, 2022). To recruit highly qualified individuals to become secondary science teachers, this qualitative study analyzed a major component of Noyce's recruitment process, the pre-residency experience. It is a paid early field experience that takes place before students begin the teacher certification program. Results show that the pre-residency experience positively impacts an individual's decision to become a science teacher.

Stand-Alone Paper

Developing Effective Mentor Teachers for Preservice Science Teachers: Relational, Developmental, and Contextual Dimensions

Maria Rivera Maulucci*, Barnard College, USA

ABSTRACT

This study explores the critical role of mentoring in fostering positive outcomes for undergraduate science teaching interns with a particularfocus on the mentoring model,

mentor-teacher training reflections, and the impacts of the mentoring model on the interns.Research on new teacher mentoring can be categorized by the relative emphasis on relational, developmental, or contextual dimensions of mentoring.Observation checklist data show gains in teaching effectiveness across all general and science-specific criteria during the four weeks of teaching. Mentor-teacher reflections show a heavy focus on developmental concerns, relatively less emphasis on contextual concerns, and the least emphasis on relational concerns. However, relational concerns were central to their reflections on their process of debriefing with the science teaching interns. Interns' reflections emphasized the importance of relational aspects, such as how their mentor teachers supported them emotionally during the intensive teaching experience. This study has implications for the design of mentoring models duringfieldwork experiences for preservice science teachers, includingconstructing a clear learning progression with targeted expectations or checkpoints for general and subject-specific pedagogy, engaging in norming activities with mentors to clarify learning targets, providing more opportunities for structured feedback, and dedicating adequate time for planning and debriefing instruction.

Stand-Alone Paper

Development and Evaluation of a University Seminar to Foster Reflection Competency

Oliver Tepner*, University of Regensburg, Germany
Stefanie Reimer, University of Regensburg, Germany

ABSTRACT

Science teachers' reflection competency is a vital component of their professional knowledge. However, research in this area, particularly in chemistry education, remains scarce. There is a paucity of knowledge regarding the planning, teaching, and reflection processes in the field of chemistry education. This desideratum will be addressed in this research project through the development of a university seminar in which students will plan, teach, observe, and then reflect on short teaching situations. The preservice chemistry teachers engaged in reflection on the explanation of experiments, which is regarded as a distinctive feature of chemistry. Given that both observed and self-conducted lessons can give rise to reflection, it is necessary to investigate the differences in development between these two conditions in an intervention study using a linear mixed model (LMM). The primary findings indicate that the reflective abilities of both teachers and observers can be markedly enhanced through the implementation of the developed university seminar. There are indications that the capacity for reflection develops at disparate rates in the two groups.Findings can contribute to insights into reflection processes and derive possible consequences for teacher education. The presentation will focus on the university seminar, the study's design and most important results.

Climate Literacy and Environmental Awareness

Strand 7: Pre-service Science Teacher Education
24-Mar-25, 1:30 PM-3:00 PM
Location: Baltimore 2

Stand-Alone Paper

Promoting ICT literacy in pre-service science teacher education with gamification-elements designed for species protection awareness

Ann-Katrin Krebs*, Leuphana University Lueneburg, Germany

ABSTRACT

In today's evolving educational landscape, a modern pre-service teacher education, ICT literacy, and innovative methodologies such as gamification are essential. This study highlights the importance of these elements by focusing on gamification-elements designed and used for species protection awareness. Pre-service STEM teacher students used diverse digital tools create digital learning environments centred on bats and their habitats for playful learning of serious contents. Documented through Work-in-Progress papers and analysed via Qualitative Content Analysis, the research shows increased ICT literacy, improved problem-solving skills, and a positive outlook on using gamification to enhance future pupils' engagement and motivation. Integrating these strategies in pre-service science teacher education prepares educators to create dynamic, engaging, and effective learning experiences.

Stand-Alone Paper

Science Preservice Teachers' Transformative Approaches to Climate Change Education

Kaylee Laub*, University of California, Santa Barbara, USA
John Galisky, University of California, Santa Barbara, USA
Liliana Garcia, University of California, Santa Barbara, USA
Matthew Shackley, University of California, Santa Barbara, USA
Julie Bianchini, University of California, Santa Barbara, USA

ABSTRACT

Teaching about climate change is complex: Such instruction should include examination of social, political, economic, and environmental dimensions as well as scientific concepts. Given this complexity, preservice science teachers must be encouraged to envision what teaching about climate change for understanding and transformation couldbe. Using interviews and artifacts from a small cohort of preservice secondary science teachers, we conducted an embedded single case study of how they envisioned opportunities for students to learn about the complexities of climate change in their current and future classrooms. We adapted and used a framework of four commitments to teacher collectives to support transformative teaching and learning of climate change to code our participants' interviews and artifacts. We found that the preservice teachers envisioned three types of opportunities to engage students in learning about climate change: 1) valuing diverse perspectives, 2) integrating transdisciplinary concepts and skills, and 3) taking action toward just futures. We conclude

by discussing how these opportunities could shed light on the complexities, systems, and injustices that are often disregarded when traditionally teaching about climate change. Learning from preservice teachers about their envisioned opportunities for students should interest both teacher educators and those intent on teaching about climate change.

Co-Design and Professional Learning in Curriculum Development

Strand 8: In-service Science Teacher Education
24-Mar-25, 1:30 PM-3:00 PM
Location: Annapolis 3

Stand-Alone Paper

Moving Beyond the NGSS: Integrating Multiple Ways of Knowing and Sustainability into Co-Designed Curriculum Units

Julia Poel*, University of Illinois Urbana-Champaign, USA
Nicholas Leonardi*, University of Illinois Urbana-Champaign, USA
McKenna Lane*, University of Illinois Urbana-Champaign, USA
Barbara Hug*, University of Illinois Urbana-Champaign, USA

ABSTRACT

As teachers work to implement the Next Generation Science Standards (NGSS) and create equitable science learning environments, they have been challenged to take a three-dimensional approach to science learning and expand what counts as science (NASEM, 2022). One way teachers can begin to address these challenges is to support students in navigating Multiple Ways of Knowing (MWK) and sustainability issues (Bang Medin, 2010; Marouli, 2021). We explore how professional learning participants engaged in a brainstorming activity to integrate MWK and sustainability into co-designed science units. Using thematic analysis (Braun Clarke, 2006), we identified themes for how participants engaged with the brainstorming activity to integrate MWK and sustainability into their units. Our findings suggest that participants considered curriculum design features that students and teachers would bring in. Further, we found that the integration of MWK and sustainability was most successful when the design features in the unit created opportunities for both students and teachers to bring in MWK and sustainability. Professional learning facilitators should consider how professional learning activities can be designed to support teachers in navigating both MWK and sustainability with their students in their instruction and help them move beyond the NGSS.

Stand-Alone Paper

How Professional Learning with Educative Curriculum Materials Supports Teachers Modeling Knowledge and Pedagogical Design Capacity

Karen Lionberger*, WestEd, USA

ABSTRACT
A robust body of research has demonstrated the importance of sustained professional learning (PL) hours in supporting science educators' continued growth and development of pedagogical content knowledge (PCK) throughout their careers. Despite this evidence, the landscape of how teachers engage in PL is shifting towards reduced time for in-person learning opportunities and is being replaced by shorter one-to-two-day PL and/or virtual learning. This shift towards shorter and fragmented models of PL for in-service science teachers is outpacing our research in what, if any, effect those learning opportunities have in shaping teacher knowledge. Additionally, despite the prominence of modeling research since the release of the Next Generation Science Standards, we still have known gaps in our understanding of explicit professional learning practices that support teachers' modeling knowledge, especially with in-service life science educators. Utilizing educative curriculum features in task designs may offer a method for extending learning shifts gained during shorter, more focused PL. Therefore, this study worked to center the lived realities of in-service, biology teachers by examining what, if any, impact on teachers' metamodeling knowledge and modeling-oriented PCK occurs during a short, focused professional learning event followed by examination and implementation of an educative, modeling-based performance task.

Stand-Alone Paper

Opportunities to Learn Using Curriculum Cases in Professional Development

Nicholas Leonardi*, University of Illinois Urbana-Champaign, USA
Julia Poel*, University of Illinois Urbana-Champaign, USA
McKenna Lane*, University of Illinois Urbana-Champaign, USA
Barbara Hug*, University of Illinois Urbana-Champaign, USA

ABSTRACT
Reform efforts in science education advocate expanding what can count as science to make classrooms equitable (NASEM, 2022). To support teachers in expanding what counts as science in their classrooms, professional development experiences can be designed to help teachers make changes to their practice. One strategy for supporting teacher learning is using cases, which allow teachers to discuss and reflect on problems related to teaching or learning (Loucks-Horsley et al., 2008). This study explores how opportunities to learn differ across teams of professional learning participants when engaging in case discussions focused on expanding what counts as science. Our findings show that opportunities to learn can differ for professional learning participants when they engage in case discussions since teams may mobilize conceptual resources differently. Although cases designed to explore problems of practice can help in-service teachers move toward adopting equitable pedagogical approaches that can support students in building science ideas, this study demonstrates that merely learning about a concept, even through strategic tools such as cases, may not be enough to help teachers make the bridge between the hypothetical and concrete practices.

Stand-Alone Paper

Catalyzing Change: Influence of Teacher Collaborative Curriculum (re)design on Teacher Practice and Student Learning

Sherry Ssoutherland*, Florida State University, USA
Patrick Enderle, Georgia State University, USA
Jennifer Schellinger, Florida State University, USA
Will Rogers, Yale, USA
Ellen Granger, Florida State University, USA
Todd Bevis, Florida State University, USA
Sierra Morandi, Florida State University, USA
Ruveyde Kaya, Florida State University, USA

ABSTRACT

This research sought to answer the following question:How do opportunities for collaborative design influence teachers' enactment of curricular materials and their students' biology learning?In this quasi experimental study, we compare two models of professional development, one that featured teacher collaboration on the redesign of curriculum materials and a very similar one in which such collaboration and redesign feature was not supported. Thirteen high school biology teachers and 274 students participated in the study. The instructional rigor of lesson plans and classroom enactment were determined for four lessons usingInstructional Quality Assessment - Science Observation Rubrics. Students' biology learning was measured using theScience Learning Activation SurveyandAssessment for Biological Reasoning. We used a Bayesian data analysis to enable flexibility with model assumptions and superior fitting capabilities to frequentist statistical approaches. Our findings suggest that teacher collaboration on the redesign of ambitious curricular materials does have a positive impact on their enactment of those materials, which influences students' biology learning (both in reasoning and students' affect toward science). Our findings also speak to the need for focused attention on teachers' epistemological beliefs, as they were shown to be an important influence on teachers' enactment and student learning.

Stand-Alone Paper

'Your insights give me a better understanding": Co-Learning in a Curriculum Design Partnership

Symone Gyles*, University of California, Irvine, USA

ABSTRACT

Although teachers are central stakeholders in partnership work, they often find themselves positioned as outsiders within the partnership. While there has been much research around teacher-researcher partnerships in science education, specifically focusing on engagement challenges in partnership work, there is less research on the ways in which partners mitigate those challenges. This study explores the practices one teacher-researcher partnership engaged in to disrupt traditional roles and support collective learning experiences that created spaces to critically think and imagine, negotiate knowledge and meaning, and develop a trusting and humanizing relationship. Through an exploration of our practices of

expanding political identities and scaling up, I provide foundational practices other teacher-researcher partnerships in science education could adopt and adapt to create reciprocal learning spaces.

Integrating Research, Industry, and Pedagogy in STEM Education

Strand 8: In-service Science Teacher Education
24-Mar-25, 1:30 PM-3:00 PM
Location: Magnolia 2

Stand-Alone Paper

Translating Research Lab Experiences into Classroom Experiences: Impacts on Teaching Beliefs, Content, and Pedagogy

Elizabeth Edmondson*, Virginia Commonwealth University, USA
Eric Lindley*, Virginia Commonwealth University, USA
Hsin-Ling Hung, Virginia Commonwealth University, USA
Linda Le, Virginia Commonwealth University, USA

ABSTRACT

The Next Generation Science Standards (NGSS, 2013) calls for providing students with more authentic science experiences in the classroom. Teachers, who have yet to conduct research themselves, may find this challenging to bring to life in their classrooms. Our program, which is located in a metropolitan setting, seeks to cultivate in inservice teachers the skills needed to conduct cutting-edge biomedical research and to translate that research experience into curricula for their students. Participating inservice teachers complete two eight-week research experiences in consecutive summers in a laboratory setting. They work with their research mentors who specialize in various fields related to drug and alcohol abuse (NIH NIDA-funded labs). A qualitative case study approach was used to learn from 10 participants about the impact of the program on their classroom practices. Laboratory experiences varied among the participants with some experiencing more hands-on bench-type research and others involved in a more observational capacity in the lab or with human subjects. Evidence of impacts on teaching beliefs, content delivery, and pedagogical approaches were found. The model of two years of research experience and PLC opportunities during the summer and school year can change teacher practice and ultimately impact student understanding of science.

Stand-Alone Paper

Secondary science teachers' goal conflicts in an alternative energy focused engineering RET project

Joseph Brobst*, Old Dominion University, USA

ABSTRACT

In this qualitative study, we utilize a goal conflicts framework modeled after Hutner et al., 2022 to understand the experiences of secondary science teachers in the context of an

alternative energy focused engineering Research Experiences for Teachers (RET) project. Teachers spent seven weeks conducting engineering research on topics related to use of solar, biomass, hydrogen, and wind for alternative energy production. In concert, they engaged in weekly professional development sessions utilizing the Argument Driven Inquiry model of instruction. Focus group data indicated that teachers experienced multiple dimensions of goal conflicts as they sought to translate their experiences into usable ADI-based lessons: connecting research to instruction; ADI vs. other instructional models; conflicts with student needs and capabilities; conflicts with standards and time. Follow-up lesson observations found only a small subset of teachers ultimately even attempting to carry out lessons developed during the RET. Findings confirm the challenges of connecting engineering research experiences to secondary science instruction, underscore the importance of ongoing teacher support, and bring into question the effectiveness of the traditional RET model where the majority of activities are concentrated during the summer.

Stand-Alone Paper

From Industry to Classroom: The Benefits of Combining STEM Industry Immersion with Pedagogical PD

Vance Kite*, Kenan Fellows Program for Teacher Leadership, USA
Kevin Winn, Friday Institute for Education Innovation, USA
Teresa Leavens, Friday Institute for Education Innovation, USA
William Reynolds, North Carolina State University, USA

ABSTRACT

STEM experiences for teachers (SETs) are promoted to enhance students' STEM learning by immersing educators in industry settings. The SET professional development (PD) model assumes that deep immersion alone motivates pedagogical change. However, these initiatives often lack the pedagogical PD necessary for translating industry experiences into classroom practices. This study explores the effectiveness of The Fellowship Program (TFP, pseudonym). TFP is a year-long program that combines a three week SET with 80 hours of pedagogical and leadership development (SET+PD). This qualitative study used Clarke and Hollingsworth's Interconnected Model of Professional Growth (IMPG) to analyze the impact of TFP on 32 teachers' professional growth. Our findings reveal that participants identified Industry Connections and Professional Development as particularly impactful elements of TFP. TFP's SET+PD model strongly influenced educators' Personal Domain, including their knowledge, attitudes, and beliefs. There was a consistent pathway from changes in teachers' Personal Domain, through their Domain of Practice, to positive outcomes in their Domain of Consequence (e.g., increased student opportunities and enhanced teacher leadership). This study underscores the efficacy of the SET+PD model for sustainable STEM integration in classrooms; highlighting the need for PD programs that improve teachers' STEM knowledge, pedagogy, self-efficacy, and industry network.

Stand-Alone Paper

Science educators' engagement and practice changes in a design-based implementation research (DBIR) initiative

Melissa Livingston*, Oregon State University, USA

Cory Buxton, Oregon State University, USA
Camila Kennedy, Education Northwest, USA

ABSTRACT
This study investigates how educators' science backgrounds influence their teaching practices over a multi-year Design-Based Implementation Research (DBIR) project. The project involves inservice educators leading after-school STEM clubs across a state in the northwestern US and aims to support them in integrating contemporary, justice-centered educational practices. The research focuses on educators' engagement with professional development (PD) opportunities and their implementation of the STEM for All model, which emphasizes language development, cultural and community connections, and knowledge building in science. Over three years, data were collected through event engagement records, educator logs, focus group interviews, and demographic surveys. Initial findings reveal that educators with STEM degrees and elementary teaching experience show the highest enactment of the STEM for All practices. Furthermore, educators who participated in all three years of the project demonstrated an increase in the use of project practices, suggesting the potential for long-term sustainability and effective translation of PD into classroom practices. This study contributes to the understanding of how science backgrounds affect educators' professional learning and practice, highlighting the importance of dynamic, responsive PD that incorporates educators' experiences and supports their diverse enactments of educational models.

Advancing Measurement of Science Learning

Strand 10: Curriculum and Assessment
24-Mar-25, 1:30 PM-3:00 PM
Location: Magnolia 1

Stand-Alone Paper

Development and Validation of the Diagnostic Test for Heuristics in Chemistry using Rasch Measurement Approach

Jonathan Barcelo*, Saint Louis University, Philippines

ABSTRACT
In chemistry education, students often rely on heuristic reasoning rather than analytical approaches. While heuristics can facilitate the understanding of certain chemistry concepts, they may also lead to misconceptions. Thus, identifying and diagnosing heuristic reasoning in chemistry learners requires further exploration. This study aimed to develop and validate the Diagnostic Test for Heuristics in Chemistry, a two-tiered multiple-choice assessment designed to gauge students' propensity for heuristic reasoning across selected chemistry topics. The first tier presents one correct answer, one heuristic-driven answer, and one incorrect answer, while the second tier allows students to indicate the certainty of their answers through a dichotomous option. Grounded in the Heuristic-Analytic Theory, the six levels of response patterns are based on the premise that heuristic reasoning characterizes

both low- and high-ability students. The Rasch analysis was utilized to provide empirical evidence for the test's construct validity, reliability, unidimensionality, item fit, and item category functioning. However, further iterative analyses with a larger sample size are necessary to validate the proposed six levels of answer progression and explore the test's differential item functioning. This diagnostic test has the potential for identifying heuristic reasoning among students and guiding chemistry educators in developing strategies to foster analytical reasoning.

Stand-Alone Paper

Measuring Giftedness in Biology: Development and Validation of Subject-Specific Test Instruments

Colin Peperkorn*, Bielefeld University, Germany
Claas Wegner, Bielefeld University, Germany

ABSTRACT

Research indicates that biology teachers can recognize general intelligence but fail to identify domain-specific gifts. Currently, there is no empirically proven subject-specific model of giftedness in biology. A potential approach to address these issues is using psychometric tests within giftedness diagnostics, but there are currently no suitable instruments. Three test instruments were designed to measure Scientific Inquiry (SI), Scientific Inductive Thinking (SiT), and Scientific Divergent Thinking (SDT) in biological subject areas. The tests were administered toN =207 students from third to fifth grade. Results showed a weak correlation between SI and IQ, indicating that relevant traits for giftedness in biology may differ from those assessed by standard intelligence tests. SiT test results were significantly correlated with IQ, suggesting its efficacy in assessing cognitive abilities. The results of the SDT showed no significant correlation with IQ, but they were linked to SI and SiT. The findings suggest that traditional intelligence tests may capture certain cognitive aspects, but a more detailed approach is needed to identify giftedness in specific subject areas such as biology.Further studies on giftedness in biology are necessary to provide teachers with an empirically sound basis for identifying gifted students.

Stand-Alone Paper

Applying Machine Learning Methods to Understand Differential Item Functioning in a Flu Knowledge Assessment

Tanvi Banerjee, Wright State University, USA
William Romine*, Kairos Research, USA
Derrick Cox*, Wright State University, USA

ABSTRACT

We conduct an in depth analysis of differential item functioning (DIF) for four items on the Assessment of Knowledge of Influenza (AKI) dealing specifically with four aspects of flu transmission. Using a dataset from previous work (Authors), we draw upon both statistical and machine learning paradigms to evaluate potential DIF in these items. Through a model-agnostic machine learning epistemology, we investigate DIF from three vantage points that statistical methods do not address directly: (i) the importance of specific affective and

demographic features in generating accurate predictions, (ii) evaluating the generalizability of predictions across schools, and (iii) evaluating the generalizability of these effects across different types of models. We found no significant DIF with respect to demographic factors such as gender and ethnicity. Rather, affective traits such as perceived complications of illness and barriers against mitigation practices were sources of DIF which generalized well across the six schools in the study. We make the case that moving beyond model-specific inferential methods toward model-agnostic machine learning-based methods will enhance our ability to detect biases in our assessments using data-driven techniques, and to focus on those which persist across different populations and diverse modeling paradigms.

Stand-Alone Paper

Assessing Reliability and Validity of a Science Content Knowledge Questionnaire for Elementary PSTs: Rasch Modeling

Soon Lee*, Kennesaw State University, USA
Anna Arias, Kennesaw State University, USA
Preethi Titu, Kennesaw State University, USA
Jessica Reaves, Kennesaw State University, USA
Rasheda Likely, Kennesaw State University, USA

ABSTRACT

This study aimed to assess the reliability and validity of a Science Content Knowledge Questionnaire (SCKQ) for elementary preservice teachers (PSTs) using Rasch modeling. The SCKQ was developed to address the need for efficient, scalable assessments of PSTs' integrated science content knowledge, understanding of relevant DCIs and CCCs addressed in the two science content courses. The questionnaire items were carefully selected from established standardized science assessment repositories. Participants included 145 PSTs enrolled in two integrated science courses. The SCKQ and the Science Teaching Efficacy Belief Instrument-B (STEBI-B) were administered pre- and post-course. Data analysis included Rasch modeling, paired samples t-tests, and correlations. Results demonstrated high internal consistency (Cronbach's α = 0.77-0.84) and test-retest reliability (r = 0.54-0.64, p 0.001) for the SCKQ. Wright map analysis revealed that most items were relatively easy for PSTs, suggesting a need for more challenging items. The SCKQ showed sensitivity to instruction, with significant improvements in scores from pre- to post-test (p .05). Convergent validity was supported by positive correlations between SCKQ scores and STEBI-B scores. The study contributes a psychometrically robust instrument for assessing elementary PSTs' science content knowledge, potentially informing curriculum development and evaluating the effectiveness of science content courses.

Learning from Black Students, Teachers, and Stories in Science/STEM Education

Strand 11: Cultural, Social, and Gender Issues
24-Mar-25, 1:30 PM-3:00 PM
Location: Azalea 1

Stand-Alone Paper

'In the minority from the jump'': Black Men Teachers and Their Experiences in Science Education

Joshua Modeste*, Teachers College, Columbia University, USA
Felicia Mensah*, Teachers College, Columbia University, USA

ABSTRACT

The underrepresentation of Black men in the teaching profession is well-documented in educational research. Despite research indicating the positive impacts of Black teachers on student performance, Black men currently represent less than 2% of the teacher workforce. Although some literature exists regarding Black men teachers across subject and grade levels, there is very little research that explores the motivations, realities, and recruitment of Black men science teachers in urban public secondary schools nor are there specific supports and strategies to promote their recruitment and retention. Within science education, Black men can be further marginalized by stereotypes perpetuated in sociopolitical discourse, which overgeneralize and limit the expression and performance of Black male educators. These roles are further confirmed through hypersexuality and Eurocentric aesthetics, hyperaggressive roles and responsibilities, and misconceptions of content expertise and pedagogical effectiveness (anti-intellectualism), which parallel assumptions made about Black boys. These stereotypes are reinforced in schools through social interactions, teacher education, and racial macro- and microaggressions. This study uses intersectionality and counternarratives to highlight the experiences of three Black men science teachers. Participant narratives revealed three emergent themes: relationships in STEM education, recruitment into teaching, and the impact of race and gender in teacher education.

Stand-Alone Paper

Interrogating anti-Blackness in STEM education: Argument countering the erasure to promoting Black excellence in STEM

Theila Smith*, Brooklyn College (CUNY), USA
Takeshia Pierre*, Tufts University, USA
Bhaskar Upadhyay, University of Minnesota, USA

ABSTRACT

In this proposal, we discuss the importance of centring Blackness within STEM education in the US while emphasising how Blackness has also been removed. The silence surrounding the advancements of Black people bellows this notion that Black people are not contributors of knowledge and a part of the foundation of society despite having built the U.S. along with the major empires we see on the continent of Africa, the Diaspora, and beyond. There are examples outside of white innovations that allow us to look at race and Blackness to not only

include Black students but to offer them a counter-narrative to Euro-centric science—centring topics that bolster the stories of innovations and empires developed from communities of African descent would support Black people's capabilities in STEM spaces. We provide brief examples of the rich histories and discoveries illuminating African history and discuss Black STEM Scholars to begin these conversations.

Stand-Alone Paper

Re-Humanizing the Br-other: Implications for the Next Generation as Advised by Black Men in STEM

Takeshia Pierre*, Tufts University, USA
Latoya Haynes-Thoby, University of Connecticut, USA

ABSTRACT

Black people have a disturbing history with science in America. However, there is an exhaustive history of violence, racism, and dehumanization experienced by Black Males. Despite this history of dehumanization, Black Males have arguably been made quantifiable by U.S. society, with information on them being largely discussed in a data-driven format. Black Male voices are not commonly represented in STEM research, nor amplified in the assessment of methods to combat [under]representation in STEM fields. In this study, we shed light on the experiences and advice of Black Men in STEM to elicit ideas to support the next generation of Black Males in pursuing careers in STEM. 52 Black Men in STEM and health careers were interviewed and their thoughts were interpreted through a critical and Afrofuturistic lens.

Stand-Alone Paper

The Untold Counterstory: A Researcher's Account of Investigating the Experiences of Black Students Studying Biology

Analisa Brown*, University of California, Davis, USA

ABSTRACT

Drawing on counterstorytelling, a core principle of Critical Race Theory (CRT), this paper draws attention to the importance of the counterstory of scholars whose work focuses on the communities to which they belong. Positioned as both a researcher and a graduate student, this paper focuses on how I grappled with and interrogated my emotions and biases while studying the experiences of Black students in biology at a Minority Serving Institution (MSI). In sharing my transformative experience and providing evidence from the literature, I illustrate how conducting such work is not only liberating but also can be daunting at the same time, which calls into question the motive behind the work of educational scholars. Finally, I present key takeaways that higher education scholars should consider when working with marginalized communities.

Supporting Youth Agency and Belonging in STEM Education

Strand 11: Cultural, Social, and Gender Issues
24-Mar-25, 1:30 PM-3:00 PM
Location: Azalea 2

Stand-Alone Paper

Concurrent Phenomenological Analysis of STEM Career Aspirations in Underrepresented Youth: Role of Experiences and Identity

Amdad Ahmed Awsaf*, Florida International University, USA
Nicole Giansanti, Florida International University, USA
Susan Sunbury, Harvard University, USA
Remy Dou, Florida International University, USA

ABSTRACT

Despite numerous initiatives aimed at enhancing diversity and achieving equity in the STEM workforce, racially and ethnically minoritized individuals remain underrepresented in STEM disciplines and the STEM workforce. While many factors influence STEM identity (i.e., seeing oneself as a STEM person), it strongly correlates with individuals' future STEM career choices. This phenomenological qualitative study explores the impact of formal or informal STEM-related recognition that influences minority youths' aspirations to pursue a STEM career. Results indicate that though misrecognition negatively impacts one's motivation to study STEM areas, lack of recognition in formal schooling contexts was sometimes mitigated by recognition and support from family. The study suggests providing targeted interventions to facilitate underrepresented youths' achievements in STEM to foster a strong STEM identity and STEM career aspirations.

Stand-Alone Paper

Spacetimematter Entanglements in a Digital Environmental Story

Mary Short*, Smithsonian Institution, USA

ABSTRACT

This paper uses Karan Barad's (2007) agential realism to think about a video developed by a sixth-grade student. Through this engagement with the video material, I consider complex system of apparatuses involved in creating new digital material alongside their exclusions and the implications therein. A diffraction analysis is used to surface new findings about spacetimematter entanglements in a video about trash in a park. Implications for thinking about the exchange of digital media as agentic matter shaping reality are discussed.

Stand-Alone Paper

You are the Dreamer the Dream: Black Nerds Reimagining Space Time Through Counterspaces STEM Identities

Brandi Cannon*, Stanford University, USA

ABSTRACT
In this work I examine how Black learners resist hegemonic STEM culture through their own counterculture and how they use counterspaces to radically reimagine STEM education. I use mixed methods (survey and focus groups) to gather evidence and analyze how Black nerds reflect and understand their experiences and relationships to STEM and how they re-envision STEM education through the lens of Afrotufuturism. This research provides an understanding of how to diversify and expand notions of STEM learning and those experiences that come with it. Black learners possess a wealth of knowledge within their communities that merits inclusion in STEM environments and have the potential to contribute to the production of scientific knowledge enriched with historical and cultural context, which can transform our perception of and experiences with STEM. This study is particularly urgent as contemporary science curricula continue to inflict harm by perpetuating static Western concepts of scientific knowledge and understanding on those most marginalized.

Stand-Alone Paper

Bicycles and STEM: Unearthing Black and Brown Genius

Noemi Waight*, University at Buffalo, USA
Ryan Rish, University at Buffalo, USA
Jennifer Tripp*, University at Buffalo, USA
Sophie Wisoff, GOBike, USA
Darryl Marks, East Side Bike Club, USA

ABSTRACT
This study framed by Muhammad's (2019) historically responsive literacy framework and four pursuits to unleash genius, examined the experiences of Black and Brown youth in a STEM bicycle and biking summer program in a midsize Northeastern city. More specifically, we documented how students narrated their understandings of related scientific and engineering phenomena, their experiences of the biking program, and how these experiences informed their disposition for STEM learning. The findings revealed that (a) students developed formative proficiency with biking while lacking understandings of the bike; (b) the bike as medium and context for learning stimulated interest and learning; and (c) the bicycle highlighted and offered a concrete model for students to explore the engineering process and engage scientific understandings. This study has implications for understanding how Black and Brown youth learn science and engineering in the context of the bicycle and bike riding. Importantly, it informs how historical and cultural technological contexts are powerful mediums to unleash critical Black and Brown geniuses.

Working collaboratively with AI to produce learning progression-based feedback
Strand 12: Technology for Teaching, Learning, and Research
24-Mar-25, 1:30 PM-3:00 PM
Location: Baltimore 5

Related Paper Set
Generating Learning Progression-based Actionable Feedback to Support Students' Three-Dimensional Learning: A Large Language Model Approach
Peng He*, Washington State University, USA

ABSTRACT
This study leverages large language models (e.g., GPT) to generate automatic actionable feedback on students' responses to classroom assessment tasks. Two middle school science teachers have implemented our 3DLP-based classroom assessment. We collected their 191 students' written responses to the seven assessment tasks. This study employed few-shot prompting strategies to train the GPT automatic generated feedback for students' written responses. Our preliminary analysis showed that the GPT models could identify the separate DCIs (Chemical Reaction), SEPs (Constructing Scientific Explanations), and CCCs (Cause and Effect). When generated actionable feedback, we found that without any feedback examples, the GPT models tended to provide generate feedback on students' challenges. Our findings showed that the human-GPT feedback served as exemplars to enhance the GPT-generated feedback. The study design and the exploration of using generative AI as a partner will significantly contribute to the teaching and learning of science with innovative technologies.

Related Paper Set
Learning Progression-Guided AI Evaluation of Scientific Models To Support Diverse Multi-Modal Understanding in NGSS Classroom
Leonora Kaldaras*, Texas Tech University, USA
Tingting Li, Michigan State University, USA
Prudence Djagba, Michigan State University, USA
Kevin Haudek, Michigan State University, USA
Joseph Krajcik, Michigan State University, USA

ABSTRACT
Learning Progressions (LPs) can help adjust instruction to individual learners needs if the LPs reflect diverse ways of thinking about a construct being measured, and if the LP-aligned assessments meaningfully measure this diversity. The process of doing science is inherently multi-modal with scientists utilizing drawings, writing and other modalities to explain phenomena. Thus, fostering deep science understanding requires supporting students in using multiple modalities when explaining phenomena. We build on a validated NGSS-aligned multi-modal LP reflecting diverse ways of modeling and explaining electrostatic phenomena and associated assessments. We focus on students modeling, an essential practice for building a deep science understanding. Supporting culturally and linguistically diverse students in building modeling skills provides them with an alternative mode of

communicating their understanding, essential for equitable science assessment. Machine learning (ML) has been used to score open-ended modeling tasks (e.g., drawings), and short text-based constructed scientific explanations, both of which are time- consuming to score. We use ML to evaluate LP-aligned scientific models and the accompanying short text-based explanations reflecting multi-modal understanding of electrical interactions in high school Physical Science. We show how LP guides the design of personalized ML-driven feedback grounded in the diversity of student thinking on both assessment modes.

Related Paper Set

Collaborating with Teachers to Generate ML-Based Feedback: Contextualizing and Developing Meaningful and Relevant Feedback

Selin Akgun*, University of Minnesota, USA
Kevin Haudek, Michigan State University, USA
Leonora Kaldaras, Michigan State University, USA
Joseph Krajcik, Michigan State University, USA

ABSTRACT

Authors draw from literature about formative assessment and the process outlined in Paper 1 to develop LP-aligned feedbacks based on identified principles. Authors examine how teacher expertise and classroom experience help revise these feedback statements used for AI-based scoring systems.

Related Paper Set

Feedback on Utilizing Deep Learning AI to Analyze Scientific Models

Tingting Li*, Washington State University, USA
Leonora Kaldaras, c. University of Colorado Boulder, USA
Kevin Haudek, Michigan State University, USA
Joseph Krajcik, CREATE for STEM Institute, USA

ABSTRACT

This study explores the integration of deep learning AI for evaluating scientific models within three-dimensional science learning contexts. Utilizing a Convolutional Neural Network (CNN) model, we analyzed 1,151 student models from a high school curriculum, comparing AI-generated scores with human assessments. Despite high accuracy, inconsistencies emerged, especially concerning models developed by students from diverse backgrounds. Human raters and experienced teachers provided critical feedback on these discrepancies, highlighting the importance of transparency and the potential biases in AI scoring. Thematic analysis of teacher interviews identified key areas for improvement in AI training and application. This research underscores the need for human oversight to enhance the equity and effectiveness of AI-driven assessments in science education.

A Moral Inquiry into Epistemic Insight through Socioscientific Issues: Global Perspectives

Strand 13: History, Philosophy, Sociology, and Nature of Science
24-Mar-25, 1:30 PM-3:00 PM
Location: Camellia 1

Symposium

A Moral Inquiry into Epistemic Insight through Socioscientific Issues: Global Perspectives

Dana Zeidler*, University of South Florida, USA
Fouad Abd-El-Khalick, University of Massachusetts Amherst, USA
Rola Khishfe, American University of Beirut, Lebanon
Yeonjoo Ko, Jeju National University, Korea, Republic of
Shiang-Yao Liu, Taiwan Normal University, Taiwan
Amanda McCrory, University College London, United Kingdom
Li Le, University of Nevada-Reno, USA
Troy Sadler, University of North Carolina, Chapel Hill, USA
Ben Herman, Texas A&M University, USA
Martha Georgiou, University of Athens, Greece

ABSTRACT

The Socioscientific Issues (SSI) Framework has evolved over several decades having pedagogical and theoretical impact in the field of science education. This participatory symposium is centered on the facilitation of epistemic insight through a moral inquiry of scientific problems embedded in the social and cultural fabric of our world. The aim of this symposium is to present global perspectives and facilitate discussion on how SSI research and practice has been framed around past, present, and future trends that have impacted and continue to advance scientific literacy. To that end, this symposium examines the state of research, policy and practice of SSI-relarted initiatives from the vantage point of scholars representing 17 different countries around the globe.To that end, the focus of this symposium is to explore the underlying presuppositions that have guiding related elements of the SSI research program impacting the philosophical, sociological, and psychological underpinnings of the framework, its role with respect to moral education in the context of science education, and what it means, from a global perspective, to pursuemoral inquiryandepistemic insightin the practice of science teaching and learning through SSI.

School, Family & Community Participation
Strand 14: Environmental Education and Sustainability
24-Mar-25, 1:30 PM-3:00 PM
Location: Baltimore 3

Stand-Alone Paper
Family Promoted Access to Children's Interactions with Biodiversity and Outdoor Play
Allison Antink-Meyer*, Illinois State University, USA
Anthony Lorsbach, Illinois State University, USA
Ryan Brown, Illinois State University, USA

ABSTRACT
Teachers, schools and formal settings have an important role to play in the development of sustainability mindsets and nature play opportunities among children, but the role of families is central to children's long term environmental orientations and science interests. Children's access to outdoor spaces, the relationship to their health, and connections to their later interest and value of nature are areas of understanding where researchers have made significant contributions in recent years. Children's access to the outdoors within their homelives and the ways they interact with biodiversity are less understood. The purpose of this study is to contribute to this gap in research to better understand not only the types of interactions children have with biodiversity in outdoor spaces, but also the access afforded to them within their families and communities. Underlying associations between types of outdoor space and children's access were found. Direct and intentional interactions with biodiversity were related to specific types of outdoor play space. Given access, children will seek out interactions with biodiversity. Given that patterns exist between how families access both private and community outdoor spaces, community planning that designs for access to less available types of natural settings within more available types is suggested.

Stand-Alone Paper
Into the Weeds: Pro-Environmental Behavior Through the North Carolina Native Plant Forum on Facebook
Sera Harold*, North Carolina State University, USA
Carla Johnson, North Carolina State University, USA

ABSTRACT
Global biodiversity loss and climate change highlight the importance of environmental education in the population at large. Americans gain environmental knowledge almost exclusively from sources outside of formal schooling, and increasingly, the internet and social networking sites are the preferred sources of that specific, just-in-time learning. The North Carolina Native Plant Forum is a regionally specific Facebook group focused on environmental education with over 80,000 members. This case study uses forum member interviews and analysis of the Facebook site itself to explore pro-environmental behavior development using the Native Plant Forum. These data reveal a process of information seeking, sharing experiences, obsession, and pro-environmental intentions leading to the

planting of native plant species. Forum users generally garden with members of their families, they become advocates for native plants in their various communities, and are sensitive to outside feedback (as from homeowners' associations). Users of the forum expressed how much they learned from the Facebook group and particularly valued the photographs shared daily by other forum members of their native planting projects. The ability of social networking sites to support and incentivize pro-environmental knowledge and behaviors is a critical area of research for adapting environmental education to a new information age.

Stand-Alone Paper

Middle School Students' Environmental Moral Reasoning on Socioscientific Issues: Terrestrial vs. Extraterrestrial Environments

Cansu Basak Uygun*, Middle East Technical University, Turkey
Özgül Yilmaz-Tuzun, Middle East Technical University, Turkey

ABSTRACT

The present study aimed to investigate middle school students' patterns of environmental moral reasoning on two different SSIs: space exploration (SPE) and nuclear power plants (NPP), referring to extraterrestrial and terrestrial environments, respectively. For this purpose, a survey design was utilized. A total of 465 students from eight public middle schools in five different districts of the capital city of Türkiye participated in the study. Middle school students' environmental moral reasoning was obtained through open-ended questions, adapted by Chang Rundgren and Rundgren (2010) and Chang and Chiu (2008), addressing their claims and supporting reasons. To analyze, qualitative data obtained by open-ended questions were coded utilizing the framework of Kortenkamp and Moore (2001), including ecocentric, anthropocentric, and non-environmental patterns, with the addition of mixed and no-reasoning patterns as emerging codes. Descriptive findings indicated that middle school students dominantly utilized the anthropocentric pattern over other patterns of environmental moral reasoning regarding both SSIs, which means that they mostly considered the instrumental value of nature regarding both SPE and NPP rather than its intrinsic value. This study might have the potential for science and environmental education programs in consideration of integrating more balanced viewpoints to promote students' environmental moral reasoning regarding different SSIs.

Stand-Alone Paper

Bringing Together Global Experts Insights on One Health Education to Enhance Scientific Literacy

Sascha Johann, Justus Liebig University, Germany
Benedikt Heuckmann, University of Münster, Germany
Ulrich Hobusch, University College for Agricultural and Environmental Education, Austria
Kerstin Kremer*, Justus Liebig University, Germany

ABSTRACT

The consideration of health problems such as zoonoses has increasingly challenged society in medical, social, and political aspects. Next to different Visions of Scientific Literacy (SL), a

transdisciplinary understanding of human, animal and environmental health at different system levels is required to overcome these challenges. So far, there is a lack of knowledge on how this view can be taken through One Health (OH) in Science Education and which competencies are needed to become more resilient in a changed (pandemic) reality. Frameworks so far only describe competencies for OH professionals (SL Vision I). Thus, the study investigated two research questions: (RQ1) From OH experts perspective, which competencies are relevant for professionals to implement OH research (Competent insiders, SL Vision I) and (RQ2) which OH competencies are relevant and should be communicated to society (Competent outsider, SL Vision II / III)? Therefore, 38 international OH experts were interviewed using an open-ended questionnaire. A qualitative content analysis indicated (RQ1) that the competencies described in existing frameworks were confirmed. For RQ2, we found several competencies to become an OH competent outsider in three domains (cognitive, socio-emotional, behavioral). We discuss the implication of these findings for the impact of OH for SL.

In praise of Science Teachers: Through the Eyes of STEM Gatekeepers for Black Scientists - Essential Partners in Researching, Reframing, and Reforming Science Teaching, Learning, and Learning to Teach

24-Mar-25, 3:15 PM-4:45 PM
Location: Annapolis 2

Administrative Session

Rona Robinson-Hill, Ball State University, USA
Shari Watkins, American University, Washington DC, USA
Jonathan Hall, California State University, San Bernardino, USA
Lanier Watkins, John Hopkins University, USA
Kristina Kramarczuk,University of Maryland, College Park, USA
Quinton Williams, Howard University, Washington DC, USA
Mariano Sto. Domingo, University of Maryland, USA
Meg Bentley, American University, Washington DC, USA

ABSTRACT

The first part of the 90-minute in person administrative session sponsored by The Continental and Diasporic Africa in Science Education (CADASE) Research Interest Group (RIG) which includes a 45-minute panel presentation with our inaugural five invited Dr. Mary Atwater Distinguished Lecturers, who are STEM Gatekeepers serving in the District of Columbia (DC) – Maryland – Virginia (DMV). The five Dr. Mary Atwater Distinguished Lecturers are: Drs. Lanier Watkins (John Hopkins University), Marioano Sto. Domingo (University of Maryland Baltimore County), Kristina Kramarczuk (University of Maryland), Quinton Williams (Howard University), and Meg Bentley (American University). After the panel presentation, a question-and-answer period will be held, followed by poster presentations from approximately 6 - 10 presenters. The rationale for our session is: 1) to unearth how STEM Gatekeepers at DMV institutions support Black STEM students to persist in STEM disciplines;

and 2) share how CADASE members are impacting their communities with their research in praise to STEM students, faculty, and teachers.

Publishing, Reviewing, and Writing for JRST

24-Mar-25, 3:15 PM-4:45 PM
Location: Azalea 2

Administrative Session

Felicia Moore Mensah, Teachers College, Columbia University, USA
Troy Sadler, University of North Carolina at Chapel Hill, USA
Matthew Kloser, University of Notre Dame, USA
Dana Vedder-Weiss, University of the Negev, Israel
Edna Tan, University of North Carolina Greensboro, USA

ABSTRACT

The Journal of Research in Science Teaching (JRST) is the official journal of NARST: A global organization for improving science education through research. JRST is the premier journal in the field with the largest impact factor. Its reputation relies on our associate editors, reviewers, and authors to promote compelling research consistent with the highest standards of varied theoretical traditions. In this session, the outgoing editors, Dr. Felicia Moore Mensah and Dr. Troy Sadler will present an overview of important factors in writing and reviewing for JRST. They will explain the processes JRST uses to facilitate peer review and make publication decisions, and provide some examples for discussions. This will be an interactive session in which participants are encouraged to ask questions about the journal and its processes and share ideas for improving JRST.

Drs. Moore Mensah and Sadler will provide updates on how they have fulfilled their vision for JRST during their tenure and the transition to the new in-coming Editors-in-Chief team. The incoming editors, Drs. Matthew Kloser, Dana Vedder-Weiss & Edna Tan, will share some new features they envision for the journal and discuss ways that the NARST community may work together for improving the journal and its outreach and support.

Transformative educational environments in STEM classroom: The role of contexts and instructors in centering students

Strand 2: Science Learning: Contexts, Characteristics and Interactions
24-Mar-25, 3:15 PM-4:45 PM
Location: Annapolis 1

Related Paper Set

Transdisciplinary teacher sensemaking during collaborative design centering student and community perspectives

Solaire Finkenstaedt-Quinn*, University of Michigan, USA
Ginger Shultz, University of Michigan, USA

ABSTRACT

This study explores the transdisciplinary sensemaking of a science teacher who is part of a collaborative team of sixth grade teachers designing, interconnected culturally relevant lessons. Using a case study approach, we examine how the science teacher engages in both collective and individual sensemaking during the design process. Our findings indicate that while the science teacher engaged in transdisciplinary sensemaking, both across subjects and community knowledge, they were constrained by socially constructed disciplinary boundaries.

Related Paper Set

'Meet them where they are'': Chemistry Graduate Teaching Assistants' Noticing for Equity

Daisy Haas*, University of Michigan, USA
Dani Losinski, University of Michigan, USA
Ginger Shultz, University of Michigan, USA

ABSTRACT

This study explores the experiences of chemistry graduate teaching assistants' (GTAs') teacher noticing for equity. Using a combination of a case study methodology and a teacher noticing for equity framework, this research explores GTAs' values and enactments (or lack thereof) of their pedagogical commitments for equity in the authentic classroom setting, offering implications for how GTAs create equitable chemistry learning spaces and the barriers they experience in doing so.

Related Paper Set

Exploring Chemistry Teaching Assistant Pedagogy and Perspectives in Renovated vs. Unrenovated Instructional Laboratories

Meng-Yang Wu*, The Ohio State University, USA
Cassandra Miller, The Ohio State University, USA
Dalyanne Hernandez-Sanchez, The Ohio State University, USA

ABSTRACT
This study investigates general chemistry teaching assistants' enacted pedagogies in renovated versus unrenovated instructional laboratory spaces. Using proxemics and video-stimulated recall interviews, emergent findings indicate that active learning classroom features do not invite student-centered teaching, that moment-to-moment instructional decision making is nuanced, and that a fine-grained approach is needed to better understand mechanisms to cultivate teaching for both equity and excellence

Related Paper Set

Why Do They Do What They Do? The drivers of learning assistant facilitation practices

Nicolette Maggiore*, Tufts University, USA
Jessica Karch, TERC, USA
Vesal Dini, Tufts University, USA
Ira Caspari-Gnann, Tufts University, USA

ABSTRACT
This study explores the different factors that drive LA facilitation from two levels: the interaction level and the course design level. Using an embedded case study and two sociocultural frameworks, we developed a model that describes and connects these drivers, showing how they lead to differences in dialogic versus authoritative LA facilitation. Variation in facilitation leads to variation in student learning outcomes, and instructor beliefs about what it means to learn science heavily influence the opportunities students have for learning in active learning, LA-facilitated courses.

Related Paper Set

Pathways in Chemistry: Investigating the Learning Ecosystems of Introductory Chemistry Undergraduate Students

Jocelyn Nardo*, The Ohio State University, USA
Alison Anderson, The Ohio State University, USA
Johnathan Chisam, The Ohio State University, USA
Samantha Chrin, The Ohio State University, USA

ABSTRACT
This study explores the impact of STEM Learning Ecosystems (SLE) on the chemistry identity formation of undergraduate students in introductory chemistry courses. Using ethno-methods to analyze survey responses, interviews, and observations, the research highlights how unequal access to resources and support systems affects student outcomes, offering practical implications for creating more inclusive and supportive educational environments that promote equity in STEM education.

Delving into the challenges and opportunities in STEM education, particularly in diverse and underrepresented contexts

Strand 4: Science Teaching — Middle and High School (Grades 5-12): Characteristics and Strategies

24-Mar-25, 3:15 PM-4:45 PM

Location: Baltimore 4

Stand-Alone Paper

Exploring Students' Information Sources, Interests, and Perceptions on COVID-19 in a Rural US High School

Sahar Alameh*, University of Kentucky, USA
Anna Hoover, University of Kentucky, USA
Savannah Tucker, University of Kentucky, USA
Rebecca Smith, Adair County High School, USA

ABSTRACT

This study investigates public high school students' information sources, interests, and perceptions about COVID-19 and the pandemic in a rural area of the south-central United States. Data from 83 high school students were collected in Spring 2023, early in the post-pandemic period. This research examines how students gather information about COVID-19 and explores the relationship between these sources and their knowledge and perceptions of COVID-19 and the pandemic. Additionally, we assess how students' interests in virology align with their science curriculum. Results indicate that students frequently rely on governmental agencies, healthcare professionals, and mainstream media for information about COVID-19, while less frequently on sources like internet personalities and teachers. Preliminary findings also show a relationship between the information sources students use and their perceptions of COVID-19. The study further reveals a strong interest among students in understanding the biology of viruses, treatment options, and the origins of COVID-19. However, gaps exist between these interests and the coverage of related topics in their current school science curriculum. This research highlights the need for educational strategies that better align with students' interests, particularly in the context of public health crises, to enhance their scientific literacy and engagement.

Stand-Alone Paper

Rural Middle Schools' Design and Implementation of STEM Career and Community Connected Project-based Learning Units

DeNae Kizys*, University of Sout Carolina, USA
Christine Lotter*, University of Sout Carolina, USA
Rachel Gilreath, University of Sout Carolina, USA
Lucas Perez, University of Sout Carolina, USA
Dodie Limberg, University of Sout Carolina, USA
Angela Starrett, University of Sout Carolina, USA

ABSTRACT
Teachers often lack professional development in effectively integrating science, technology, engineering, and mathematics (STEM) careers into their instruction, and collaboration between teachers and school career counselors is infrequent and undervalued, especially in rural areas. A southeastern university partnered with rural middle schools to implement a year-long professional development program for science and mathematics teachers to foster collaboration and improve teachers' project-based learning instruction and students' career development. This case study examined two educator teams' experiences and challenges in implementing project-based learning units, which included local community and STEM career connections. The study was guided by two research questions: 1) How did the team's project-based learning unit implementations reflect key project-based learning design elements? 2) How did the teams integrate local community assets and STEM careers into their project-based learning units? Data included observation videos of the multiple-week units evaluated through an observation rubric and video content coding, teacher reflection journals, and post-implementation educator interviews. The teams showed varied implementation levels of PBL design elements, but effectively integrated local community assets and STEM careers into their units to engage students in science and mathematics content.

Stand-Alone Paper

Place-Based Learning and Career Interest in STEM: Joint Consideration of STEM Interest, Identity, and Demographics

Guan Saw*, Claremont Graduate University, USA
Kimberly Megyesi-Brem*, Claremont Graduate University, USA
Ryan Culbertson, Texas Tech University, USA
Paola Rosenberg*, Claremont Graduate University, USA

ABSTRACT
This study examines the relationship between place-based learning and career interest in STEM, as well as the mediating effects of STEM interest and identity, and the moderating effects of gender, race/ethnicity, college generation, and socioeconomic status (SES). A series of structural equation modeling (SEM) analyses with a diverse sample of 953 middle/high school students show that place-based STEM learning is positively related to STEM career interest, and the relationship is stronger for Hispanics/Latines, Asians, and students from low-SES families, compared with their White and high-SES counterparts, respectively. Our data also show that the relationship between place-based learning and career interest in STEM is fully mediated by STEM interest, and partially mediated by STEM identity. Our multigroup SEM results indicate that the mediating effect of STEM interest on the relationship between place-based STEM learning and STEM career interest is stronger for Hispanics/Latines, Asians, potential first-generation college students, and youth from low-SES families, compared with their White, potential continuing-generation college, and high-SES peers, respectively. Taken together, our study findings offer novel insight into the heterogeneity effects of place-based STEM education, and the demographic differences in motivational pathways by which place-based STEM learning influences STEM career interest of adolescents.

Stand-Alone Paper

Understanding Experiences of a Science Teacher Teaching Precollege Engineering Design Course: Challenges, Strategies, and Recommendations

Assad Iqbal*, Purdue University, USA
Adam Carberry, The Ohio State University, USA
Medha Dalal, Arizona State University, USA

ABSTRACT

This study investigates the experiences of a high school science teacher who implemented a pre-college engineering design course in an all-girls classroom at a high school in [State Name]. Through a single case study approach, we explore the challenges encountered and strategies used to overcome those challenges, by the teacher who lacked formal engineering training but taught the curriculum designed to introduce students to engineering design. The research involved classroom observations, post-lesson interviews, and the specific teacher responses in a focus group discussion. Findings reveal that while the teacher initially struggled with confidence due to inexperience and time constraints, she effectively employed strategies such as differentiated instruction and peer support to address these challenges. The hands-on nature of the curriculum engaged students, although balancing the pace for a mixed-grade class proved difficult. Support from school administration and community partners was crucial in fostering a positive learning environment. The study underscores the importance of community support, professional development, and flexible curriculum design in enhancing pre-college engineering education. The insights gained provide actionable recommendations for improving curriculum implementation and teacher preparation in similar educational contexts.

STEM Career Development and Retention

Strand 5: College Science Teaching and Learning (Grades 13-20)
24-Mar-25, 3:15 PM-4:45 PM
Location: Magnolia 3

Stand-Alone Paper

A National Social and Academic Support Program: STEMM Career Choice and Retention

Or Shav-Artza*, Technion—Israel Institute of Technology, Israel
Shahaf Rocker Yoel, Technion—Israel Institute of Technology, Israel
Yehudit Dori, Technion—Israel Institute of Technology, Israel

ABSTRACT

Due to the global shortage of professionals in science, technology, engineering, mathematics, and medicine (STEMM), a comprehensive study examined the career trajectories of Social and Academic Support Program (SASP) graduates. This initiative focuses on bridging social and economic disparities, emphasizing STEMM fields. The research utilized

Social Cognitive Career Theory (SCCT) and the Theory of Justice as theoretical frameworks. The methodology involved surveying data from 4,905 graduates and analyzing 215 questionnaire responses. The study aimed to identify factors influencing and supporting individuals from underrepresented groups in pursuing higher education and STEMM careers. Results revealed that 89% of SASP graduates are employed in STEMM-related fields, underscoring the program's effectiveness. The research highlighted the significant role of financial support, particularly in aiding women and individuals from underrepresented communities. These findings provide valuable insights for policymakers and educators in designing and promoting initiatives like SASP. Such programs are crucial for engaging youth from peripheral areas to pursue STEMM careers, addressing professional shortages, and fostering diversity. The study also explored factors such as self-efficacy, academic performance, national service, and voluntary and social activities, emphasizing the multifaceted approach needed to support underrepresented groups in accessing STEMM education and careers.

Stand-Alone Paper

Exploring the Relationship between STEM Graduate Teaching Assistants Perceived Teaching Autonomy and Pedagogical Discontentment

Alyssa Freeman*, Middle Tennessee State University, USA
Beari Jangir, Middle Tennessee State University, USA
Marco Said, Middle Tennessee State University, USA
Chelsea Rolle, Middle Tennessee State University, USA
Kadence Riggs, Middle Tennessee State University, USA
Grant Gardner, Middle Tennessee State University, USA

ABSTRACT

Many universities in the United States heavily rely on graduate teaching assistants (GTAs) to teach introductory courses and laboratory sections. As such, GTAs have a large impact on the learning of undergraduate students and could influence student retention in the STEM disciplines. Prior research has indicated the importance of considering an individual's perceptions of their teaching environment to support their use of evidence-based teaching practices. In this explanatory mixed methods study, we were specifically interested in GTAs' perceptions of their self-efficacy (confidence for teaching), pedagogical discontentment (dissatisfaction with one's teaching practices), and autonomy (control over what and how an instructor teaches). Survey data was used to explore the role teaching autonomy has on GTAs' pedagogical discontentment and self-efficacy, as well as the differences in these variables between STEM disciplines. Correlation coefficients indicated that GTAs who tended to report lower perceptions of autonomy also tended to report higher perceptions of pedagogical discontentment. Interviews further showed that the classroom environment can influence GTA's perceptions of self-efficacy and pedagogical contentment.

Stand-Alone Paper

Teaching Beyond Tenure: The Role of Identity in STEM Faculty's Instructional Choices

Sule Aksoy*, CUNY Graduate Center, USA

ABSTRACT
Many empirical studies on the factors associated with the faculty's decision to adopt evidence-based instructional practices have examined the individual and contextual characteristics. However, little attention has been afforded to STEM faculty's professional identities about their classroom practices as STEM teachers. Our goal is to examine the demographic differences for instructional practices and professional identity and the link between teacher identity and reform-based teaching practices. We collected data through Postsecondary Instructional Practices Survey (PIPS) and Professional Identity Survey (PIDS). A sample of 135 STEM instructors was recruited to participate in this study, with faculty and graduate teaching assistants self-reporting data. Independent t-test, ANOVA, and correlational analysis were conducted to determine demographic differences and the relationship between identity and practice. Significant differences in teacher-identity scores were found between graduate instructors and the faculty. We also found that pre-tenured faculty reported lower scores for the teacher-identity factor. Further analysis showed a positive correlation between teacher identity and the use of reform-based instructional practices. The results presented and implications of these findings demonstrate a potential link between identity formation and practices. Future work includes the need for ongoing research to study the interplay of identity and practice.

Stand-Alone Paper

Examining Post-Lesson Conversations of STEM Undergraduate Faculty Instructional Change Teams: What Makes Them (Un)Productive?

Josie Melton*, Western Washington University, USA
Dustin Van Orman, Western Washington University, USA
Daniel Hanley, Western Washington University, USA
Sophie Westermann, Western Washington University, USA
Abbey Gray, Western Washington University, USA
Makayla Wilson, Western Washington University, USA

ABSTRACT
The use of professional learning communities to improve instruction in higher education institutions is becoming more common, yet little is known about the factors that contribute to productive collaboration in these contexts. As part of a larger project to embed student-centered and equitable instruction in undergraduate STEM courses, six groups of 3-4 participants conducted nine peer observations of lessons and debrief conversations to support each other's learning and practice. Groups met prior to the observation to share learning and instructional goals, took notes during the lesson, and met after the observation to debrief the lesson—using a guide for each step. Nine debrief conversations were audio recorded and qualitatively analyzed to learn more about the content of the conversations and how groups interacted throughout the conversation. Findings indicate that more collaborative conversations were those in which the instructor and the observer(s) took up similar 'airtime' and included less instances of advising, wherein observers told the instructor what they should do. Groups whose conversations included unequal airtime and higher rates of advising were often composed of observers with higher institutional or departmental

status than the instructor, which may have contributed to a more advisory or evaluative tone. Implications are provided.

Equity and Social Justice in Teacher Education

Strand 7: Pre-service Science Teacher Education
24-Mar-25, 3:15 PM-4:45 PM
Location: Baltimore 1

Stand-Alone Paper

Starting with the Problem: Preservice Elementary Teachers' Ideas for Teaching a Social Justice Science Issue

Jessica Bautista*, University of Michigan, USA

ABSTRACT

Science is often perceived as an objective, apolitical, and static body of knowledge, rather than a set of practices for understanding how and why the world works. Teaching science through social justice science issues (SJSIs) can both facilitate a more complex and nuanced understanding of science while supporting children to recognize how science can be a tool to either oppress or push against injustice. Integrating science and social justice, however, can be challenging for early career teachers, and particularly elementary teachers. For this qualitative study, five preservice elementary teachers grappled with how they might advise a colleague to teach science through one social justice science issue—a train derailment in a nearby state. In foregrounding an SJSI for a hypothetical lesson, teachers shared affordances and challenges to this work, illuminating and exploring three boundaries: (1) boundaries of what counts as science; (2) boundaries of one's own knowledge; and (3) boundaries of one's role as a teacher. I discuss implications for teacher education programs, with specific emphasis on supporting teachers to engage in transdisciplinary work and their own critical reflection.

Stand-Alone Paper

Creating a Critically White Practice-Based Science Teacher Education

Jonathan McCausland*, Iona University, USA

ABSTRACT

This paper details how one teacher preparation program blended practice-based teacher education and critical whiteness pedagogy to prepare White science teachers to be more equitable in their teaching practice. By using storytelling as method, this paper describes how interns participating in a secondary science programpracticed equitable science teaching by grappling with race, created nuance around equitable science teaching, and addressed white supremacy as they worked to teach equitably. By merging practice-based science teacher education with critical whiteness pedagogy I argue that White interns had numerous opportunities to take risks around, think deeply about, try out, and take responsibility for engaging in more equitable forms of science teaching. Finally, this paper

joins ongoing efforts in science education to address inequities in science education by articulating critically white practice-based science teacher education as a way to prepare White interns to teach science in more equitable ways.

Stand-Alone Paper

Conceptualizing a framework for culturally nurturing science teacher identity

Khanh Tran*, Purdue University, USA
Lynn Bryan, Purdue University, USA
Jenna Gist*, Purdue University, USA

ABSTRACT

In school science, culturally sustaining science teachers have sought to enculturate young learners to recognize, accept, and value scientific practices in learning science. Yet, they may not consider the cognitive negotiation and harm of traversing a culture that contradicts their intellectual livelihood. To be culturally sustaining in science education would mean equal shares of power, epistemological values, and knowledge production. However, we argue that the field is not ready for a culturally sustaining science education, and assuming such a possibility without attending to reality would do our historically marginalized students and their communities a disservice. This roundtable presentation explores the development of a conceptual framework for cultivating a culturally nurturing science teacher identity, drawing on research on culturally nurturing/sustaining pedagogies and science teacher identity. We illustrate essential tenets that onto-epistemologically align with culturally nurturing pedagogy as well as practices science teacher educators could draw on, which include: (a) locating students' onto-epistemologies; (b) developing epistemic care; (c) fostering courageousness; (d) cultivating a critical pedagogy of place; and e) co-generating a movement towards liberation. We contend that this framework will guide teachers to become more justice-oriented in their teaching practices, which will subsequently empower students in science learning.

Insights on Preservice Teachers' Teaching and Learning practices

Strand 7: Pre-service Science Teacher Education
24-Mar-25, 3:15 PM-4:45 PM
Location: Baltimore 2

Stand-Alone Paper

Pre-Service Teachers' Conceptions of Critical Thinking and Inquiry

Steffen Wagner*, Humboldt-Universität zu Berlin, Germany
Burkhard Priemer, Humboldt-Universität zu Berlin, Germany

ABSTRACT

The study explores how pre-service primary school science teachers (PPSSTs) perceive critical thinking (CT) and inquiry within an inquiry-based learning (IBL) environment. Recognizing CT as essential in education, the research focuses on how these teachers' conceptions of CT

evolve. The study involved 13 PPSSTs participating in a 7-day physics-focused seminar designed within an IBL framework. The intervention included hands-on experiments, explicit instruction, and reflective activities to foster CT. The research utilized word association tests to assess changes in participants' conceptions of CT and inquiry before and after the intervention. Results showed that participants' associations shifted from general cognitive processes to more discipline-specific and metacognitive elements. For instance, "measurement uncertainties" and "reflection" became more central in their understanding of CT, while "creativity" emerged as a key association in inquiry. The study concludes that targeted IBL environments can significantly enhance PPSSTs' conceptions of CT and inquiry, leading to a deeper and more nuanced associative image of these crucial educational concepts. However, the research acknowledges limitations, including the short-term nature of the intervention and the need for further assessment of long-term impacts and competency gain.

Stand-Alone Paper

'They find answers on their own": Novice Teachers' Trajectories for Teaching for Scientific Sensemaking

Patricia Bills*, Oakland University, USA
Amber Bismack, Oakland University, USA

ABSTRACT

Teaching for scientific sensemaking is central to helping learners develop robust scientific arguments and explanations. However, it is a challenging skill for novice teachers to learn, especially in elementary classroom contexts where little time is devoted to focused science learning. This study uses longitudinal qualitative case study methodology to examine how novice teachers learn to teach for sensemaking in elementary classrooms. The learning of four elementary teacher education candidates were studied from the beginning of their coursework in a mid-sized Mid-Western teacher education program through their first year of teaching. Data sources include transcribed interviews and videos of teaching. Each interview and teaching video was coded for scientific sensemaking ideas and pedagogical moves using both open coding anda prioricodes derived from research. Results showed that novice teachers possessed early skills in teaching for scientific sensemaking, but developed more varied and more complex pedagogical moves over time. Additionally, some pedagogical moves were more consistent over time than others. Results offer initial insights into novice teachers' trajectories for teaching for scientific sensemaking over time that can inform research on teacher education and teacher learning for sensemaking writ large.

Stand-Alone Paper

Transforming Biology Teacher Education: Fostering Reflective Skills and Research Competence through Inquiry-Based Learning

Pauline Sommerer*, Institute for Biology Education, University of Cologne, Germany
Nadine Großmann, Institute for Biology Education, University of Cologne, Germany
Jörg Großschedl, Institute for Biology Education, University of Cologne, Germany

ABSTRACT
This study examines the impact of Inquiry-Based Learning (IBL) on fostering reflective skills and research competence in the affective-motivational domain (e.g. research-related tolerance of complexity) among pre-service biology teachers. These skills are essential for teachers, to critically evaluate and innovate their teaching practices. To support the development of these skills, extended practical phases in teacher education, offer a valuable context for IBL by linking theoretical knowledge with practical application. A quasi-experimental study was conducted with 41 preservice biology teachers at a German university. The experimental group received immediate feedback on their teaching activities, which they used in their research projects, while the control group did not receive feedback and conceived research projects independently. Preliminary results show no significant differences between the groups concerning the constructs assessed in the affective-motivational domain, intrinsic motivation, and perceived stress. However, a significant decrease in research-related tolerance of complexity was observed across both groups. The analysis of written reflections on teaching activities is ongoing and may offer further insights into IBL's effectiveness in bridging the gap between theory and practice. Only results from the first cohort are currently available. The results, including another cohort surveyed next semester, will be presented at the conference.

Stand-Alone Paper

Enhancing Scientific Literacy in Distance Elementary Education: A closeup on Pre-Service Teacher Beliefs and Practices

Keren Dagan*, Technion, Israel
Dina Tsybulsky, Technion, Israel

ABSTRACT
This phenomenological study investigated the beliefs of 10 pre-service elementary science teachers about synchronous distance science education and its impact on fostering students' scientific literacy. The aim was to better understand how beliefs shape practice in this context and to provide insights for addressing challenges in synchronous distance science education. Data collected using semi-structured interviews, reflective reports, and portfolios were analyzed using Interpretive Phenomenological Analysis. The findings revealed that pre-service teachers reported both positive and negative experiences when teaching synchronous distance science education. The challenges included managing online classes, engaging students, and fostering effective scientific discourse while struggling to adapt traditional teaching practices to this environment. The benefits included peer and pedagogical instructor support, which fostered a sense of belonging and confidence. The findings indicate that pre-service teachers' beliefs regarding synchronous distance science education are complex and often conflicted. Future research and teacher education should address the hurdles of adapting traditional practices to a synchronous distance context, given the importance of human connections and effective communication to foster student engagement and scientific literacy.

Professional Development and Resource Utilization for Early Career STEM Educators

Strand 8: In-service Science Teacher Education
24-Mar-25, 3:15 PM-4:45 PM
Location: Annapolis 3

Stand-Alone Paper

Emotional Resilience Narratives in New Science Teachers' Lessons: Delineating Emotion-Attuned Science Instruction

Ella Yonai*, University of Georgia, USA
Elizabeth Ayano, University of Georgia, USA
Jose Pavez, Western Illinois University, USA
Lisa Borgerding, Kent State University, USA
Shannon Navy, Kent State University, USA

ABSTRACT

Science is exciting, frustrating, and socially driven. However, research on science teaching often overlooks teacher-student social interactions in the classroom, the emotions they induce, and their impact on teachers' instruction and student learning. This study explores the interplay between new science teachers' emotional resilience, their interactions with students, and the implementation of science instruction. Twenty-one new science teachers from high-need schools participated in the study over two years. Data were collected by recording teachers' lessons at three different time points each year and conducting stimulated recall interviews shortly after each lesson about teachers' resilience and specific classroom events. Qualitative coding was used to distill the three constructs of interest (i.e., emotional resilience, teacher-student interactions, science instruction). Narratives were developed from the codes and video recordings by analyzing each teacher's six lessons longitudinally. Results revealed rich connections between the constructs and highlighted the complexity of navigating emotions and instruction in the science classroom. The study describes new science teachers' successes and challenges in teaching science while drawing on emotional resilience to manage their own and their students' emotions, providing emotion-attuned science instruction.

Stand-Alone Paper

'Foundational knowledge is paramount": Early Career Science Teachers Use of Personal Resources

Adepeju Prince*, Kent State University, USA
Shannon Navy, Kent State University, USA

ABSTRACT

Early career science teachers (ECST) rely on resources to navigate the transition into a new professional context and provide effective science instruction to students. Previous studies have identified teachers' reliance on personal, social, and material resources (Lee et al., 2016). This qualitative study focuses on ECSTs' perception of personal resource use and how they

utilize them to overcome challenges in science teaching. Nine ECSTs were purposefully selected from high-needs schools from three regions of the United States. Findings revealed that ECSTs start the school year with few personal resources and use multiple personal resources concurrently throughout the school year. Additionally, there are differences in what ECSTs consider essential personal resources based on teaching experience. While teachers within the first two years of teaching considered personal resources on self-awareness and student knowledge essential, teachers with three to five years of teaching experience found knowledge of science content and instructional strategies more important.

Stand-Alone Paper

Early Career Science and Mathematics Teachers' Access to and Use of Resources Over Two Years

Robert Idsardi*, Eastern Washington University, USA
Emily Hamada, Eastern Washington University, USA
Shannon Navy, Kent State University, USA
Lisa Borgerding, Kent State University, USA
Julie Luft,University of Georgia, USA
Ella Yonai, University of Georgia, USA

ABSTRACT

Early career science and mathematics teachers are vulnerable to attrition. To lower attrition rates, some schools provide early career teachers with social, material, and/or human resources. This study describes the resources that early career science and mathematics teachers in high needs schools have access to and use over two academic years. This quantitative observation study was framed by the Conservation of Resources theory. Participants included 24 early career science and math teachers. Teachers reported their access to and use of social, material, and human resources through electronic surveys at the beginning, middle, and end of the 2022-2023 and 2023-2024 academic years. We examined whether teachers' access and use of resources changed within and across the academic years, and we used a hierarchical cluster analysis to identify patterns of resource use. Teachers' access to resources increased from Year 1 to Year 2, but their use of resources did not change over time. We identified different groups of teachers that varied in their use of resources, with some using resources substantially more than others. This study provides a detailed description of resource use of early career teachers and includes discussion on supporting preservice and early career teachers.

Stand-Alone Paper

Novice Secondary Teachers' Developing Beliefs about Project-Based Learning

KARTHIGEYAN SUBRAMANIAM*, University of North Texas, USA
Mila Rosa Carden*, University of North Texas, USA
Chris Long, University of North Texas, USA
Pamela Esprívalo Harrell, University of North Texas, USA
Marlon Harris, University of North Texas, USA
Ruthanne Thompson, University of North Texas, USA

ABSTRACT
The purpose of this study was to identify novice teachers' beliefs about their implementation of and instruction with Project-Based Learning (PjBL) in authentic secondary science and mathematics classrooms in their first school placements as teachers of record. Teachers' beliefs are one of the key determinants in their decision-making for using teaching practices and how to teach. Investigating beliefs contributes to the knowledge base related to the progressive development of PjBL in K-12 classrooms. Analysis of data from two focus group interviews revealed two themes capturing participants' developing beliefs about project-based instruction: (a) beliefs about how students learn with PjBL implementation, and (b) beliefs about instruction with PjBL implementation. Implications include the need to conceptualize a complex perspective of PjBL from school and classroom contexts, and to move away from conceptualizing PjBL as a set of procedures that conform to classroom practices.

Teacher Identity and Emotional Dynamics in Science Education Practice

Strand 8: In-service Science Teacher Education
24-Mar-25, 3:15 PM-4:45 PM
Location: Magnolia 2

Stand-Alone Paper

The role of leveraging emotions in elementary science teachers making changes to practice

Andrea Phillips*, Indiana University, USA

ABSTRACT
Teaching involves extensive emotional labor. The act of making changes to practice through professional development programs brings about both positive and negative emotions. This study aimed to understand how teachers leverage emotions toward beneficial changes in practice. Findings show that teachers leveraged their positive emotions through contagious positivity (student excitement increases their own excitement and desire to plan for science teaching), further investment in science teaching, and willingness to try new things. Teachers leveraged their negative emotions through higher vigilance in science planning and persisting through negative emotions to try new things and learn from teaching experiences. These findings inform the design and implementation of professional development programs regarding attending to and acknowledging teacher emotion. Specifically, understanding how teachers leverage their positive and negative emotions as they change their practice informs our abilities to support them through the emotional nature of changing practice and to improve teacher experience.

Stand-Alone Paper

Latent Profiles of U.S. Science Teacher Identities

Xiufeng Liu*, University of Macau, China
Jennifer Tripp, University at Buffalo, USA

ABSTRACT
Previous research on science teacher identity is mostly qualitative, with findings of limited generalization and comparison across cases, settings, and time; there is a need for quantitative research, particularly studies using large-scale national data sets, to understand general patterns of science teacher identity. This study used a large, nationally representative sample of science teachers in the U.S. We conducted latent profile analysis to identify prevalent profiles of science teachers in terms of their science teacher identities and examined differences in these profiles according to various characteristics. We found that there were two dominant profiles among U.S. science teachers. Profile 1 had 155 teachers (42.4%), and Profile 2 had 211 teachers (57.6%). Profile 1 science teachers may be described as having low social utility motivation and below average teaching practices, job satisfaction, and self-efficacy, while Profile 2 science teachers may be characterized as having high social motivation and above average teaching practices, job satisfaction, and self-efficacy. The two profiles are associated with differences along teacher demographics and educator preparation program elements, including gender, whether teaching was their first career choice, and science-specific pedagogy training in teacher education. The above findings have implications for teacher education recruitment and programming.

Stand-Alone Paper

Investigating Science Leadership Professional Identity

Jennifer Bateman*, University of Georgia, USA
Brooke Whitworth, Clemson University, USA
Golnaz Arastoopour-Irgens, Vanderbilt University, USA

ABSTRACT
District Science Coordinators (DSCs) play crucial roles in science education, yet their professional identity remains unexplored in the literature. This study addresses this gap by investigating the professional identity of DSCs, building upon existing frameworks from the science and teacher leadership domains.Data included interviews with DSCs in various districts and contexts to gain insight to the diversity of this role. Quantitative Ethnography is used to visualize the competence, performance, and recognition of the participants to understand how DSCs perceive themselves and are perceived by others in their professional roles. Findings suggest recognition is linked to the title DSCs hold and understood by others. Overall, this research contributes to understanding the operationalization of competence, performance, and recognition in shaping DSCs' professional identities, and how others view them.

Stand-Alone Paper

Embodied Praxis: How Teacher Identity Influences Instruction

Heather Shaffery*, University of Oklahoma, USA

ABSTRACT
The continued success of Next Generation Science Standards (NGSS) and three-dimensional (3D) pedagogy requires teachers to adopt these into their classroom practice. To understand

why science teachers choose to implement reform measures in their classrooms requires that we learn about these complex people and how they engage with 3D pedagogy. However, science education literature operates under an implicit assumption that all teachers will teach three-dimensionally eventually. Given that teacher identity informs classroom decisions and reform adoption, insufficient knowledge of the individuals responsible represents a significant gap in our understanding, with potential consequences for science education reform success. The perspective of teacher identity promises insight into the adoption of 3D pedagogy; however, it is often explored within a narrow definition of identity, rather than a holistic view of the complex person. To better understand pedagogical choices requires a broader view of teachers. This session presents results from a study examining how two middle school teachers represent their complex personal identities in their instruction. Using a combination of interviews, reflections, and classroom observation, vignettes were constructed to re-present the teachers' stories through the lens of their identities. The relationship between teachers' identities and how that influenced each of their classrooms is discussed.

Innovative Approaches for Developing Science Curriculum and Assessment

Strand 10: Curriculum and Assessment
24-Mar-25, 3:15 PM-4:45 PM
Location: Magnolia 1

Stand-Alone Paper

Implementing Grand Challenges in Middle School Classrooms: A Case Study of Innovative Curricula Implementation

Rebecca Lesnefsky*, University of North Carolina, USA
Natasha Segal, Weizmann Institute of Science, Israel
Zhen Xu, University of North Carolina, USA
Nannan Fan, University of North Carolina, USA
Heewoo Lee, University of North Carolina, USA
Shira Passentin, Weizmann Institute of Science, Israel
Keren Dalyot, Weizmann Institute of Science, Israel
David Fortus, Weizmann Institute of Science, Israel
Troy Sadler, University of North Carolina, USA

ABSTRACT

In response to the growing emphasis on addressing global socio-scientific issues like climate change and viral pandemics in K-12 education, we designed three socio-scientific units for middle school science. We call this curriculum Grand Challenges (GC). The GC curriculum shifts from traditional methods to a focus on socio-scientific issues resonating locally and globally, preparing students for future complexities. GC is a response to the evolving landscape of science education, which emphasizes transformative, future-focused approaches that engage students with science content through contextualized, disciplinary practices. This study explores the implementation of the GC curriculum by two teachers,

highlighting their choices and the impact on instruction. The findings reveal the crucial role of teachers in actualizing innovative curricula, the challenges of adopting new practices, and the need for robust support systems. This work contributes to understanding how to effectively integrate socio-scientific issues into science education, fostering critical thinking and global citizenship among students.

Stand-Alone Paper

'You get to tinker with your brain": Middle school students' perspectives on three-dimensional, phenomenon-driven assessments

Cari Herrmann-Abell*, BSCS Science Learning, USA
Clarissa Deverel-Rico, BSCS Science Learning, USA
Patricia Olson, BSCS Science Learning, USA
Chris Wilson, BSCS Science Learning, USA

ABSTRACT

In response to reform efforts to center students' interest and identity in the context of assessment, we pilot tested a set of three-dimensional, phenomenon-driven assessment tasks and asked students to respond to additional items that prompted them to reflect on their experience with the tasks. Overall, most students agreed with Likert scale statements about whether they (1) used prior disciplinary knowledge, (2) approached the task as a scientist would, and (3) wanted to learn more about the topic. Preliminary grounded coding of students' written response to what they liked about the tasks has surfaced the following themes: Use of multimodal representations (e.g. images), had a scenario/backstory, was directly applicable to them or real life, allowed for multiple ways of demonstrating understanding, provided opportunities to think and share ideas, allowed use of prior knowledge/skills, andincluded an interesting topic. Additionally, students provided suggestions for ways in which the tasks could be improved, including reducing the number of words and improving the drawing tool. We hope that our findings help add to the ongoing conversations around developing assessments that better cohere with current science education reform efforts to shift assessment towards being more equitable and meaningful for students.

Stand-Alone Paper

Designing Three-Dimensional Assessment Tasks for Classroom Formative Assessment

Alexander Paulchell*, University of Arizona, USA
Malissa Hubbard*, University of Arizona, USA
Mingfeng Xue, University of California, Berkeley, USA
Kristin Gunckel, University of Arizona, USA
Linda Morell, University of California, Berkeley, USA
Mark Wilson, University of California, Berkeley, USA

ABSTRACT

Three-dimensional learning frameworks that intertwine disciplinary core ideas (DCIs), crosscutting concepts (CCCs), and science and engineering practices (SEPs) require

multidimensional assessment tools to support teachers in tracking student progress. However, assessment items that measure all three dimensions at once may make it challenging for teachers to identify and respond to the source of student challenges as they progress in their science learning. This poster examines how a unidimensional item on a three-dimensional task can provide teachers with information about classroom-level trends and individual student thinking to inform future instruction. The focus assessment task, Life Zones (LZ), assessed participating middle school students on the DCI of natural resources and human impacts, the CCC of patterns, and the SEP of argumentation, targeting dimensional skills with a broad effect on student thinking. Findings suggest that formative assessments with unidimensional items provide teachers with (a) classwide trends showing strengths and stretches by dimension and (b) individual student response data that highlights student thinking by ability level. This type of formative assessment data can help teachers move beyond the ingrained, didactic ideas of right and wrong and towards the development of more sound scientific reasoning.

Stand-Alone Paper

Scripted Curriculum in the Science Classroom

Maizie Dyess*, University of Nevada, Las Vegas, USA
Burak Sahin*, University of Nevada, Las Vegas, USA
Katherine Wade-Jaimes*, University of Nevada, Las Vegas, USA

ABSTRACT

This study analyzes the experiences of elementary and middle school teachers using a mandatory scripted science curriculum in a large, urban school district. The prevalence of scripted curricula in United States public schools is rapidly expanding while rooting itself in comprehensive school reform, high-stakes testing initiatives, and remediation of inequities (Rigell et al., 2022; Narayanan et al., 2023). While some schools and districts encourage teachers to adapt the curriculum, others are pressured and required to adopt it (Fitz Nikolaidis, 2019). Whether administration decides to adapt or adopt has a large impact on teachers' perceptions of the curriculum, with adapting teachers appreciating the structure of the curriculum and phenomenon ideas, while adopting teachers feel like their autonomy has been taken away (Timberlake et al., 2017; Fitz Nikolaidis, 2019). Without the ability to select content, scripted curriculums can rob teachers of their ability to meet the needs of their students. The diverse cultural makeup of today's classrooms makes it unlikely that one scripted curriculum will meet the needs of all learners (Ede, 2006). Curriculum needs to be flexible enough for teachers to construct lessons that are relatable to their students, and engage them in creating knowledge and building critical-thinking skills (Ede, 2006).

Critical Science Consciousness: A Framework and Applications Across Science Teachers, Teacher Educators, and Researchers

Strand 11: Cultural, Social, and Gender Issues
24-Mar-25, 3:15 PM-4:45 PM
Location: Azalea 1

Symposium

Critical Science Consciousness: A Framework and Applications Across Science Teachers, Teacher Educators, and Researchers

Megan Walser*, Michigan State University, USA
Kate Miller, Michigan State University, USA
Sinead Brien, University of South Carolina Upstate, USA
Lenora Crabtree, University of North Carolina Charlotte, USA
Nick Confer, Washington-Liberty High School, USA
Nicole Hefty, West Ottawa High School, USA
Taylor MacKenzie, Waverly High School, USA
Andrea Nguyen, Macatawa Bay Middle School, USA

ABSTRACT

Many scholars have argued that it is essential for teachers to develop critical consciousness of systems of power and how they relate to schools (e.g., Freire, 1970/2000). However, this alone is not sufficient for enacting social justice science teaching; teachers also need to develop critical consciousness of their discipline (e.g., Mutegi et al., 2022) – referred to as ''critical science consciousness'' (CSC) (Author 4, 2021). In this symposium, secondary science teachers, teacher educators, and education researchers discuss perspectives on CSC. We begin by presenting our conceptualization of CSC, outlining three facets. Then, five secondary science teachers present findings from self-studies and lead a discussion connecting their CSC development, teaching practice, and the CSC framework. Next, four secondary science teacher educators/researchers share findings, including methods to support and research science (pre-service and novice) teacher CSC development. These presentations are followed by a discussion guided by attendee questions. After the discussant provides closing remarks, we invite attendees to join us as a community of critical scholars interested in continuing the conversation about CSC.

Teachers' Approaches to Indigenizing STEM Education through Instructional Practice and Curriculum

Strand 11: Cultural, Social, and Gender Issues
24-Mar-25, 3:15 PM-4:45 PM
Location: Annapolis 4

Symposium

Teachers' Approaches to Indigenizing STEM Education through Instructional Practice and Curriculum

Kathryn Gardner-Vandy*, Oklahoma State University, USA
Jillian Cicek, University of Manitoba, Canada
Rebekah Hammack*, Purdue, USA
Mishack Gumbo, University of South Africa, South Africa
Noelani Puniwai, University of Hawai'i at Mānoa, USA
Julie Robinson, University of North Dakota, USA
Rif'ati Handayani, University of Jember – Indonesia, Indonesia
Beth Covitt, University of Montana, USA
Leena Kanandjebo, University of Namibia, Namibia
Faustina Kashinauua, University of Namibia, Namibia

ABSTRACT

Diversifying the voices and perspectives of those participating in STEM experiences, discourse, and fields will ensure that challenges are faced with creativity, conscience, and an awareness of those most impacted. Integrating Indigenous knowledge with Western STEM can revitalize relationships with the natural world, cultural identity, and histories that can inform future approaches. However, classrooms at all levels continue to present STEM from a Western lens that decontextualizes concepts and learning from relevant and culturally-situated knowledge. This lack of cultural orientation results in barriers to participation for Indigenous students because the learning and content is disconnected from their values, understandings, and assets. Educators who provide inclusive STEM learning experiences implement strategies such as: 1) connecting concepts to the land, place, and community interests; 2) inviting in members of the local cultural community; 3) integrating disciplines; 4) using storytelling, art, and observation; 5) honoring all elements within a place as sacred; 6) connecting to local traditional knowledge, and 7) centering STEM within critical consciousness, policy, and improvement. Presentations in this session will highlight the work of teachers across a variety of educational contexts and regions of the world who are using such approaches effectively to embed Indigeneity into STEM instruction.

Student Performance in STEM Education

Strand 12: Technology for Teaching, Learning, and Research
24-Mar-25, 3:15 PM-4:45 PM
Location: Baltimore 5

Stand-Alone Paper

Utilizing Eye Tracking Data to Monitor the Impact of Multimedia Learning Content on Student Performance

Muhammad Rehman*, University of Florida, USA
Do Hyong Koh, University of Florida, USA
Christine Wusylko, University of Florida, USA
Priya Prasad, University of Florida, USA
Xiaoman Wang, University of Florida, USA
Pavlo Antonenko, University of Florida, USA
Kara Dawson, University of Florida, USA
Albert Ritzhaupt, University of Florida, USA
Jonathan Martin, University of Florida, USA
Ellen Martin, University of Florida, USA

ABSTRACT

There is limited research on how differences in working memory capacity and media integration strategies influence learning with multimedia (Mayer, 2014; Wiley et al., 2014). Most research on improving multimedia learning has focused on material design, neglecting the mediating effects of learners' individual differences on multimedia learning processes and outcomes (Plass et al., 2010). Adapting multimedia learning based on individual differences is unexplored, which is problematic because this approach could transform the learning experience for individuals who may be highly motivated but have differences in working memory capacity and media integration strategies (Andresen et al., 2019). In this study, we utilized the novel eye-tracking technology to explore media integration strategies used by learners and to monitor the impact of multimedia learning content on learners' performance. Specifically, we examined how undergraduate students' multimedia learning performance was impacted by verbal and visuospatial working memory capacity when studying geoscience using text and images. This research study is a part of a National Science Foundation grant that aims to design and test the usability and feasibility of a gaze-driven adaptive multimedia learning solution based on the effective multiple media integration strategies used by individuals with differences in working memory capacity.

Stand-Alone Paper

Impact of Computing-STEM Curriculum on University Students' Computer Programming Self-efficacy, Understanding, and Problem-Solving Performance

Shu-Fen Lin*, National Changhua University of Education, Taiwan
Dong-Ke Huang, National Changhua University of Education, Taiwan

ABSTRACT
This study aimed to examine the effects of a computing-STEM curriculum on university students' self-efficacy of and learning achievement of computer programming, and problem-solving performance. To improve students' understanding of computer programming, two real-world projects, designing a smart parking lot and a coin machine, were designed with BBC micro:bit programming and Gigo robotics. Twelve students completed a 6-hour full course, and 9 took the 3-hour beginning course. Before and after their participation, participants were recruited to complete two instruments, the Computer Programming Self-Efficacy Scale (CPSES) and the Computer Programming Learning Achievement test. Participants' self-assessment and difficulty records for each task and videotape recorder were collected. The results showed that the curriculum could significantly improve the CPSES scores of participants without block programming learning experience to approach those with block programming learning experience. The curriculum significantly improved the participants' computer programming self-efficacy and computer programming learning achievement in the completed course. Moreover, the five subscale CPSES scores of 12 participants improved significantly after the course. The two teaching strategies of demonstration and explaining code verbally could improve students' understanding of computer programming. The majority of participants were able to build a coin machine that classified, identified, and counted coins.

Stand-Alone Paper

Fostering Scientific Creativity in Health-Allied STEM Students Using the Contextualized General Physics Courseware Package

Fredyrose Ivan Pinar*, De La Salle University, Philippines
Lydia Roleda, De La Salle University, Philippines

ABSTRACT
Scientific creativity is a critical yet often overlooked aspect of education, especially within the health-allied sciences, where students face unique challenges. These include misconceptions about science's difficulty, the struggle to relate scientific concepts to real-world applications, and an emphasis on rote memorization over creative problem-solving. Additionally, there is a lack of hands-on experimentation and inquiry-based learning opportunities. This study evaluates the efficacy of a Contextualized General Physics Courseware Package (CWP) in enhancing scientific creativity, conceptual understanding, engagement, and motivation among Grade 12 health-allied STEM students. Using a concurrent mixed-methods approach, the research involved 200 participants and employed instruments like the Physics Motivation Questionnaire (PMQ) and the Scientific Creativity Test (SCT). Results showed significant improvements in students' physics understanding, engagement, and motivation, and scientific creativity, particularly through health science applications. The study highlights the importance of integrating contextual and interactive learning strategies to foster student motivation and engagement, offering valuable insights for educators and curriculum designers in developing relevant and effective educational materials.

Stand-Alone Paper

Exploring the Potential of STEM Media Read-Alouds

Lauren Shea*, American University, USA

ABSTRACT

STEM picture book read-alouds can encourage students to explore science content, facilitate cognitive and affective engagement with literacy and science, and broaden access to STEM content. Currently, educators use a multitude of media STEM read-alouds, however much remains unknown about how children can learn from and/or become engaged in the presented STEM content. This research examines how children learn from a media-based program featuring diverse STEM professionals digitally reading-aloud STEM-focused picture books. Through a mixed-methods study, we uncover benefits of media STEM read-alouds to engage young children from low-income communities who disproportionally lost over a year of STEM instruction over the pandemic. Suggestions for using media read-alouds to address educational inequalities in STEM teaching and learning are reviewed.

Climate Change Action

Strand 14: Environmental Education and Sustainability

24-Mar-25, 3:15 PM-4:45 PM

Location: Baltimore 3

Stand-Alone Paper

The Knowledge and Action Intentions of Tomorrow's Citizens in Facing the Climate Change Challenge

Oshra Aloni*, The Weizmann Institute of Science, Israel
Ornit Spektor-Levy, Bar Ilan University, Israel
Orit Ben Zvi Assaraf, Ben Gurion University of the Negev, Israel
Yael Shwartz, The Weizmann Institute of Science, Israel
Anat Yarden, The Weizmann Institute of Science, Israel

ABSTRACT

The Mediterranean region has been identified as a climate change "hotspot". Weather extremes have detrimental socio-economic and ecological impacts. Climate literacy is one of the foundations for well-informed citizens that will take actions for adaptation and mitigation measures. This study sought to ask: What do 9th-grade students know about climate change? To what extent they are willing to adopt pro-environmental behaviors? In what ways does knowledge about climate change affect the willingness to adopt pro-environmental behavior? To what extent are there gender differences in the level of knowledge and the willingness to engage in pro-environmental behavior? The study encompassed 476 ninth-grade students, 266 girls (55.9%), and 22 (4.6%) respondents opted not to disclose their gender. A two-part Likert-type questionnaire was adopted from Sinatra et al. (2012) and adjusted to middle-school students and the Mediterranean region. Findings

revealed a positive correlation between knowledge and intentions to act, although students demonstrated significantly higher levels of knowledge than their intentions to act. Girls exhibited significantly higher intentions toward pro-environmental behavior compared to other genders. This may raise questions about the effectiveness of current climate change education in promoting pro-environmental behaviors and the need to design learning materials that address the diversity of students.

Stand-Alone Paper

Localizing Climate Change Education: Impacts on Student Knowledge and Agency in High School Science Classrooms

Jeffrey Snowden*, BSCS Science Learning, USA
Emily Harris, BSCS Science Learning, USA
Lindsey Mohan, BSCS Science Learning, USA

ABSTRACT

This study examined the impact of localized climate change education units on high school students' environmental science agency. Using a quasi-experimental design, teachers implemented both business-as-usual (BAU) and localized climate change units across two years. The localized units incorporated locally relevant climate issues while maintaining a standardized core curriculum. Data was collected using assessments of climate change knowledge, science identity, roles and expertise in science, and foundations for change. Mixed-effects models revealed that students who experienced the localized units showed significant gains in climate change knowledge and foundations for change compared to the BAU condition. While positive trends were observed, effects on science identity and roles/expertise were not statistically significant. Analysis of pre-existing climate change attitudes indicated that students with higher initial awareness or concern demonstrated greater improvements in their readiness to engage with climate solutions. The study suggests that supporting teachers in adapting climate change units for local contexts can enhance student knowledge and agency, potentially offering a scalable and equitable approach to climate change education. This research contributes to understanding effective climate education strategies and introduces environmental science agency as a framework for evaluating climate change learning outcomes.

Stand-Alone Paper

A Cross-Cultural Study Comparing Turkish and Indonesian Preservice Science Teachers' Orientations towards Climate Change

Osman Aksit, Bogazici University, Turkey
Gaye Ceyhan, Bogazici University, Turkey
Rita Hagevik*, University of North Carolina – Pembroke, USA
Nejla Yürük, Gazi University, Turkey
Betül Alatlı,Balıkesir University, Turkey
Sabri Kocakülah, Balıkesir University, Turkey
Emine Adadan, Bogazici University, Turkey
Sedat Uçar, Cukurova University, Turkey
Ebru Muğaloğlu, Bogazici University, Turkey

Laura Wheeler, Brigham Young University, USA
Hartono Hartono, Sriwijaya University, Indonesia
Rita Inderawati, Sriwijaya University, Indonesia
Sofendi Sofendi, Sriwijaya University, Indonesia
Pelin Aksüt Arslan, Bolu Abant Izzet Baysal University, Turkey
Kathy Trundle, Utah State University,

ABSTRACT
This cross-cultural study aimed to describe and compare Turkish and Indonesian preservice science teachers' (PSTs) cognitive and affective orientations towards climate change since both Türkiye and Indonesia have long been experiencing the adverse impacts of climate change. The participants included a total of 885 PSTs from Türkiye (n=536) and Indonesia (n=349). The International Climate Change and Civic Engagement Survey, which had Cronbach's alpha scores ranging from .88 to .74, was used. Results showed that around 50% of the PSTs from each country had completed at least one course on environmental issues at college. There was a distinct difference between the Turkish (40%) and Indonesian (75%) PSTs self-assessed knowledge of climate change, stating that they knew "enough" about climate change. Furthermore, Indonesian PSTs exhibited significantly lower levels of uncertainty about climate change, encompassing both disinterest in the topic and skepticism about its anthropogenic causes. In terms of epistemic beliefs, Turkish PSTs perceived climate change knowledge as more simplistic and were less likely to attribute climate change knowledge to scientists compared to Indonesian PSTs. Lastly, Indonesian PSTs reported higher levels of both ecocentric and anthropocentric attitudes towards the environment. This research includes the discussion of results and the implications for science education.

Stand-Alone Paper

Diverse Roles of Environmental Educators: Science Content Experts, Professional Development Providers, Environmental Advocates, and Mentors

Hamza Malik*, Lloyd Center for the Environment, USA
Stephen Witzig*, University of Massachusetts Darmouth, USA
Rachel Stronach*, Lloyd Center for the Environment, USA

ABSTRACT
Environmental educators are frontline workers who hardly get acknowledgment for educating people (especially children) about environmental issues. These educators interact with students and teachers across different programs, i.e., professional development workshops, classroom projects, field trips, etc.For this research study, I collected data (September 2022 to December 2023) from three environmental educators from a local environmental education center called the Dale Center for Environmental Education (pseudonym). Three semi-structured interviews were conducted as a primary data source with each participant. Additional secondary data sources included observations, documents from Dale Center for the Environment (DCE) education programs, newsletters, websites, teacher packets, and informal conversation notes. The data analysis methods included a constant comparative method and a hybrid inductive and deductive coding approach.The findings are organized around four assertions, each situated within the primary constructs of

the study - environmental educators, in-school and out-of-school settings, and environmental education centers as 1) Environmental educators are science content experts for students and teachers, 2) Environmental educators are science content professional development experts, 3) Environmental educators operate as environmental advocates through educational outreach, and 4) Environmental educators are mentors for the next generation. This study has implications for science education research, practice, and professional development.

Implementing Science Education Reform: Understanding Stakeholder Perspectives, Roles, and Factors

Strand 15: Policy, Reform, and Program Evaluation
24-Mar-25, 3:15 PM-4:45 PM
Location: Camellia 1

Stand-Alone Paper

A spotlight on science education in Australian early childhood teacher qualifications

Cristina Guarrella*, The University of Melbourne, Australia
Caroline Cohrssen, University of New England, Australia
Naomi Lilley, The University of Melbourne, Australia

ABSTRACT

Australia's national Science, Technology, Engineering and Mathematics (STEM) education agenda highlights the importance of science education in the early years before school. Yet, the guiding documents for Australian early childhood curricula and practice continue to lack systematic integration of science teaching and learning. There is similarly limited guidance for the integration of science in accreditation documents for early childhood initial teacher education (ITE). This research aims to investigate how limited guidance in policy documents may influence the incorporation of science in ITE programs across Australia. A social research audit of publicly accessible course handbooks was used to understand how science is positioned within Australian early childhood ITE programs, focusing on when, how and to whom these are delivered. Findings suggest that preparation to teach science is highly variable, ranging along a continuum from none at all, through exposure to science within an integrated STEM or TEAM subject, to the development of discipline-specific science pedagogical content knowledge. This variability has implications for future research, policy and practice which are discussed to support NARST members to reflect on how this research could be adapted to their context to understand connections between policy and the positioning of science in ITE.

Stand-Alone Paper

The Grand challenges Project in Middle Schools: Principals as Adopters and Leaders of Reform Curricula

Keren Dalyot*, Weizmann Institute of Science, Israel

Troy Sadler, University of North Carolina Chapel Hil, USA
David Fortus, Weizmann Institute of Science, Israel

ABSTRACT

The Grand Challengesproject integrates various established research streams in science education, with a primary goal to overcome obstacles identified in previous studies and pioneer curriculum reform in middle school classes.The current study is part of an internationalresearch projectwitha range of research foci, looking at both student and teacher level. Here we focus on school principals' perceptions and attitudes to complement our understanding ofthechallenges and successes in implementing such a broadand ambitiousreform curriculum. We interviewed the principals from the three participating schools.As administrators of the school, the principals were cognizant of their role as mediators between national policy level demands and expectations, and their need to ensurethat theirteacherswere supported. At the same time, they were aware of the importanceofengaging the students and maintaining their interest in science. The study contributes to underscoring the critical role of school principals as mediators in the complex process of implementing education reforms. It highlights the need for a balanced approach that considers several factors: external policy demands, internal dynamics within schools, as well as the principals' own background and attitudes to drive successful reform initiatives.

Stand-Alone Paper

Exploring the Nexus of Teaching and Research Productivity in a Research-Intensive University among STEM Faculty

Anna Kye*, University of California Irvine, USA
Brian Sato, University of California Irvine, USA
Kameryn Denaro, University of California Irvine, USA

ABSTRACT

This study investigates the relationship between research and teaching productivity among STEM faculty at a research-intensive university. Utilizing data from 553 STEM faculty members focusing on four STEM units - Biological Sciences, Engineering, Information and Computer Sciences, and Physical Sciences, we applied cluster analysis and logistic regression to explore how productivity metrics correlate with faculty demographics such as position type, rank, gender, and discipline. Our analysis identified distinct productivity clusters that exhibit varying degrees of research and teaching outcomes across different faculty demographics. Findings indicate significant disparities in productivity profiles, underscoring the need for university policies that effectively support teaching and research to enhance faculty success. This research contributes to a more nuanced understanding of faculty roles and informs strategies for efficient and equitable institutional resource distribution and faculty development and evaluation. By highlighting the complex interplay between teaching and research productivity, the study offers valuable insights for enhancing faculty support systems and ultimately, advancing institutional missions in STEM education.

Graduate Student Forum
24-Mar-25, 4:45 PM-6:15 PM
Location: Cherry Blossom Terrace

Social Event
Jennifer Bateman, University of Georgia, Athens, USA

ABSTRACT
The Graduate Student Forum hosts round table discussions, which focus on topics important to graduate students. This year will be a NEW format and will allow for more discourse between graduate students. We hope you will make connections with other peers, find common ground in struggles and have meaningful conversations.

Poster Session
24-Mar-25, 4:45 PM-6:15 PM
Location: Cherry Blossom Ballroom

Strand 1: Science Learning: Development of student understanding
Poster
Modeling as an Approach to Encourage Moral Deliberations during SSI Decision-Making
Jamie Elsner*, University of North Carolina at Chapel Hill, USA
Zhen XU, University of North Carolina at Chapel Hill, USA
Eric Kirk, University of North Carolina at Chapel Hill, USA
Laura Zangori, University of Missouri, USA

ABSTRACT
Socioscientific Issues (SSI)-based instruction can promote moral character development such as feelings of responsibility, conscience, and care for addressing the issue. In particular, SSI decision-making requires students to consider moral conflicts and weigh the benefits and drawbacks of possible solutions, which we contend is an essential skill for scientific literacy. To support science learning which incorporates students' personal values and morals as well as scientific knowledge, we design an instructional approach to help students reason about an SSI with the goal of proposing a policy recommendation to resolve the issue. In this study, we engage middle school students in multiple modeling tasks to scaffold the SSI decision-making process. We examine the values students express while negotiating an SSI related to a viral disease outbreak (e.g., social responsibility, money, risk reduction) and analyze how the modeling activities encourage moral deliberations. For example, one student group considers the outcomes of two policy options—one policy has greater financial consequences versus another which has greater health consequences—and must make a

moral judgment on which policy would be the better choice. We find that modeling supported students in making these kinds of moral decisions and discuss in the paper implications for practice.

Strand 1: Science Learning: Development of student understanding
Poster

Unlocking Interdisciplinary Insights and Understandings on Carbon Cycling Through Topic Modeling

Hyesun You*, The University of Iowa, USA
Minju Hong, University of Arkansas, USA
Seungho Maeng, Seoul National University of Education, Korea, Republic of

ABSTRACT

Natural phenomena and their corresponding scientific issues inherently cross multiple disciplines within the natural sciences. Students therefore must engage in various scientific subjects to understand these phenomena and their associated problems. In this study, we explored the epistemological foundation of students' interdisciplinary understanding of carbon cycling using structured topic modeling. We analyzed theresponses of 556 college students to five constructed response items on an interdisciplinary science assessment and revealed various types of interdisciplinary understanding. These included knowledge from single scientific disciplines and combinations of two or more science disciplines.Even within the same constructed response items, students demonstrated different varieties of interdisciplinary understanding. Additionally,we observed significant differences in the integration of diverse science disciplines (e.g., biology, chemistry) among gender, grade classification groups, and number of science courses. The variety in interdisciplinary understanding in the student responses was a significant predictor of their performance in interdisciplinary assessment.Examining interdisciplinary connections among clusters of science disciplines offers valuable insights into a wide range of curricular and instructional methods in interdisciplinary science education.

Strand 1: Science Learning: Development of student understanding
Poster

Fostering Students' Understanding of Ecosystems and Metamodeling Knowledge

Jinzhi Zhou*, Indiana University, USA
Qiuyu Lin, Rutgers University, USA
Zach Ryan, Indiana University, USA
Cindy Hmelo-Silver, Indiana University, USA
Joshua Danish, Indiana University, USA
Ravit Duncan, Rutgers University, USA
Clark Chinn, Rutgers University, USA

ABSTRACT

Modeling practice is helpful for developing conceptual understanding, yet its potential to enhance metamodeling knowledge remains underexplored. This study aims to support 6th-grade students in understanding ecosystems and metamodeling knowledge, particularly

criteria for evaluating models, through a model-based inquiry unit. We engaged students in constructing, evaluating, and revising models, with scaffolded peer critique activities. Pre- and post-test analysis from two classes (n=45) revealed statistically significant improvements in overall scores. Content analysis showed enhanced understanding of ecosystem dynamics and increased awareness of using scientific criteria and providing constructive feedback during model evaluation. Our findings demonstrate the effectiveness of modeling practice in teaching complex concepts and metamodeling knowledge. We highlight the communicative aspects in modeling, especially the importance of balancing scientific criteria with constructive critique, providing insights for designs that support students' engagement in modeling practice.

Strand 1: Science Learning: Development of student understanding
Poster

Exploring the role of the body in supporting mechanistic reasoning

Genelle Diaz-Silveira*, Boston University, USA
Eve Manz, Boston University, USA

ABSTRACT

This proposal presents a case exploring how embodied learning can support children to engage in mechanistic reasoning and in what ways embodiment can support students communication and co-construction of causal explanations. The case is drawn from a second-grade classroom in which children used a fan to investigate whether certain seeds travel by wind. We trace the development of the classs explanation of maple seed flight through the lens of one student. As the case unfolds, we see gesture and interaction with physical materials helping students to reason mechanistically by marshaling appropriate sensorimotor resources and serving as a gestural model for them to collaboratively and iteratively refine. We also find that pointing and representational gestures can support students communication by serving as a discursive tool that does not depend on mastery of scientific language. Our findings lend support to the existing literature about the importance of embodiment in cognitive processes associated with developing explanations.

Strand 1: Science Learning: Development of student understanding
Poster

Learning How the Respiratory System Works Through Scientific Modeling in Early Childhood

Dulce González Ramírez, Instituto Superior de Investigación y Docencia para el Magisterio, Mexico
Silvia Ramos De Robles, University of Guadalajara, Mexico
Verónica Pérez Serrano Flores*, Universidad Panamericana, Mexico

ABSTRACT

The research analyzes the scientific modeling processes developed by early childhood children when studying the respiratory system model. The sequence of scientific modeling was made up of 13 activities that begin by recovering the children´s ideas of breathing and then develop experiments andscaled and interactive modelswhere the respiratory system, its

components and functions are represented. We propose school scientific modeling as a constant dynamic ofsensemaking process. Methodologically, our perspective is interpretive. Our data comes from video recordings, drawings, and students´ work. The methods implemented to analyze interaction, and images were conversational analysis and compositional interpretation were respectively.Children´s ideas show that while 60% of students associate breathing with the nose, mouth or lungs, 40% associate it with elements such as blood, mind-brain and stomach. They do not identify breathing as a process of exchange but as "something" composed of independent elements (body and air-wind-oxygen). After the modeling activities, students are able to understand the rest of the organs involved in breathing, their name and their functions. Nonetheless, although some alternative ideas remain, the models built at the end of the sequence were more complete and more complex.

Strand 1: Science Learning: Development of student understanding
Poster

Fostering Scientific Practices Through Critique: The Impact of Structured Peer Feedback on Ninth-Grade Students

SaeYeol Yoon*, Delaware State University, USA
Nurcan Keles, Dicle University, Turkey
Claudia Aguirre-Mendez, Emporia State University, USA
Brian Hand, University of Iowa, USA

ABSTRACT

This study examines how structured argumentative activities within a peer feedback environment can enhance learning outcomes in science education. The research involved 95 fourth and ninth-grade students participating in an argument-based inquiry (ABI) approach guided by the Science Writing Heuristic (SWH). Ninth graders designed experiments, analyzed findings, and wrote reports for a younger audience. Fourth graders provided structured, scaffolded critiques of these reports, which the ninth graders used to revise their work. The study found a significant overall improvement in ninth-grade students' writing scores, from pre- to post-intervention, across content knowledge, argumentation, rhetoric, and multimodal representation categories. Researchers found the "yes/no" component of critiques (identifying the presence or absence of target ideas) was significantly correlated with the "description" and "interpretation" components of critique, as well as overall post-writing scores. The study highlights that argumentative activities, integrated within structured peer feedback environments, facilitate deeper cognitive processing and improve understanding of scientific concepts. Researchers suggest that educators create learning environments that prioritize both peer critique and argumentation as central to the instructional process. They also recommend educators implement training programs that guide students in providing specific, constructive feedback, with a focus on clarity and depth.

Strand 1: Science Learning: Development of student understanding
Poster

The Pathways to Quantum Immersion Program

Jessica Rosenberg*, George Mason University, USA

Nancy Holincheck*, George Mason University, USA
Benjamin Dreyfus, George Mason University, USA
Xiaolu Zhang, George Mason University, USA
Gen Konowe*, South Lakes High School, USA
Iamen Ibrahim, Forest Park High School, USA
Nathan D'Cruze, Richard Montgomery High School, USA

ABSTRACT

The Pathways to Quantum Summer Immersion Program introduced high school students to key quantum concepts and careers through a 4 component program: (1) a two-week virtual program focused on teaching basic quantum concepts, (2) a one-week in-person experience in which students build on their understanding of the quantum key concepts and visit research labs, companies engaged in quantum, and an organization focused on quantum policy, (3) an optional follow-up in which students create a poster on their vision of future uses for quantum, and (4) an optional (additional application required) extended research experience in quantum. This poster explores students' knowledge of quantum concepts and careers before they enter the Quantum Immersion program and the changes to their knowledge and interest through their participation in these components. We examine these changes in the context of social cognitive career theory and how the students' development of academic and career goals is mediated by their developing' self-efficacy and academic and career expectations. We find that the combination of conceptual understanding, seeing others in these roles, working with peers to develop their knowledge and understanding, and improving their expectations all contribute to an increase in students' knowledge and interest in quantum concepts and careers.

Strand 2: Science Learning: Contexts, Characteristics and Interactions
Poster

Exploring high school students' practical epistemology, epistemic emotions, and self-efficacy in STEM learning activities

Min-Hsien Lee, Program of Learning Sciences, National Taiwan Normal University, Taiwan
Wei-Shou Chen*, Graduate Institute of Information and Computer Education, National Taiwan Normal University, Taiwan
Chia-Ching Lin, Graduate Institute of Science Education & Environmental Education, National Kaohsiung Normal University, Taiwan
Yen-Yuan Chen, Department & Graduate Institute of Medical Education & Bioethics, National Taiwan University, College of Medicine, Taiwan

ABSTRACT

Given the critical importance of STEM learning in the field of science education, this study investigates how students' practical epistemology is associated with their epistemic emotions, which are related to their self-efficacy in STEM learning. A total of 155 students from 10th and 11th grades across three different high schools in Taiwan participated in this study. The hypothesized model of this study was proposed through a literature review and was examined using partial least squares structural equation modeling (PLS-SEM) technique. The results reveal that students' beliefs about the transferability of scientific knowledge and

their capacity for argumentation and negotiation with peers are crucial factors that shape their emotional experiences and self-efficacy in STEM knowledge. Positive epistemic emotions, such as enjoyment and curiosity, mediate these relationships, underscoring the importance of fostering mature epistemic beliefs and positive emotional experiences in STEM learning. This study suggests the potential benefits of fostering mature practical epistemic beliefs and positive emotional experiences in STEM learning activities. By encouraging practical epistemology and addressing negative emotions, educators may enhance students' self-efficacy and attitudes toward STEM learning, thereby potentially improving their engagement and success in STEM fields.

Strand 2: Science Learning: Contexts, Characteristics and Interactions
Poster

Predictors of intention to donate stem cells to leukemia patients among young students

Julia Holzer*, University of Bremen, Germany
Doris Elster, University of Bremen, Germany

ABSTRACT

This study investigates factors influencing students intention to donate stem cells to leukaemia patients. As a theoretical framework an extended model based on the Theory of Planned Behaviour (TPB) is used, the TPB+ model. TPB+ model includes motivational internal factors of TPB, and selected external factors such ascontent knowledge,moral obligation,moral reasoning andempathy. Based on TPB+ the teaching unit Wake up - sensitisation for stem cell donation is developed and conducted with 263 10 to 12-graders from German high schools. The research questions are: (1) Which factors have a significant influence on the intention to become a stem cell donor? (2) To what extent do the measured constructs of TPB+ change among non-intenders and intenders, after participation in the teaching unit? The participants complete a questionnaire in a pre-post-design. The data are analysed with t-tests and regression analyses. The findings demonstrate that the TPB+ model permits an accurate prediction of intention. In addition, the teaching unit influences significantly some factors (e.g. negative attitude) as well as the intention for stem cell donation. To sum up, for closing the knowledge-behaviour gap it is recommended to consider the mentioned factors when developing teaching units in context of health education.

Strand 2: Science Learning: Contexts, Characteristics and Interactions
Poster

Responsive Instruction Engagement in Science Practices: A Systematic Review of Pedagogical Strategies in Biology Education

Niki Koukoulidis*, University of Florida, USA
Julie Brown, University of Florida, USA

ABSTRACT

This systematic literature review examined pedagogical strategies used to engage multilingual learners in NGSS science practices within secondary and undergraduate biology

education. Using the Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) protocol, we screened and reviewed 20 empirical studies published since 2013. Teacher practices were coded using a protocol for culturally and linguistically responsive instruction, and student engagement in science practices was analyzed using the IONIC protocol. Our findings focus on strategies such as hands-on inquiry and multimodal communication, which were shown in studies to significantly enhance engagement in science practices and foster meaningful learning experiences. We found that responsive instructional elements like translanguaging and affirming identities were commonly employed in biology classrooms, reinforcing the connection between language support and science practice engagement. While acknowledging the limitations of our review, we highlight the need for future research to further align biology education practices with best practices for multilingual learners' language acquisition and participation in scientific practices. This study informs educators and researchers about effective strategies to support multilingual learners, promoting their success in biology education and scientific literacy.

Strand 2: Science Learning: Contexts, Characteristics and Interactions
Poster

Instructional Supports and Contexts for Enhancing the Level of Scientific Argumentation among Elementary Students

Hoon Jeong*, Department of Science Education, Seoul National University, Korea, Republic of
Soo-Yean Shim, Department of Science Education, Seoul National University, Korea, Republic of

ABSTRACT

This research investigates the effects of Teacher-mediated conditions (TMCs) on enhancing levels of scientific argumentation among elementary students in small group. A 9-lesson unit was developed focusing on argumentation about "What will happen to the ecosystem if bees disappear?" Video recordings of the entire classroom, small-group activities, and class outputs were collected and qualitatively analyzed. The results revealed that TMCs acted not in isolation but in combination, serving as scaffolds that either "expanded the breadth of ideas discussed" or "deepened the depth of ideas." In Small Group 1, students were passively participating. A teacher noticed this problem and provided two types of TMCs: individual questioning and encouragement to focus on each other's ideas. These acted as scaffolds that expanded the breadth of students' ideas. This process helped students recognize conflicting opinions, provided a necessity for consensus. In Small Group 2, students were contemplating which other organisms could replace bees. The teacher encouraged students to utilize models they had learned previously and consider ideas from other groups. These TMCs acted as scaffolds that deepen the depth of their ideas by justifying and connecting ideas. This study provides insights into the effective educational strategies for enhancing scientific argumentation in small groups.

Strand 2: Science Learning: Contexts, Characteristics and Interactions
Poster

An Integrated Co-Design Framework: Applying Co-Design Across Science Education Settings

Anne Levendusky*, University of Florida, USA
Darby Drageset, University of Florida, USA

ABSTRACT

Co-design is the collaborative effort of researchers, designers, and end-users in the development of products that encompass the shared knowledge and understanding of all involved. Co-design is used across a multitude of disciplines; however, there is a lack of clarity surrounding key practices, principles, and the role of the end-user when including vulnerable populations(Moll et al., 2020). In science education research, co-design is a valuable approach because it supports the design of products that are attuned to the needs of the users, resulting in greater use(Penuel et al., 2007). Additionally, co-design can equalize the power between researchers, designers, and end-users(Raman French, 2022), empowering participants. We seek to understand how co-design is being conceptualized and operationalized in formal and non-formal science education settings with vulnerable and non-vulnerable participants. Using two pre-existing frameworks for co-design (Moll et al., 2020; Roschelle et al., 2006), we seek to identify elements of co-design that are implemented across science education research settings with vulnerable and non-vulnerable populations. The common elements of co-design are then used to generate a framework that can be used by science education researchers who are interested in conducting co-design across science education settings with a variety of participants.

Strand 2: Science Learning: Contexts, Characteristics and Interactions
Poster

Affection and cognition in science lessons at Elementary School: Discursive interactions with and about artifacts

Deborah Cotta*, Universidade Federal de Minas Gerais, Brazil
Danusa Munford, Universidade Federal do ABC, Brazil
Vanessa Neves, Universidade Federal de Minas Gerais, Brazil

ABSTRACT

This study examines relationships between emotion and cognition in processes of discursive construction of knowledge when children bring artifacts to science lessons. The research question is: How interactions with and about artifacts became resources for talking science and participating in experimentation practices? The study took place in a Brazilian public school. We followed lessons from 1stto 3rdgrade in a classroom of 25 students and their teacher, conducting participant observation and videorecording. This study focuses on an activity in 2nd grade. The research was oriented by Ethnography in Education, Microethnography and Cultural-historical Theory, with macro and microscopic analyses. At the macroscopic level, we mapped the artifacts and the contexts related to them. At the microscopic level, we analyzed the discursive interactions between the participants based on Vygotsky's unit of analysis: affection-cognition.Macroscopic analyses evidenced the importance of experimentation practices for participants over time. Microscopic analyses indicated that a bottle of acid became a cultural artifact that mediated processes of sense making. Our results indicate that the interactions with artifacts constituted social practices that reverberated in concept building and cultural development.

Strand 2: Science Learning: Contexts, Characteristics and Interactions
Poster

Epistemic Practices and Critical Thinking: Identifying Relationships Based on Chemistry Activities in a Brazilian School

Diorleno Santos, Universidade de São Paulo, Brazil
Matheus Damasceno, Universidade de São Paulo, Brazil
Lúcia Sasseron*, Universidade de São Paulo, Brazil

ABSTRACT

In this paper, we assume that critical thinking can be developed, mobilizing epistemic practices. These practices can be provided in science classes through different activities. In this study we intend to identify the epistemic practices mobilized by students when they take part in chemistry activities, and to assess the possible relationships between these practices and the development of critical thinking in these students. For this purpose, we analyzed the responses to three activities developed in a Brazilian 1st year high school class. Base on Kelly and Licona (2018) ideas, we look for possible relationships between epistemic practices and Jiménez-Aleixandre and Puig (2022) components of critical thinking: cognitive and epistemic skills. Based on the data, we observed that the students mobilized elements associated with the practices of Propose, Communication and Evaluation, which are intrinsically associated with the subjects' relationship with the processes of analysis and judgment of information, which involves processes of evaluation of evidence, construction of justifications and informed explanations, with analytical and critical rigor.

Strand 2: Science Learning: Contexts, Characteristics and Interactions
Poster

What STEM Career Explorations Reveal About Rural High School Students' Motivations Towards STEM Career Pathways

Sera Harold*, North Carolina State University, USA
Brooke Bentley, North Carolina State University, USA
Margaret Blanchard, North Carolina State University, USA

ABSTRACT

Developing high school students' interest in STEM and STEM careers has proven to be a challenge, especially for rural and minoritized populations. This study asks 189 rural high school students from seven schools in a southeastern state to choose one of more than 100 STEM careers to explore. Guided by situated expectancy-value theory, this qualitative study analyzed students' questionnaire responses. Students show high interest (60%) in their chosen careers. Students (59%) were motivated by the perceived enjoyment (intrinsic value) of the daily activities of the job, and by external goals like salary (47%), and a desire to help people, animals, and the environment (30%; utility value). Students (20%) were also concerned with the costs of education needed for many of the careers and weighed the salaries with the necessary education. Many (41%) students gained interest in their explored career during the course of their research and (60%) said that they could see themselves in that career. This study implies that high school students' interest in STEM careers can be

encouraged by emphasizing the wide array of work environments and the ability to help others.

Strand 3: Science Teaching — Primary School (Grades preK-6): Characteristics and Strategies
Poster

Lessons Learned Using ChatGPT to Create First Grade Science Lesson Plans

Wardell Powell*, Framingham State University, USA
Steve Courchesne, Framingham State University, USA

ABSTRACT

Studies have reported that Generative AI can support teachers in the lesson-planning process. However, teachers should be cautious when using Generative AI to create lesson plans. This qualitative study employed an exploratory case study design to examine a specific lesson design activity involving a series of prompts and responses from ChatGPT. The desired science lesson on heredity was aimed at first-grade students. We analyzed the process's efficiency, finding that within 30 minutes, we could generate and substantially refine a lesson plan that accurately aligned with the desired curriculum framework and the 5E model of instruction. However, the iterations of the lesson plan included questionable components, missing details, and a fake resource. We discussed the implications of these findings for faculty looking to train pre-service teachers to use generative AI in lesson planning appropriately.

Strand 3: Science Teaching — Primary School (Grades preK-6): Characteristics and Strategies
Poster

Primary and Intermediate Elementary Teacher Background and Confidence in NGSS Implementation

Laura Longo*, SUNY Stony Brook, USA
Angela Kelly, SUNY Stony Brook, USA

ABSTRACT

A solid grasp of scientific concepts and practices is crucial for teaching science at any level, yet certification standards for elementary teachers in science are often inadequate to prepare them for teaching biology, Earth science, chemistry, physics, and engineering. This study aims to assess the content knowledge, self-efficacy, and self-reported teaching practices of K-2 and 3-5 elementary teachers regarding scientific phenomena, science and engineering practices, and crosscutting concepts, six years after Next Generation Science Standards (NGSS) implementation. A survey was administered to 80 elementary teachers from grades K-5 across three school districts with varying socioeconomic backgrounds, focusing on their preparedness and confidence in science content knowledge and NGSS. Bivariate correlations indicated that graduate-level science course taking significantly related to the quality and frequency of NGSS-aligned instruction, however, there were no differences between K-2 and 3-5 teachers and their frequency of incorporating the NGSS components of phenomena, science and engineering practices, and crosscutting concepts. Additionally, self-

efficacy in teaching engineering showed the strongest correlation with the frequency of incorporating the components of NGSS for three-dimensional learning. These results suggest that elementary education requirements should include graduate-level science courses tailored for elementary teachers, and that professional development should emphasize engineering skills and design.

Strand 3: Science Teaching — Primary School (Grades preK-6): Characteristics and Strategies
Poster

Bridging the Gap: Using Literacy to Teach Quantum Concepts in Elementary Education

Jennifer Simons*, George Mason University, USA
Cindy Hamblin*, Prince William County Schools, USA
Maya Butler-Hall, Anne Arundel County Public Schools, USA
Marin Moore, Alexandria City Public Schools, USA
Chanelle Carter, Prince George's County Public Schools, USA
Nancy Holincheck*, George Mason University, USA
Stephanie Dodman, George Mason University, USA
Jessica Rosenberg, George Mason University, USA
Benjamin Dreyfus, George Mason University, USA
Xiaolu Zhang, George Mason University, USA

ABSTRACT

While quantum education has typically been the domain of university classrooms, recent declarations by the White House have placed greater importance on teaching quantum concepts in all K-12 education. This qualitative proposal follows the development and incorporation of quantum concepts into the elementary curriculum. Teachers in the project worked to find connections to their existing curriculum, especially literacy. They connected quantum concepts to fiction and created non-fiction texts for their students related to quantum concepts. This poster presentation will offer science education researchers and teacher educators an opportunity to connect with the elementary teachers who are co-authors of this study, and to consider how novel concepts like quantum can be integrated into elementary classrooms through literacy.

Strand 3: Science Teaching — Primary School (Grades preK-6): Characteristics and Strategies
Poster

A Theoretical Game-Based Model For Scaffolding Elementary Science Instruction

Rob Monahan*, North Carolina State University, USA
James Minogue, North Carolina State University, USA

ABSTRACT

This proposal presents a new pedagogical model for integrating game-based education (GBE) into elementary science curricula, focusing on the end goal of the development of 21st-century skills such as critical thinking, problem-solving, and scientific literacy. Building on

constructivist learning theory, the model outlines a tri-level approach that includes implementing modern constructivist strategies, and utilizing both serious games and gaming pedagogy to enhance content knowledge and skill development. We argue that GBE offers a powerful method for engaging students in active, experiential learning, where they can apply scientific concepts in real-world contexts. By scaffolding student learning through the use of interactive game environments and formative assessments, educators can diagnose misconceptions early and provide targeted support. The model is centered on the role of teachers in facilitating game-based education from the ground up. This work contributes to the field of science education by offering a practical, research-backed approach to incorporating games and gaming pedagogy into the classroom, ultimately aiming to better prepare students for the demands of the 21st century. The implications are significant for educators and policymakers interested in innovative teaching methods that promote equity and engagement in science learning.

Strand 3: Science Teaching — Primary School (Grades preK-6): Characteristics and Strategies
Poster

Cultivating a STEM-driven School Culture: A Librarian's Journey

Carol Waters*, University of Houston-Clear Lake, USA

ABSTRACT

Librarians play a crucial role in fostering discovery and a desire to explore new concepts. This exploratory case study examines the librarian's role in implementing STEM concepts and applications in a Texas elementary school. Focus group and interview data were analyzed and coded to identify patterns and themes. This paper focuses on the emergent themes of the (a) librarians' role in STEM education and (b) supporting a STEM-driven school culture. Findings include the librarian's creation of a professional learning network, her leadership role, and how she supported a STEM-driven school culture. The results of this study point to how school librarians can play an instrumental role in supporting teachers and students. Implications on how librarians can help create and support a STEM-driven school culture are discussed.

Strand 4: Science Teaching — Middle and High School (Grades 5-12): Characteristics and Strategies
Poster

Teaching Circuits Using the EPo Concept: Impact on Conceptual Understanding in Middle Schools

Tilmann Steinmetz*, University of Tübingen, Germany
Jan-Philipp Burde, University of Tübingen, Germany
Thomas Schubatzky, Universität Innsbruck, Austria
Verena Spatz, TU Darmstadt, Germany
Martin Hopf, Universität Wien, Austria
Claudia Haagen-Schützenhöfer, Universität Graz, Austria
Lana Ivanjek, Johannes Kepler Universität Linz, Austria
Benedikt Gottschlich, University of Tübingen, Germany

Thomas Wilhelm, Goethe-Universität Frankfurt am Main, Germany

ABSTRACT

The EPo (Electricity with Potential) project, conducted by seven physics education research groups in Germany and Austria, aims to improve middle school students' understanding of electric circuits. The project focuses on the concepts of voltage and potential, using color-coding to help students easily recognize potential differences in circuits. Based on the electron gas model, the EPo concept introduces voltage as an 'electric pressure difference', analogous to air pressure differences, before addressing electric current. Following an initial empirical evaluation, the teaching materials were refined during a second DBR cycle. This included a longitudinal study with 22 teachers and 1,144 students across southern Germany and Austria, assessing the EPo concept's learning effectiveness. Each teacher taught the topic of simple circuits to two cohorts: first using their traditional approach (control group) and the following using the EPo concept (treatment group). Conceptual understanding was measured using the 2T-SEC-Test and analyzed through Rasch data analysis. Multilevel analysis shows that the EPo concept leads to a significantly higher increase in conceptual understanding compared to traditional teaching approaches. Further analysis shows that it particularly improves students' conceptual understanding of voltage, underlining the effectiveness of the refined EPo approach.

Strand 4: Science Teaching — Middle and High School (Grades 5-12): Characteristics and Strategies

Poster

A digital and metacognitive tool to support high school students in decision making

Jana-Sabrin Blome, TU Dortmund University, Germany
Insa Melle*, TU Dortmund University, Germany

ABSTRACT

In the age of social media and fake news, it is becoming increasingly difficult for students to make reflective and rational decisions based on content knowledge. Therefore, supporting decision mak-ing is a cross-curricular task across all subjects in school. Natural sciences in particular have an important contribution to make, often involving controversial issues (e.g. climate change, renew-able energy).Against this background, we developed, implemented, and evaluated a digital metacognitive tool to support the decision-making process in chemistry classes. In this two-group intervention study, all students use a digital learning environment in the first phase to work on chemistry content. In the second phase, they formulate a written assessment, for which one group uses the tool to work with a given structure to make a decision, while the other group uses their own approach to for-mulate the assessment.As part of the study, students' decision-making skills and content knowledge were assessed before, and after the intervention. Our results show that both groups were able to significantly improve their content knowledge during the intervention. There is also some evidence that the tool improves decision-making skills.

Strand 4: Science Teaching — Middle and High School (Grades 5-12): Characteristics and Strategies
Poster

Remember, Recall, Retain: Unleashing the Power of CTCA in Computer Studies

Deborah Agbanimu, National Open University of Nigeria, Nigeria
Peter Okebukola*, Lagos State University, Nigeria
Juma Shabani, University of Burundi, Burundi
Franklin Onowugbeda, Lagos State University, Nigeria
Esther Peter, Lagos State University, Nigeria
Adekunle Oladejo, Lagos State University, Nigeria
Olasunkanmi Gbeleyi, Lagos State University, Nigeria
Ademola Ibukunolu, Lagos State University, Nigeria

ABSTRACT

Unlocking the full potential of education hinges on improving student retention, particularly in STEM subjects. Although the widespread recognition of the importance of education has paved the way for too many approaches to teaching and learning, the limitations of these approaches have led to a search for innovative methods that better support student knowledge retention. This study investigated the effectiveness of the culturo-techno-contextual approach (CTCA) in enhancing knowledge retention among junior secondary school students, focusing on flowcharts and algorithms. The sample comprises 185 computer studies students. The study employed a quasi-experimental research design. The experimental class had 103 subjects while the control group had 82 subjects of junior secondary school 3 computer studies students in Lagos State, Nigeria. Quantitative data were collected through achievement tests with acceptable instrument measures. The experimental group was taught using culturo-techno-contextual approach while the control group had their learning experiences through the lecture method. Results indicated significantly higher retention scores (mean 15.78) among students taught with CTCA compared to traditional methods (mean 7.54) (F = 145.21, p .05). These findings underscore the CTCA's efficacy in enhancing learning retention, particularly in complex topics like flowcharts and algorithms, offering implications for culturally embedded STEM education.

Strand 4: Science Teaching — Middle and High School (Grades 5-12): Characteristics and Strategies
Poster

The Data Fluency Framework for Teaching: A Conceptual Model of Teacher Knowledge for Data-Rich Instruction

Nicole Wong*, WestEd, USA
Rasha Elsayed, WestEd, USA
Leticia Perez, WestEd, USA
Corynn Del Core, WestEd, USA
Kirsten Daehler, WestEd, USA

ABSTRACT
This paper introduces the Data Fluency Framework for Teaching (DFFT), a model that outlines the knowledge, skills, and beliefs necessary for STEM teachers to foster data fluency among middle school students.Data fluencyis the ability and confidence to make sense of and use data. There is an increasing emphasis on data fluency in K–12 education, but there is a gap in teacher preparedness for such instruction. In response, we propose the DFFT as a tool for providing (a)school and district leaderswith a coherent roadmap of teachers' needs; (b)STEM teacherswith guidance for planning instruction; and (c)developers and researcherswith a common language for structuring and studying professional learning and classroom resources.The DFFT is a model that depicts intersections among four knowledge bases that teachers draw from when supporting their students' data fluency: technology, pedagogy, data, and the STEM domain. The full paper includes a description of each knowledge base and presents vignettes illustrating their practical application in teaching and professional learning. This work contributes to more equitable data learning in STEM classrooms by making explicit the types of teacher knowledge, skills, and beliefs that contribute to robust data learning.

Strand 4: Science Teaching — Middle and High School (Grades 5-12): Characteristics and Strategies
Poster

Science teachers understanding of interdisciplinary teaching

Tiina Naissoo, Tallinn University, Estonia
Priit Reiska*, Tallinn University, Estonia
Birgit Soosalu, Tallinn University, Estonia

ABSTRACT
This paper explores the implementation and challenges of interdisciplinary teaching in science education. With increasing global challenges requiring a broad range of expertise, interdisciplinary approaches are crucial for developing students' problem-solving skills and understanding. The study reviews existing models of interdisciplinary teaching and introduces a new model that includes dimensions such as learning organization, preparation, and process. An empirical study involving 53 Estonian science teachers assessed their understanding of interdisciplinary teaching and identified key methods and obstacles. Teachers frequently mentioned collaboration, practical learning, and connections as vital aspects, while also facing challenges related to time constraints, curriculum scope, and lack of support. The study found that teachers rate their skills in interdisciplinary methods and artificial intelligence lower compared to other competencies. The results indicate that while effective methods like discussions are commonly used, there is room for incorporating a wider range of teaching strategies. The article underscores the need for better resources, support, and professional development to enhance interdisciplinary teaching. Addressing these needs is essential for preparing students to tackle complex, interdisciplinary problems in the future. Further discussion of these findings will be presented at the conference.

Strand 4: Science Teaching — Middle and High School (Grades 5-12): Characteristics and Strategies
Poster

Deliberative argumentation to improve the understanding of climate change in a group of secondary students

Pablo Escobar, Pontificia Universidad Católica de Valparaíso, Chile
Claudia Vergara, Universidad Alberto Hurtado, Chile
Antonia Larrain, Universidad Alberto Hurtado, Chile
Hernan Cofré*, Pontificia Universidad Católica de Valparaíso, Chile

ABSTRACT

This study aimed to describe the knowledge and alternative conceptions of climate change in a group of 101 secondary school students aged 15-18 years from Chile before and after deliberative argumentation instruction. The study used a quantitative approach with a quasi-experimental designwith 3 experimental and 1 control group, in which a Climate Change Questionnaire previously validated was applied. In the experimental groups, the teacher applied a unit of 6 lessons of 80 minutes each including 6 activities in which deliberative argumentation about controversial issues in CC were included. The results demonstrated that the whole group of students had a low knowledge about climate change, presenting alternative conceptions, such as confusion about greenhouse gases, solar radiation, and the false relationship between ozone layer thinning and the greenhouse effect, but after instruction, all experimental groups improve their knowledge in a significant way. Although students improved their knowledge of the human effect on CC, the greenhouse effect, the albedo effect, and the carbon cycle, alternative conceptions of ultraviolet rays and the hole in the ozone layer persisted in most students after instruction. This is the first research work about teaching CC from Latin America) therefore, it is an original contribution to NARST.

Strand 4: Science Teaching — Middle and High School (Grades 5-12): Characteristics and Strategies
Poster

Food and Cooking: Inclusive Methods to "Do Science" and Draw on Student Assets

Kate Strangfeld*, Harvard University, USA
Pia Sörensen, Harvard University, USA

ABSTRACT

This study investigates the use of food and cooking to teach science in grades 6-12. Food is uniquely positioned to address needs in secondary science education by providing opportunities for teachers to facilitate (1) inclusive science instruction that leverages student assets, and (2) activities and labs that emphasize "doing science" and real-life applications of science. We developed and assessed the impact of a curriculum-based professional learning program centered on a series of food-based lessons. A total of 56 teachers from 25 states participated by attending a workshop in the summer. Teachers were then encouraged to implement lessons and engage throughout the school year through Zoom meetings. Data were collected to assess teachers' attitudes about using food and cooking to teach science

and to evaluate whether the program addressed the needs listed above. Data sources included surveys administered pre-program, post-workshop, and post-implementation, as well as interviews.Findings showed that 1) teachers were interested in using food as a pedagogical tool and saw it as a way to address existing challenges, but were limited by barriers like subject matter content knowledge and a lack of high-quality instructional resources 2) the program addressed both existing needs and barriers.

Strand 5: College Science Teaching and Learning (Grades 13-20)
Poster

Sharing Our Stories: Fostering Belonging in STEM Classrooms Using a Personal Narrative Activity

Melissa Zwick*, Stockton University, USA
Ally Hunter, Landmark College, USA

ABSTRACT

Incorporating inclusive teaching practices into STEM higher education is essential for fostering a classroom environment where all students feel valued and supported. This study examines the effectiveness of a personal narrative and STEM trajectory activity designed to promote inclusivity from the start of the academic term. The activity, grounded in the Critical-Inclusive Pedagogy (CIP) framework, aims to enhance both intrapersonal and interpersonal awareness among students by encouraging them to share their personal identities and STEM experiences. We implemented the activity across various undergraduate and graduate biology courses, employing a mixed-methods survey approach to assess students' sense of belonging and comfort with sharing their identities. Findings reveal that students generally felt a sense of belonging and inclusion, particularly during small group discussions, though there was lower comfort reported in sharing with the larger class. This aligns with the tenets of CIP and supports the broader integration of critical and social justice pedagogies into STEM education. This study underscores the need for STEM faculty to adopt inclusive practices and highlights the potential of such activities to positively impact classroom dynamics and student engagement.

Strand 5: College Science Teaching and Learning (Grades 13-20)
Poster

Exploring The Relationship Between Self-Efficacy And Teaching Approach In Graduate Teaching Assistants

Cody Smith*, Missouri State University, USA

ABSTRACT

Graduate teaching assistants (TAs) are often assigned to teach undergraduate courses with little to no teaching experience or teacher training. In the absence of experience and preparation, one’s self-efficacy is indicative of the quality of their performance at a given task. Higher self-reported levels of self-efficacy may result in having more student-centered versus teacher-centered teaching approaches, which would positively impact student-learning. This study sought to understand the relationship between TAs’ self-efficacy and teaching approach. Correlation analyses were conducted of the relationships between the Graduate

Teaching Assistant Teacher Self-Efficacy Scale and the Approaches to Teaching Inventory, used to measure self-efficacy and teaching approach, respectively. Results indicated that TAs with more teaching experience who are higher in self-efficacy also have more student-centered teaching approaches, while less experienced TAs showed positive relationships between self-efficacy and both teacher- and student-centered approaches. Based on these findings, it is suggested that experience may be a key variable in determining whether self-efficacy impacts TAs' approaches to teaching.

Strand 5: College Science Teaching and Learning (Grades 13-20)
Poster

Factors of Undergraduate Students' Academic Success in Introductory Chemistry: A Systematic Literature Review

Jessica Chestnut*, North Carolina State University, USA
Carla Johnson, North Carolina State University, USA

ABSTRACT

Undergraduate introductory chemistry is a gatekeeping course preventing students from persisting in STEM degree programs. It is important to understand students' experiences of introductory chemistry and better support students as this course traditionally has high attrition and failure rates. This systematic literature review (SLR) examines the factors of academic success for undergraduates in introductory chemistry courses and aims to understand how these factors differ for varying student groups. A review of 31 articles uncovered three emergent themes for promoting students' academic success: course design, instructional tools and resources, and student learning and characteristics. Most notably, active learning environments, metacognitive assessments, and student affective variables such as identity and motivation emerged as significant predictors of students' academic success. Additionally, this review demonstrates how differences in student demographics, achievement levels, affective variables, and participation in chemistry affect the extent to which students succeed in this course. Student demographics were most frequently reported to cause disparities in course performance, with students from historically underrepresented populations exhibiting the most disadvantages in overall course performance. These findings signify the importance of creating effective learning environments in introductory chemistry for students from diverse backgrounds to achieve equitable outcomes and sustain STEM interest.

Strand 5: College Science Teaching and Learning (Grades 13-20)
Poster

New recognitions of self during a summer undergraduate research experience at an ecological field station

Anna Grinath*, Idaho State University, USA

ABSTRACT

Student participation in science practices through idea construction and critique is an essential part of undergraduate science learning. Such learning experiences aim to position students as knowers, doers, and shapers of science, or epistemic agents. Yet, to design

effective learning experiences, it is necessary to examine how undergraduates recognize and take up epistemic agency. I conducted a single naturalistic case study to examine how undergraduate students experienced new recognitions of themselves in relation to participating in science and in relation to science practice communities during a summer research experience at an ecological field station. I conducted interviews with 18 participants and took a constructivist grounded theory approach to identify moments when participants expressed new or solidified recognitions of self. From these instances, I generated codes to capture the different forms of recognition that were significant to participants. Findings indicate that celebrating creativity as a successful form of participation in science was important. Participants also recognized experiencing challenges and failures as a successful form of participating in science, especially in relation to fieldwork. Participants also expressed new recognitions of self in relation to a variety of science practice communities. The findings can inform design principles for effective summer undergraduate research experiences.

Strand 5: College Science Teaching and Learning (Grades 13-20)
Poster

Chemistry Graduate Teaching Assistants' Pedagogical Commitments for Equity- and Justice-Focused Teaching Across Anti-DEI Contexts

Daisy Haas*, University of Michigan, USA
Safron Milne*, University of Michigan, USA
Ginger Shultz, University of Michigan, USA

ABSTRACT

Creating liberating higher education science experiences requires disrupting systemic inequities through the project of equity- and justice-focused teaching, and graduate teaching assistants (GTAs) have the unique possibility to contribute to the creation of new spaces, structures, and ways of being in Chemistry. Current literature on chemistry GTAs' experiences highlights the challenges in navigating culturally dominant power structures given systemic racism in the academy. Further, states enacting anti-DEI politics create violent contexts for enacting pedagogical commitments for anti-racism and equity-focused teaching. Through an intersectional and sociopolitical lens, we interviewed 27 GTAs across 3 institutions with varying state and institutional anti-DEI contexts. Pulling on critical social theory and interpretive phenomenological analysis, we constructed themes about GTAs' experiences across contexts. We found that Chemistry GTAs hold pedagogical commitments for equity and enact these values in their classrooms, but they experience institutional barriers given the power dynamics of their unique positionality, a lack of cultural prioritization and consistent professional development for (equity-focused) teaching, and inequitable institutional policies which lead to frustration, tensions, and instances of resistance. This study has implications for informing the development of support structures and suggests transformative educational community-building toward anti-racist praxis in liberatory teaching.

Strand 5: College Science Teaching and Learning (Grades 13-20)
Poster

An Inclusive STEM Environment: Experiences of Students with Disabilities in the Introductory Chemistry Course

Natasha Johnson*, University of Toledo, USA

ABSTRACT

While students with disabilities express interest in science, technology, engineering, and mathematics (STEM) fields as students without disabilities, they do not complete STEM programs at the same rates. A diverse and inclusive workforce, including students with disabilities, will be essential for the United States to produce the scientific and technical talent necessary to solve complex problems. The purpose of this study was to collectively identify critical issues in the introductory chemistry course and cogenerate solutions to improve the learning experience and academic outcome for undergraduate STEM students with disabilities. Using a critical disability theory framework, this qualitative research utilized cogenerative dialogue sessions as a platform for students with disabilities to share their experiences in introductory chemistry. It consisted of two distinct cases; one conducted during the fall semester and one conducted during the spring semester. Each case consisted of undergraduate students who were enrolled in the same introductory chemistry course and self-identified as a "disabled" student. Data was generated from cogenerative dialogue sessions, individual interviews, participant questionnaires, and instructional materials. Major themes identified include: a) isolation/otherness; b) relationships with faculty; and c) role of social networks and a support system. The findings have implications for future research.

Strand 5: College Science Teaching and Learning (Grades 13-20)
Poster

Assessing the Impact of an Undergraduate Summer Research Program for Deaf and Hearing Chemistry Students

Isobel Cobb, James Madison University, USA
Frances Thiry, James Madison University, USA
Anneliese Rogerson, James Madison University, USA
Emma McGehee, James Madison University, USA
Savannah Sprouse, James Madison University, USA
Ashlynn Stacy, James Madison University, USA
Trinity Dovan, James Madison University, USA
Joseph Harsh*, James Madison University, USA

ABSTRACT

Participation in Undergraduate Research Experiences (UREs) has been shown to positively influence students' learning, development, and educational and career trajectory, particularly for individuals from groups traditionally excluded from science, technology, engineering, and mathematics (STEM). The current study sought to understand the benefits of a university-hosted URE that integrates Deaf and hard-of-hearing (D/HH), hearing, sign language interpreting, underrepresented minority, and first-generation students in chemical research.

It also examines how participants perceive programmatic activities and how participation influenced hearing students' awareness of Deaf culture and inclusive communication. Mixed method survey data were collected from student participants (n=40) at the end of the Summer 2022 and 2023 programs. We found that students felt a stronger sense of belonging to the scientific community and reported gains in their technical and communication skills as a result of participation in the URE and program events. Hearing participants who interacted with D/HH participants identified having an increased awareness of Deaf culture and inclusive communication strategies. These findings highlight the positive impact of the experience on participants and draw attention to a gap in URE literature as to how student interactions in the research space may influence their cultural competencies as future practitioners.

Strand 5: College Science Teaching and Learning (Grades 13-20)
Poster

Research Skill Development of Undergraduate STEM Students in the LSAMP Undergraduate Research Program

Niyazi Erdogan*, Texas A&M University, USA
Michael Preuss, West Texas A&M University, USA
John Avila, Texas A&M University, USA
Karen Butler-Purry, Texas A&M University, USA
Shannon Walton, Texas A&M University, USA
Pamela Obiomon, Prairie View A&M University, USA
Mahmoud Khasawneh, Texas A&M International University, USA
Barbara Szczerbinska, Texas A&M University - Corpus Christi, USA
Karan Watson, Texas A&M University, USA

ABSTRACT

This study examines the development of research skills among undergraduate students in the LSAMP program, which aims to support underrepresented minority students in STEM fields. Through pre- and post-surveys conducted between 2019 and 2024, the study assessed the impact of undergraduate research experiences on students' confidence and competence in key research skills. The findings reveal significant improvements in areas such as formulating research questions, conducting research, and collaborating with peers, with a moderate effect size observed. These results underscore the critical role of structured research opportunities and mentorship in promoting educational equity and diversity in STEM. The study highlights the importance of continued support for LSAMP initiatives, which contribute to addressing systemic disparities and fostering an inclusive scientific community. The insights gained from this research are valuable for educators and policymakers aiming to design effective interventions to enhance the academic and professional trajectories of underrepresented students in higher education.

Strand 5: College Science Teaching and Learning (Grades 13-20)
Poster

How Student Perceptions of Lab and Lecture Relate to Ideas on "Thinking Like a Chemist"

Michelle Sinapuelas*, San Francisco State University, USA
Seiham Alansary*, San Francisco State University, USA
Angelica Kochkarova*, San Francisco State University, USA

ABSTRACT

Science educators strive to inspire students toward a robust conceptual understanding in their discipline. Many times in general chemistry courses they find students struggle to grasp the concepts presented and make few attempts to connect these ideas across curricular units.This study reports findings from 130 undergraduate students enrolled in the second semester of a year-long general chemistry course series to better understand how they viewed their learning journey. This includes collecting students' responses to survey items to measure their expectations for laboratory work, matched with written responses aimed at gauging student attitudes towards their general chemistry curriculum to understand what they envisioned as the larger takeaway from the course series—in other words, what it means to 'think like a chemist.' Student responses from this study were found to show differences in students' cognitive (thinking) and affective (feeling) learning in laboratory based on their views of "thinking like a chemist". These findings may help general chemistry instructors gain a deeper understanding of possible student beliefs about chemistry and what they may perceive as the goal in learning this content.

Strand 6: Science Learning in Informal Contexts
Poster

'They were normal people like us": exploring effects of a scientist-facilitated intervention on young people

Shannon Stubbs*, University of Galway, Ireland
Jennifer DeWitt, University of Galway, Ireland
Muriel Grenon, University of Galway, Ireland

ABSTRACT

This study explores the short-term effects of a scientist-facilitated intervention on young people's perceptions of science and scientists. In the "Meet the Scientist" intervention, a team of 4-6 volunteer scientist facilitators, trained in equity-based teaching approaches, visit a school classroom in person to facilitate a structured, Question Answer-based discussion. Pre-intervention data from 161 students aged 9-13 revealed that, while most held positive perceptions of scientists, restrictive and exclusionary stereotypes persisted among those with low levels of science capital. Post-intervention, students reported increased interest in science and a broader understanding of scientists as relatable individuals with diverse interests. The findings highlight the importance of equity-based training for scientists involved in outreach, as their ability to connect with young people on a personal level can reduce stereotypes and foster more broader perceptions of science. This research underscores the potential of scientist-facilitated initiatives to positively influence young people's engagement with science, particularly when scientists share their personalities and interests that resonate with diverse audiences.

Strand 6: Science Learning in Informal Contexts
Poster

Measuring sense of belonging in a museum: The impact of a museum-based teaching residency program

Anna MacPherson*, American Museum of Natural History, USA
Naina Abowd*, American Museum of Natural History, USA
Alexis Mayfield, American Museum of Natural History, USA
Margaret Hoffman, American Museum of Natural History, USA
Jacob Sienko, American Museum of Natural History, USA

ABSTRACT

Fostering a sense of belonging during school visits to museums may offer a promising way to maximize the potential for positive impacts and reduce negative experiences. This study sought to develop practical measures of sense of belonging for elementary teachers and students. We developed new scales and tested them with 19 teachers and 379 racially, ethnically, culturally, and linguistically diverse students that participated in a unique museum-based teaching residency at a large natural history museum. We found promising promising initial validity evidence and mean scores before and after the residency weeks increased significantly for both teachers and students. This work contributes to an effort in the informal science learning field to develop an understanding of how to support teachers' and students' sense of belonging.

Strand 6: Science Learning in Informal Contexts
Poster

A Meta-Analysis of Informal Science Education's Role in Shaping Student Interest and Attitudes

Xin Xia*, University of Virginia, USA
Lillian Bentley, University of Virginia, USA
Xitao Fan, The Chinese University of Hong Kong, China
Robert Tai, University of Virginia, USA

ABSTRACT

This meta-analysis explores the impact of informal science education experiences (such as after-school programs, enrichment activities, etc.) on students' attitudes towards, and interest in, STEM disciplines (Science, Technology, Engineering, and Mathematics). We included studies that were conducted within the United States in K-12 educational settings, over a span of thirty years (1992-2022). The findings indicate a positive association between informal science education programs and student interest in STEM. Moreover, the variability in these effects is contingent upon several moderating factors, including the nature of the informal science program, student grade level, STEM subjects, publication type, and publication year. Summarized effects of informal science education on STEM interest are delineated, and the implications for research, pedagogy, and practice are discussed.

Strand 6: Science Learning in Informal Contexts
Poster

Nurturing Community and Reciprocity in Out-of-School STEM Programs: A Conceptual Framework

george schafer*, Drexel University, USA

ABSTRACT

Youth are provided opportunities to engage in STEM (science, technology, engineering, and mathematics) in a variety of ways outside of school. These include, but are not limited to, museums, science centers, libraries, and other unique community-based spaces. Unfortunately, there are numerous inequities that exist around access to and quality of such programs, particularly for marginalized youth. Universities are well-equipped to provide support and resources to address these inequities; however, there is a need for more research-based work to drive equitable engagement and partnership. This proposal puts forth a novel framework called CROPS (Community-based, Reciprocal, Out-of-school Programs in STEM). This framework brings together four elements which have extant research in their own domain but have not been combined into one conceptual framework to improve and guide university partnerships with communities and K-12 youth. CROPS builds on existing literature emphasizing the importance and potential of providing quality out-of-school STEM programs with and for young people and infuses equity-driven elements of community and reciprocity. While primarily designed with the idea of supporting university personnel in such work, CROPS advocates for anyone involved in such programs to grapple more deeply with these concepts and work towards supporting youth in more humanistic ways.

Strand 6: Science Learning in Informal Contexts
Poster

The Impact of a Science Camp on Elementary Students' Science Identity and STEM Career Awareness

Elsun Seung*, Indiana State University, USA
Soonhye Park, North Carolina State University, USA
Aeran Choi, Ewha Womans University, Korea, Republic of

ABSTRACT

Informal STEM experiences can provide unique opportunities for children to increase their interest in science and STEM careers, as well as help them become more familiar with the work scientists do, which enhances their science identity (Bell et al., 2009). We investigated how a summer science camp combined with an elementary methods course influences elementary students' perceptions of scientists, science identity, and STEM career awareness. The participants in this study were local students in Grades 2-6 who attended our summer science camps. Data were collected over a two-year period and involved 50 students. To measure the camp participants' perceptions of scientists, science identity, and STEM career awareness, pre- and post-focus group interviews were conducted at the beginning and end of the camp. The data showed that participants' understanding of scientists' work became

more detailed, and their science identity improved after the camp. They viewed the camp activities as more closely aligned with the work scientists do compared to school science classes. Although there was no significant change in the percentage of students who wanted to become scientists or engineers after the camp, many participants believed that their career awareness improved through the career lessons during the camp.

Strand 6: Science Learning in Informal Contexts
Poster

Female Students Choosing Science Fair: A Tale of Science Teachers' Impact and Science Identity Development

Justin Andersson*, University of Nebraska at Omaha, USA

ABSTRACT

Science education in the U.S. faces substantial reform efforts due to national needs for a bolstered and more diverse STEM workforce. Recent reform efforts call for students to engage in scientific inquiry through the practices of scientists and engineers. Research highlights the potential for student immersion in research, like science fair, to meet the needs of updated science standards. Furthermore, groups of students that have traditionally been underrepresented in STEM careers, such as females, might benefit from these learning opportunities that can take place both within and outside of the school day. Constructivist grounded theory was used to theorize about motivational processes, from participant perspective as they re-engage with scientific research through grades 6-12. Interview data were collected and analyzed from 21 students across eight rural and urban school districts in a Great Plains state. Findings, vetted through theoretical sampling and member-checking, yielded a theoretical model of the processes, challenges, and supports female students encountered. This study contributes to the literature on motivation to do scientific research through science fair as findings highlight the impact of sponsor teachers, students' needs for autonomy in their research topic, realizing scientific research as an investigative tool, and suggest the development of science identity.

Strand 6: Science Learning in Informal Contexts
Poster

Connections between Science Curiosity and Youth's Making in Afterschool STEM Programs

Jennifer Weible*, Central Michigan University, USA

ABSTRACT

Curiosity is an important aspect of learning, but is lacking both in measures of curiosity and in connections to observable behaviors. This poster attempts to connect science curiosity scores and observable behaviors of youth participating in a STEM after school making experience. This study examines both science curiosity scores and video recordings of youth making to draw connections between behaviors evidenced and scale scores. For this purpose, 47 youth participated in a series of after school STEM making experiences at both a rural and urban school. The youth completed a science curiosity scale before and after the experiences as well as were interviewed following the final program. This poster will examine

case studies of four youth who scored across the curiosity range and their behaviors over the after school experience. I found that higher curiosity scores were evidenced most strongly in cognitive and practices aspects, while social factors were found in all score ranges.As science educators and researchers measure science curiosity and attempt to design for learning experiences that foster curiosity in youth and adults alike, it is imperative that we, as a field, understand the ways in which science curiosity is defined, observed, and measured.

Strand 6: Science Learning in Informal Contexts
Poster

Engaging Latinx students in scientific inquiry and metacognition through authentic STEM experiences

Angela Chapman*, UTRGV, USA
Uma Ganesan*, UTRGV, USA
Mario Almanza, UTRGV, USA
Lluvia Garcia, UTRGV, USA
Yailen Gomez, UTRGV, USA
Isabel Amaro, UTRGV, USA

ABSTRACT

Background: Informal, authentic STEM learning enhances K-12 students' knowledge, attitudes, and interests, but field-based contexts remain underexplored. Purpose: This study investigated how an authentic Journalism, Science, Technology, Engineering, and Mathematics (JSTEM) Program impacted Latinx high schoolers' science/engineering skills, practices, knowledge, STEM attitudes/interests, and transfer of informal learning to formal settings. Methodology: Using a case study approach, students participated in the JSTEM program's field-based authentic STEM activities. Data sources included assessments, observations and student artifacts. Findings/Conclusions: The approach enhanced learning of science/engineering practices, fostered positive STEM attitudes/interests, and facilitated transfer to formal environments. Students demonstrated improved skills, knowledge, and heightened interests/attitudes, and applied informal concepts formally. Implications: The study highlights the potential of informal, authentic STEM learning opportunities to engage and inspire students, particularly those from underrepresented groups. Incorporating authentic activities can foster STEM identity, belongingness, and preparedness for STEM careers and further education.

Strand 7: Pre-service Science Teacher Education
Poster

Incorporating Place within Science Methods: Preservice Teacher Perceptions of an Outdoor Learning Experience

Steph Dean*, Clemson University, USA
Summer Landreth*, Clemson University, USA

ABSTRACT

This study explores preservice early childhood educators' perceptions of an outdoor learning experience integrated into their science methods course. Recognizing the challenges in

elementary science education, such as inadequate teacher preparation and limited resources, this research aims to address these issues by examining how outdoor learning can enhance the effectiveness of science instruction. Grounded in Kolb's experiential learning theory and informed by the Next Generation Science Standards (NGSS), the study utilized qualitative data from a follow-up survey completed by 49 preservice teachers after a day-long outdoor learning experience. The findings indicate that participants viewed the experience positively, with hands-on activities in an outdoor setting fostering creativity, collaboration, and higher-level thinking. Key takeaways included a diverse range of learning outcomes, from scientific content to pedagogical skills, highlighting the potential of outdoor education in teacher training programs. The study contributes to the conversation on innovative approaches to science education, emphasizing the value of outdoor learning in cultivating positive attitudes toward science and preparing teachers to implement engaging, student-centered instructional strategies. These findings have implications for improving science education by making it more accessible and relevant, particularly in the context of K-12 education.

Strand 7: Pre-service Science Teacher Education
Poster

Supporting the Teaching of Science and Engineering in Elementary and Middle Grades for Multilingual Learners

Romola Bernard*, University of North Georgia, USA
Max Vazquez Dominguez, University of North Georgia, USA

ABSTRACT

This research highlights the significance of preparing teacher candidates to use culturally and linguistically responsive practices to serve multilingual learners to be successful in science and engineering. The preliminary findings shows that when multilingual learners are given supports that acknowledges and reinforces their culture and language, they thrive, perform well, and report positive experiences in learning science and engineering.

Strand 8: In-service Science Teacher Education
Poster

Investigating How a Curriculum-Based Professional Learning Community Can Support Teachers' and Researchers' Learning Processes

Kristine Wilbrecht*, University of Nevada, Reno, USA
Elizabeth de los Santos*, University of Nevada, Reno, USA
Darcy Clark, University of Nevada, Reno, USA
Jasmine Wong-Fortunato, University of Nevada, Reno, USA

ABSTRACT

Curriculum-based professional learning with high-quality instructional materials embedded in teachers' contexts can be a transformative approach to science teacher learning because it ensures that professional learning is relevant to teachers' classroom contexts and practices. However, the mechanisms by which teacher and researcher learning happens is less clear. In this case study, we use interaction analysis to investigate the interactions among teachers

and a researcher and relate those interactions to sociomaterial aspects of curriculum implementation. We found that the participants in the professional learning community provided different kinds of support for different challenges that the teachers encountered in their curriculum implementation. We identify remaining questions about how to navigate different kinds of challenges in a professional learning community space that are respectful and productive for participants' collective sense-making.

Strand 8: In-service Science Teacher Education
Poster

Novelty Space, Sense of Place Social Justice Science Teaching

Gail Richmond*, Michigan State University, USA
Roberta Hunter, NJ Audubonn, USA

ABSTRACT

There is ample evidence that learning outside of classrooms has benefits for students in urban schools. Yet teachers face barriers to instruction outdoors.In this paper, we explore another element that presents challenges to teaching outdoors in cities: the unfamiliar psychological, social, geographic, and cognitive facets of a place that make learning difficult.This is referred to as novelty space(NS),and the argument we make is that reducing the NS of schoolyards and neighborhoods for teachers and students supports social justice (SJ) by broadening access to the benefits of learning outdoors and helping individuals develop a sense of place that can support them in identifying and acting on issues of social and environmental justice. To support this argument, we draw on data gathered in the project we have been leading that has been designed to support urban elementary educators in enacting socially just science teaching. What we conclude is that reducing the NS of a schoolyard and neighborhood adds and is responsive to students' views of and lived experiences of/in these spaces, and listening carefully to student voices about place creates opportunity for SJ issues to be raised, and a critical lens to be directed on those experiences.

Strand 8: In-service Science Teacher Education
Poster

Teachers' Perspectives on the Implementation of the Scientific Inquiry and Practices Curriculum in Taiwan

YiWen Hung*, The Affiliated Senior High School of National Taiwan Normal University, Taiwan
Shiang-Yao Liu, National Taiwan Normal University, Taiwan

ABSTRACT

This study examines teachers' perspectives on the implementation of the Scientific Inquiry and Practices (IP) curriculum in Taiwan. The IP curriculum, introduced in 2019, emphasizes scientific inquiry and practices, but lacks ready-made textbooks and teaching materials, requiring teachers to act as curriculum agents and designers. A professional development (PD) program was designed to help teachers understand the IP curriculum and develop their pedagogical skills. The PD program consisted of four sessions, each focusing on a different aspect of the IP curriculum. Participants' responses to open-ended questions revealed that they gained a deeper understanding of inquiry-based learning, argumentation, and

modeling, and recognized the need for systematic curriculum design and pedagogical expertise. However, they also expressed challenges in selecting topics for inquiry, providing timely feedback, and assessing student argumentation, likely linked to their self-efficacy. Thus, ongoing professional development, practical training, and support are essential for enhancing teachers' confidence and skills in implementing argumentation in science classrooms. The results also highlight the importance of establishing teacher communities to share resources and experiences, facilitating effective IP curriculum implementation.

Strand 8: In-service Science Teacher Education
Poster

Characteristics of Elementary Teachers who Demonstrate Strong Science Content Knowledge

Alexys Skidmore*, Brigham Young University, USA
Hannah Dudley*, Brigham Young University, USA
Ryan Nixon, Brigham Young University, USA
Stefan Sorge, Leibniz Institute for Science and Mathematics Education, Germany

ABSTRACT

In this study, we seek to better understand the characteristics of elementary teachers with strong science content knowledge to better understand ways to support the development of content knowledge of other teachers. To find characteristics and patterns of teachers who demonstrate strong science content knowledge, we invited elementary teachers from suburban schools in a single state to participate in a science survey. The survey included three sections: a test on evolution, a test on force, and teacher background information. From a large sample of teachers, we selected 17 participants who demonstrated strong science content knowledge. From those 17 participants, two were selected to more closely analyze. We found that interest in science is a characteristic of high scoring participants. The majority of high scoring teachers have taught one or two grade levels. Most of the participants had access to science curricula but were not required to use them. In science college courses, participants tended to receive high marks. Professional development hours did not contribute significantly to having strong science content knowledge. By recognizing these patterns, we offer suggestions to help develop strong science content knowledge in all teachers.

Strand 8: In-service Science Teacher Education
Poster

"I've got to meet students where they are": The critical care from one science teacher

Sierra Morandi*, Florida State University, USA
Sherry Southerland, Florida State University, USA

ABSTRACT

Reform efforts in science education have heavily focused on ambitious science practices and the doing of science. Many argue that this vision must also include the lens of critical care, so that we might not only focus on science practices and big ideas of science, but also support

the development of the entire student as they engage in this work. This case study focuses on illuminating the perspective of critical care held by one cis-gendered, White male science teacher who served a multi-ethnic student population. Through a three-part series, Mr. Gray engaged in scenarios of minoritized learners in science classrooms to reflect on his own experiences. One component of his critical care was focused on maintaining high expectations of his students while also meeting them where they wereto foster science learning. The work uses a critical narrative perspective to explore his perspective and its ramifications for science learning.

Strand 8: In-service Science Teacher Education
Poster

Problems and Possibilities: The challenges of an early career science teacher

J. Mesiner*, University of Maryland, USA

ABSTRACT

This paper explores the complex challenges faced by an early career science teachers (ECSTs) through a detailed longitudinal case study of Alexa, an ECST navigating her transition from student teaching to full-time employment. Drawing on a four-year qualitative study involving video-recorded interviews, observations, and journal entries, the research examines Alexa's evolving professional experiences and the tensions arising at the intersection of teacher preparation and practice. Key challenges identified include difficulties in lesson design, managing instructional alignment with colleagues, and adapting to the demands of online teaching during the COVID-19 pandemic. Alexa's struggles also encompass equitable and justice-oriented teaching, particularly in supporting emergent bilingual students and balancing various instructional approaches. The study highlights the impact of institutional policies, mentorship, and the transition from pre-service training to in-service teaching on Alexa's professional growth. Findings are contextualized within existing literature on ECSTs, revealing both congruence and gaps in current research, particularly regarding pandemic-related challenges and mentor-influenced pedagogical disagreements. The paper underscores the need for teacher preparation programs to address these evolving challenges and advocate for continuous updates to literature and support systems for ECSTs to improve retention and effectiveness in the field.

Strand 8: In-service Science Teacher Education
Poster

Early Career STEM Teachers Perceptions of Resource Quality

Shannon Navy*, Kent State University, USA
Lisa Borgerding, Kent State University, USA
Robert Idsardi, Eastern Washington University, USA
Adepeju Prince, Kent State University, USA

ABSTRACT

Early career science, technology, engineering, and mathematics (STEM) teachers face challenges in the beginning years of teaching. Resources are often provided to these teachers to help them navigate these challenges and support their learning and

development. However, little is known about how early career teachers perceive the quality of the resources that are accessible to them. Therefore, this paper focuses on early career STEM teachers' perceptions of resource quality, conceptualizing resources as material resources, personal resources, and social resources. The participants included 30 early career STEM teachers in the United States. Data sources included three resource surveys, a resource quality sort, and an end-of-year interview each year of the two-year study. Findings revealed that the teachers sorted their available resources by quality in various ways. For some, the resources were sorted based on frequency of use, while for others, the quality of the resource depended on availability. In addition, the findings revealed that resources are not always assets for teachers as they can be hindrances at times. The study highlights the importance of providing early career teachers with quality resources to support their learning and development as educators.

Strand 8: In-service Science Teacher Education
Poster

Investigating Science Teachers Epistemological Beliefs and Conceptions of Models and Modeling in Science Classrooms

Laura Chalfant*, North Carolina State University, USA
Elsun Seung, Indiana State University, USA
Soonhye Park, North Carolina State University, USA
Grace Carroll, North Carolina State University, USA
Elizabeth Kluckman, North Carolina State University, USA
William Reynolds, North Carolina State University, USA
Scott Ragan, North Carolina State University, USA
Jason Painter, North Carolina State University, USA

ABSTRACT

This study examined how science teachers' epistemological beliefs and conceptions of models and modeling evolved after implementing a modeling-based science teaching approach for a year, following a professional development (PD) program. Epistemological beliefs significantly influence teaching practices, especially in science education reforms emphasizing student engagement in scientific practices. Teachers' deep understanding of models as epistemic tools and strategies that make modeling multidimensional, meaningful, and equitable is crucial for effective modeling-based science teaching. The study involved twelve secondary chemistry and biology teachers who participated in a three-week PD on modeling-based science teaching, followed by classroom implementation and ongoing mentoring. Data were collected through the Teacher Beliefs Interview and a modeling conceptions survey, and analyzed with both inductive and deductive methods. Results showed a positive shift towards more reform-oriented epistemological beliefs in most teachers, though changes were not statistically significant. Teachers' conceptions of modeling also became more sophisticated, with increased emphasis on student-centered and equitable approaches. The variation in individual teachers' changes highlights the complexity of teacher development and the necessity for individualized professional support. This study provides valuable insights into how PD can support the adoption of reform-based

science teaching, revealing the gradual and multifaceted nature of belief and conception changes.

Strand 8: In-service Science Teacher Education
Poster

Impacts of professional learning to support teachers' design capacity for localized climate units

Lindsey Mohan, BSCS Science Learning, USA
Emily Harris, BSCS Science Learning, USA
Candice Guy-Gaytán*, BSCS Science Learning, USA
Jeffrey Snowden, BSCS Science Learning, USA

ABSTRACT

Creating localized, meaningful climate learning for youth is a high need for teachers and schools. Responding to this need, we designed and tested a curriculum adaptation approach to localizing climate change curriculum materials. We provided teachers with a phenomenon- driven, three-dimensional climate change storyline unit that was 75% complete. We supported teachers in professional learning (PL) to design and localize the remaining 25% of the unit. The goal of the PL was to build teachers' pedagogical design capacity for implementing phenomenon- driven storyline units localized for student relevance. We report on the PL design and its impact on our sample of 25 high school teachers from across the US. Teachers had a significant increase in climate change content knowledge coupled with significant increases in confidence for teaching climate change and enacting phenomenon-driven learning strategies that tap into relevance. Teachers' confidence for enacting phenomenon-driven learning strategies was not significant immediately following the PL but became significant after teachers enacted localized units. Teachers continued to see gains in knowledge and confidence from post PL through enactment, indicating the importance of coupling PL with enactment of reform- oriented materials. We discuss these findings further and limitations of this study.

Strand 8: In-service Science Teacher Education
Poster

The Impact of Utilizing the Socioscientific Issues Approach on Teacher Satisfaction

Erin Shoop*, Saint Joseph's University, USA
Stacy Olitsky, Saint Joseph's University, USA

ABSTRACT

In recent years, some science curricular frameworks, such as the socioscientific issues (SSI) approach, have emphasized connecting STEM content to real-world social issues to enhance student engagement, interest, and academic achievement in STEM subjects. Although new curricular and pedagogical frameworks are adopted primarily to better meet the needs of students, policymakers should understand how these frameworks impact the teachers using them as well. With teacher shortages and high turnover rates, especially among qualified STEM teachers, new approaches must optimize teacher satisfaction in an effort to improve job commitment. This qualitative study aims to understand how adopting SSI-based

instruction affects teacher satisfaction by interviewing STEM educators currently utilizing the approach. The results of the study illuminate how using the SSI approach may enhance job satisfaction, due to factors such as customizable instruction, the role of teacher interest in lesson development, high self-efficacy, a strong support system, and deeper career fulfillment. However, strict content standards, testing requirements, and limited SSI resources are some identified barriers preventing teachers from using the SSI approach to its full extent. The results of this study may inform professional development programs on how best to equip STEM educators to implement SSI-based instruction to prioritize their job satisfaction.

Strand 8: In-service Science Teacher Education
Poster

Construction of Agency by Science Teachers' Educators in the planning of a professional developmental course

Amanda Magalhães*, Universidade de São Paulo, Brazil
Daniela Scarpa*, Universidade de São Paulo, Brazil
Danusa Munford*, Universidade Federal do ABC, Brazil

ABSTRACT
In this study we investigate aspects of professional development involved in the implementation of a new curriculum centered on scientific literacy and inquiry-based science teaching from 1stthrough 9thgrades in schools in Southeast Brazil. We analyzed discursive interactions between science teachers' educators during planning meetings for a year-long mandatory professional developmental course about the new curriculum that is informed by key ideas in science education research. Our aim is to gather evidence in an ethnographic perspective of the construction of agency when teachers' educators plan the first activity of the professional developmental course, which was based on teachers sharing a lesson plan. Our analysis shows the tension between interpretative frames of the relationship between teachers and the curriculum, evidencing the construction of agency for decision making about the professional developmental course activities.Keywords: Teacher Agency; Teacher Professional Development; Curriculum; Inquiry-based teaching

Strand 8: In-service Science Teacher Education
Poster

Teachers Managing Tensions in Developing Assessments in a Professional Learning Community

JaeBin Lee*, Department of Science education, Seoul National University, Korea, Republic of
Soo-Yean Shim, Department of Science education, Seoul National University, Korea, Republic of

ABSTRACT
This study aims to explore the tensions that arise during the development of assessments within a professional learning community (PLC), how teachers manage these tensions, and what they can gain from navigating these tensions. We conducted a case study focusing on a PLC composed of four science teachers from different secondary schools in South Korea,

along with a researcher. We qualitatively analyzed the teachers' discourse, interviews, and artifacts.The findings revealed two main types of tensions within the PLC. (1)encouraging diverse student responses the need to maintain fair scoring criteria,(2)using assessments to support students' learning processes and growth fairly quantify student performanceTeachers managed these tensions through three distinct stages: establishing direction, developing assessments, and reflecting on the assessments. The teachers prioritized reform-oriented goals in their assessment development while striving to reconcile competing objectives. During the reflection stage, they discussed specific strategies for addressing both the aspects of the tensions they successfully managed and those that required further attention.This study offers insights into how tensions are managed during assessment development within a PLC and provides implications for teacher learning and professional growth.

Strand 8: In-service Science Teacher Education
Poster

Exploring the Impact Mechanism of Interdisciplinary Teaching Practices among Elementary Science Teachers

Mengqian Wang*, China Research Institute for Science Popularization, China
Hong Cui, Central China Normal University, China

ABSTRACT

This study aims to explore the connotation of interdisciplinary teaching abilities among science teachers and their impact mechanism on teaching practice, in response to the challenges of science education transformation. Adopting a mixed research paradigm that combines qualitative and quantitative methods, the study constructs an indicator system for interdisciplinary teaching abilities of science teachers through depth interviews and questionnaire surveys, and analyzes the impact of various elements on teaching practice. The results indicate that emotional and attitudinal elements, as well as developmental elements, have the most significant influence on practical elements. Teachers' emotional attitudes and the development of teaching skills are crucial for interdisciplinary teaching practice. Meanwhile, profound professional knowledge and advanced teaching philosophies serve as the internal driving force for interdisciplinary teaching practice. The study also finds that developmental elements play a pivotal role in promoting the development of professional elements, conceptual elements, and emotional and attitudinal elements. To optimize interdisciplinary teaching practice, it is necessary to prioritize the enhancement of teachers' emotional and attitudinal elements, deepen their professional knowledge and teaching philosophies, and strengthen individual long-term learning and teaching reflection.

Strand 8: In-service Science Teacher Education
Poster

Building Teachers' Capacity for Data-Rich Instruction: Impact from a Professional Learning Course

Pai-rou Chen*, WestEd, USA
Nicole Wong*, WestEd, USA
Rasha Elsayed, WestEd, USA

Leticia Perez, WestEd, USA
Kirsten Daehler, WestEd, USA

ABSTRACT

This paper reports survey findings from a broader study about the impact of a data fluency professional learning (PL) course on teacher and student outcomes. These self-reported findings demonstrate evidence of promise for the efficacy of the PL model, which was intended to build teachers' content and pedagogical content knowledge (PCK) for data fluency through engagement in data-rich STEM investigations, analysis of classroom narratives called teaching cases, and communities of practice where teachers were supported to plan and implement data lessons. The results from pre- and post-surveys given to nine math and science teachers in grades 6–9 show that the PL improved teachers' data content knowledge and PCK, students' opportunity to learn with data, and student outcomes. A next stage of analysis will combine these results with other study data to develop case studies that describe the mechanisms behind these shifts. The study contributes to data science education by building new knowledge about features of scalable PL that effectively supports teachers' knowledge, skills, and classroom practice. Future research should aim to expand teacher participation, diversify subject areas, and examine the impact on student learning with data from student assessments and interviews, to fully evaluate the model's impact.

Strand 8: In-service Science Teacher Education
Poster

Inclusive Science Education: Ethnographic Insights into Teacher Development and Classroom Diversity

Rafael Lopes*, USP, Brazil
Danusa Munford, Universidade Federal do ABC, Brazil
Daniela Scarpa, USP, Brazil

ABSTRACT

This study explores the construction of meanings about diversity and inclusion by teacher in-service education, specifically at a public school in Brazil serving Adult and Youth Education (AYE). Employing an ethnographic approach, the research examines how teachers, from elementary and secondary education, develop and adapt inclusive practices through daily interactions in professional development spaces. The findings reveal the complex nature of classroom diversity. Tensions between broader educational policies and the realities of science classrooms underscore the need for context-specific, rather than generalized, approaches to inclusion. The study also highlights conflicts among educators, particularly between specialist and literacy teachers, which point to the importance of collaboration and structural support in fostering effective inclusion. By emphasizing the critical role of teacher-student relationships, contextual understanding, and interdisciplinary collaboration, this research contributes to the ongoing discourse on inclusive science education. It also calls for further investigation into the intersectional dimensions of diversity—such as gender, race, class, and disability—which are crucial for fully addressing equity and inclusion in science classrooms.

Strand 8: In-service Science Teacher Education
Poster

Early Career Science and Math Teacher Wellbeing: Self-Care Needs and Practices

Lisa Borgerding*, Kent State University, USA
Shannon Navy, Kent State University, USA
Ella Yonai, University of Georgia, USA
Elizabeth Ayano, University of Georgia, USA

ABSTRACT

Teacher burnout and attrition are connected to teacher well-being as teachers navigate occupational challenges. Self-care practices can help mitigate teacher stress and ultimate burnout. Previous work has documented the importance of the alignment between science and math teachers' self-care needs and practices. This study endeavors to connect teacher self-care needs and practices with their career intentions. The sample included 29 early career secondary science and math teachers who graduated from science and math teacher preparation programs from three universities located in the northwest, southeast, and midwestern U.S. Data sources included beginning and end-of-the-year interviews and three post-observation interviews. Teachers demonstrated a wide range of self-care needs and practices. The most commonly-used self-care practices included seeking care from others, setting boundaries, and engaging in emotional/mental self-care practices. Teachers were sorted by their self-care needs and practices, and their career intentions were compared across these groups. Teachers identified several connections between their self-care needs, practices, and intentions to continue in their teaching position and within the profession. Implications for teacher learning are explored.

Strand 8: In-service Science Teacher Education
Poster

Social Resource Access and Use for Early Career STEM Teachers

Emily Hamada*, Eastern Washington University, USA
Robert Idsardi, Eastern Washington University, USA

ABSTRACT

To address teacher attrition in early career science and mathematics teachers, many schools and districts provide social resources to newly hired teachers. Social resources are the individuals and/or groups of people that a teacher uses to support their work. This study is framed by the Conservation of Resources theory, which describes the role resources place in contributing to resilience. We examined the social resources that 24 early career science and math teachers had access to and used over two academic years. A multiple methods approach was used to analyze quantitative survey data and qualitative interview data. Surveys captured teachers' access and use of 20 social resources. Interviews focused on teachers' perceptions of the quality of social resources and their reasons for using or not using resources. Teachers' access increased over time, while their frequency of use decreased in Year 2. There were various ways in which teachers relied on social resources, but most used in-school social resources more extensively than out-of-school social resources. This study

provides a more nuanced description of the social resources that early career science and mathematics teachers have access to and has implications for how we support early career teachers.

Strand 8: In-service Science Teacher Education
Poster

Investigating the Role of Science Practices and PCK in the Implementation of Modeling Instruction

Laura Chalfant*, North Carolina State University, USA
William Reynolds, North Carolina State University, USA
Grace Carroll, North Carolina State University, USA
Elizabeth Kluckman, North Carolina State University, USA
Soonhye Park,North Carolina State University, USA
Scott Ragan, North Carolina State University, USA
Jason Painter, North Carolina State University, USA

ABSTRACT

This study investigated the relationship between teachers' pedagogical content knowledge (PCK), use of science practices, and the implementation of Modeling Instruction (MI) in high school biology classrooms. Informed by both the Refined Consensus Model and the Pentagon Model of PCK, we analyzed how teachers' personal and enacted PCK influenced their use of MI over one school year. This study utilized a multiple case study approach wherein we analyzed data from three biology teachers who participated in professional development focused on MI. The study examined teachers' use of science practices using the Science Instructional Practices Survey (SIPS), observed classroom practices using the Modeling-Based Teaching Observation Protocol (MBTOP), and teachers' PCK using the PCK mapping approach. We found teachers with more complex PCK demonstrated higher fidelity in MI implementation and that the relationship between MI implementation and use of science practices in instruction deviated from the expected patterns developed in previous research. This study highlights the importance of PCK in curriculum implementation and highlights the need for more investigation into the relationship between modeling instruction and the use of science practices in instruction. This research has implications both for research and those involved in designing and delivering teacher professional development.

Strand 8: In-service Science Teacher Education
Poster

Exploring Science Teacher Leaders' Professional Growth Plans

Julianne Wenner, Clemson University, USA
Brooke Whitworth*, Clemson University, USA

ABSTRACT

Science teacher leaders (STLs) are science teachers who advocate for science and support student learning. STLs' responsibilities are varied, contextually-dependent, and complex, requiring professional learning that is tailored to the STL. In response to the need for

differentiated professional learning for STLs, we created a 5-year program that supports science teachers in becoming an STL or strengthening their STL identity. As part of this program, we asked teachers to create a Teacher Growth Plan (TGP). In this TGP, we asked teachers to describe their goals for the next year, their trajectory, and the possible obstacles to their goals and trajectories. Analyzing these TGPs, we found that STLs are focused on understanding 3-dimensional standards and teaching in alignment with those standards, with concerns of obstacles such as limited time, buy-in, and resources that may prevent them from reaching those goals. Only five STLs described a trajectory that included being a formal STL, which could indicate that STLs recognize that they cannot lead others in science until they have a strong foundation in science pedagogy. This study may help inform professional learning providers and other science education stakeholders in terms of how they can support science teachers and STLs.

Strand 8: In-service Science Teacher Education
Poster

Coherence in Professional Learning/Development: An Exploratory Study of District Science Leaders

Julie Luft*, University of Georgia, USA
Ella Yonai, University of Georgia, USA
Xinyu He, University of Georgia, USA
Paulo Carneiro Loureiro, University of Georgia, USA
Brooke Whitworth, Clemson University, USA

ABSTRACT

Professional development and professional learning are an essential part of any educator's career. These are the opportunities that allow educators to understand new instructional approaches, build their knowledge, or refine their work with colleagues. Of course, the opportunities for educators to learn differ based upon their professional position. Over the years, many qualities of professional development and learning programs have been discussed by scholars. Of these areas, their professional coherence, which is the programming they are engaged in and their professional role in the school setting is one of several areas to explore. This study looks at the professional learning activities of district leaders to understand if they exhibit a traditional notion of coherence or something else. In this study, there are different dimensions of coherence that contribute to the learning of science district leaders. Areas of coherence that we examined included personal, professional, and policy coherence. Coherence is multidimensional and is an important part of the learning of educators. Understanding more about the dimensional nature of coherence is important, as it contributes to the science instruction of science teachers.

Strand 8: In-service Science Teacher Education
Poster

Dimensions of Teachers Pedagogical Content Knowledge (PCK) of Argumentation

Teresa Shume*, North Dakota State University, USA
Brooke Thiel, North Dakota State University, USA

ABSTRACT
Scientific argumentation skills are important to prepare students for todays increasingly data-drenched world filled with science-based claims about complex socio-scientific issues, ill-structured problems that are inherently multidisciplinary, open-ended, and involve multiple stakeholders. While scientific argumentation has been investigated substantially in elementary and secondary science education, few studies have investigated in-service teachers proficiency in argumentation knowledge and skills. Yet science teachers continue to report that teaching argumentation skills to students is difficult and challenging. One facet of investigating teachers argumentation is to study teachers pedagogical content knowledge (PCK). The goal of our work was to investigate teachers PCK of argumentation while participating in a specialized professional development program. Ten teacher-participants completed a 3-credit PD course in fall semester, and a 1-credit PD course in spring semester. Written reflection and transcripts of individual interviews were analyzed using a thematic analysis method. This study suggests that including both structural and dialogic orientations to argumentation may be valuable when designing PD programs to support the development of teachers PCK about argumentation. Additionally, these findings support previous research indicating that student knowledge about argumentation and strategies for teaching about argumentation skills are meaningful areas of focus for teacher PD programs about argumentation.

Strand 10: Curriculum and Assessment
Poster

Designing Socio-scientific Issues-Based Instruction Using Culturally Responsive Frameworks

Rebecca Lesnefsky*, University of North Carolina, USA
Keren Dalyot, Weizmann Institute of Science, Israel
Nannan Fan, University of North Carolina, USA
Heewoo Lee, University of North Carolina, USA
Shira Passentin, Weizmann Institute of Science, Israel
Natasha Segal, Weizmann Institute of Science, Israel
Zhen Xu, University of North Carolina, USA
David Fortus, Weizmann Institute of Science, Israel
Troy Sadler, University of North Carolina, USA

ABSTRACT
This poster explores how socio-scientific issues-based instruction can more authentically align with culturally responsive frameworks for more meaningful and transformative ends. We examine the assumption that SSI naturally incorporates culturally responsive teaching, critiquing instances where the integration falls short of its transformative potential. By employing culturally responsive frameworks (e.g., Gay, 2002; Ladson-Billings, 1995; Paris, 2012), our case study on middle school curriculum design demonstrates effective strategies for enhancing the intersection between SSI instruction and culturally responsive education. This design case goes beyond merely touching on diverse perspectives; we question how learners' perspectives are influenced by cultural, economic, and historical contexts. We

propose a more meaningful integration between SSI and culturally responsive frameworks that enhances students' critical awareness and leverages their identities as valuable assets in education.

Strand 10: Curriculum and Assessment
Poster

Semiconductor Education: A Scoping Review of Programs, Practices, and Challenges in Preparing the Future Workforce

Jaquelina Schmittlen-Garbocci*, University of Tennessee-Knoxville, USA
Hongyan Yang, University of Tennessee-Knoxville, USA
Rachel Wong, University of Tennessee-Knoxville, USA
Joanna Millunchick, Indiana University, USA
Shalaunda Reeves, University of Tennessee-Knoxville, USA

ABSTRACT

This scoping review examines educational programs in semiconductor-related fields, addressing the growing demand for skilled professionals in the industry. In this study we analyze articles to identify theoretical frameworks, curricular approaches, pedagogical strategies, assessment methods, and challenges in semiconductor education. Findings reveal a significant gap in the explicit use of theoretical frameworks and a predominance of subject-centered curricula. Pedagogical strategies range from traditional direct instruction to innovative approaches like flipped classrooms and service-oriented projects. Assessment methods vary, with exams and surveys being the most common. Challenges include the complexity of concepts, rapid technological evolution, and resource constraints. Programs addressed these through hands-on activities, multidisciplinary approaches, and industry collaboration. The review highlights the need for more diverse curricular approaches, robust theoretical underpinnings, and comprehensive evaluation methods. Recommendations for future research include developing tailored theoretical models, exploring emerging educational technologies, and creating inclusive programs targeting underrepresented groups. This review provides valuable insights for engineering educators and researchers to develop effective educational initiatives meeting the critical workforce needs in the semiconductor industry.

Strand 10: Curriculum and Assessment
Poster

Exploring the inclusion of systems thinking in middle school science curricula and textbooks

Melike Hanedar*, Boğaziçi University, Turkey
Gaye Ceyhan, Boğaziçi University, Turkey

ABSTRACT

Understanding the behavioral characteristics and structural intricacies of complex systems is increasingly challenging for scientists and students. Systems thinking (ST) offers a valuable approach for grasping complex interdependencies and crafting effective solutions while promoting creativity and problem-solving skills crucial for addressing modern issues. The

objective of science education is to facilitate students' comprehension of complex systems and natural phenomena in their daily lives, underscoring the imperative for the integration of ST in formal education. This study investigates the integration of ST in the middle school science curricula and textbooks for grades five through eight, using Arnold and Wade's (2015) systemigram within a qualitative research framework. A rubric was developed to evaluate ST tools and assessment methods. The findings indicate that, while there are some examples of ST in use, there is a need for greater scope and clarity. The limited use of causal loop diagrams, feedback mechanisms, and nonlinear relationships hinders students' understanding of complex systems. The study underscores the necessity for enhanced ST integration to develop analytical and interdisciplinary thinking skills, offering guidance for policymakers and curriculum developers.

Strand 10: Curriculum and Assessment
Poster

Introduction about Automated Scoring System for Descriptive Assessment and Application

Sangeui Lee*, SEOUL NATIONAL UNIVERSITY, Korea, Republic of
Minsu Ha, Seoul National University, Korea, Republic of

ABSTRACT

This study introduces and evaluates the Scoring Assistant using Artificial Intelligence (SAAI) system, an automated scoring platform designed to assist teachers in evaluating descriptive assessments. Rooted in constructivist learning theories and the Understanding by Design curriculum, descriptive assessments are crucial for diagnosing students' learning progress and providing timely feedback. However, the challenges associated with grading such assessments—such as time consumption and inconsistencies in scoring—limit their practical application. The SAAI system addresses these challenges by offering a web-based platform that analyzes students' responses, extracts key concepts, and generates individualized feedback. The study compares the SAAI system's performance with human graders across multiple assessments, revealing a moderate to high correlation (r = 0.578, p 0.01) in scoring consistency. Items with multiple correct keywords showed stronger correlations, while short-answer questions exhibited weaker correlations. The SAAI system's ability to assist in grading open-ended questions demonstrates its potential to enhance the diversity and effectiveness of assessments, ultimately promoting deeper student learning and teacher autonomy. The findings suggest that the SAAI system is a valuable tool for educators seeking to implement descriptive assessments more effectively in their classrooms.

Strand 10: Curriculum and Assessment
Poster

Incorporating Science Topics in Nontraditional Subjects: Teacher Strategies in K-12 Classrooms

Siddika Guzey*, Purdue University, USA
Emily Haluschak*, Purdue University, USA
Christine McDonnell, Purdue University, USA
Deana Lucas, Purdue University, USA

Tamara Moore, Purdue University, USA

ABSTRACT
Developing and teaching interdisciplinary curriculum units in science classrooms is well-established. Yet, the introduction of microelectronics education in K-12 classrooms is a novel concept for many educators including science teachers. Recognizing the demand for microelectronics workforce development in the US, we collaborated with teachers to develop and implement curriculum units centered around microelectronics. We conducted a study on one of the curriculum units and documented three teachers' adaptations of the curriculum unit, with a particular emphasis on discursive practices. The findings and implications derived from this study will assist researchers, teachers, and curriculum developers in their efforts to integrate microelectronics content into K-12 classrooms.

Strand 10: Curriculum and Assessment
Poster

An Approach to Unpacking NGSS Performance Expectations for Language-Diverse First Graders

Nonye Alozie, SRI International, USA
Arif Rachmatullah*, SRI International, USA
Daisy Rutstein, edCount, LLC, USA
Ron Fried, SRI International, USA

ABSTRACT
This paper describesthe use of evidence-centered design (ECD) to unpack nine NGSS performance expectations (PEs) for first grade by incorporating first grade languagedevelopment andequityand inclusion.Through our approach, we successfully deconstructed nine PEs into 9 integrated dimension maps (IDMs) that were used to generate a total of 22 learning performances (LPs).Additionally, this project developed a design pattern template specifically designed to support the creation ofscience assessments tailored to the language development andexperience with science phenomenaof first-grade students. We believe that our approach and results can significantly contribute to enhancing the quality of formative assessment task development for early elementary science education.

Strand 10: Curriculum and Assessment
Poster

Using Multiple Models to Learn Population-Level Viral Transmission

Zhen Xu, University of North Carolina at Chapel Hill, USA
Jamie Elsner*, University of North Carolina at Chapel Hill, USA
Eric Kirk, University of North Carolina at Chapel Hill, USA
Troy Sadler, University of North Carolina at Chapel Hill, USA
Laura Zangori, University of Missouri, USA

ABSTRACT
This design-based research illustrates how we integrated multiple models (i.e., computational models and participatory simulations) were used to help students make sense of population level viral transmission. This poster introduces the iterative design and development of lessons that target middle school students to enhance students' understanding of probability and its role in the spread of viruses. Preliminary results indicate that students improved their ability to analyze data and understand the probabilistic nature of viral spread. This study contributes to the literature by providing a practical framework for embedding mathematical concepts in science curricula, addressing a gap in the integration of mathematical thinking into K-12 science education.

Strand 10: Curriculum and Assessment
Poster

Equitable Science Curriculum for Multilingual Learners: Curriculum Critique

Anna Kim*, Penn State, USA

ABSTRACT
This curriculum critique paper evaluated the NGSS exemplar unit, the unit Marathon Runner: Unit 1 in Biology, based on an equity-driven framework focusing on Multilingual Learners(MLs). The framework used in the paper emphasizes two themes: local phenomena and contemporary perspective on second language acquisition. The unit was evaluated as an appropriate example that fits MLs' needs in general. This paper suggested multiple improvements toward an equity-based curriculum. First, supplementary resources for context can be provided to foster MLs' understanding. Second, the curriculum needs to be more connected with solving problems with science. Third, the curriculum should suggest diverse and adaptive ways of assessment to teachers. Finally, the curriculum should include more opportunities for teachers to provide feedback on students' work. This paper applied the framework used in prior literature on the secondary-level curriculum, providing a great example of an equitable curriculum for all students, including ML students.

Strand 10: Curriculum and Assessment
Poster

The impact of Place-Based Education within the framework of Next Generation Science Standards three dimensions

Heewoo Lee*, University of North Carolina at Chapel Hill, USA
Troy Sadler, University of North Carolina at Chapel Hill, USA

ABSTRACT
The literature review explores the impact of Place-Based Education (PBE) within the framework of the Next Generation Science Standards (NGSS) three dimensions: Science and Engineering Practices (SEPs), Crosscutting Concepts (CCCs), and Disciplinary Core Ideas (DCIs). PBE, which engages students with local environments and real-world phenomena, offers a unique approach to science education through experiential learning. By considering the multidimensional aspects of the NGSS alongside the hands-on, localized focus of PBE, this review highlights how these two approaches work together to enrich science education.

The study addresses a gap in the literature by conducting a systematic review from 2003 to 2023, focusing on how PBE supports science learning by incorporating the three dimensions of NGSS. The analysis categorizes studies based on the role of 'place' in PBE and its impact on students' learning with SEPs, CCCs, and DCIs. The findings are expected to provide insights into how PBE can be effectively integrated into science curricula to enhance science learning and promote a deeper understanding of scientific concepts in real-world contexts. This study will contribute to the ongoing discourse on PBE's role in science education and its alignment with NGSS.

Strand 10: Curriculum and Assessment
Poster

Lessons Learned from Developing NGSS-Aligned Formative Assessments for 1st Graders

Arif Rachmatullah*, SRI International, USA
Nonye Alozie, SRI International, USA
Hui Yang, SRI International, USA
Daisy Rutstein, EdCount, LLC, USA
Anna Jennerjohn, SRI International, USA
Ron Fried, SRI International, USA
Marta Mielicki, SRI International, USA

ABSTRACT

Engagingyounglearnersin science learningcan be especially challenging as teachers need toconsiderstudentslanguage developmentalongwiththe science.In this study, we present the design considerations for developingNext Generation Science Standards (NGSS)-aligned formativeassessments forfirst-gradestudents.Theassessment tasksare situated in the context ofsmallgroupsettingsto encourage students todemonstratetheir science knowledge through verbal responses, collaborative learning, drawing,and the use of manipulatives.Subsequently, wereporton the successes and lessons learnedin designing and implementing these smallgroup formative assessments, drawing on data from expert reviews and student cognitive interviews. We further discuss the contribution of our study for improving science instructionfor younglearners.

Strand 11: Cultural, Social, and Gender Issues
Poster

Promoting Sociotechnical Perspectives of Engineering During a Summer Bridge Program

Jacob Pleasants*, University of Oklahoma, USA

ABSTRACT

To address the complex challenges of contemporary society, we need to prepare engineers who are not only technically competent but also able to incorporate social, cultural, and ethical considerations into their professional practice. In this study, we investigate the impacts of an Engineering Summer Bridge (ESB) program that included several learning experiences designed to promote students' understandings of engineering as a socially

engaged practice. Using a case study methodology, we explore changes in ESB students' thinking and identify factors that made it more or less likely for students to adopt socially engaged ways of thinking about engineering. We found that students were most likely to add socially engaged perspectives when they entered the ESB program with relatively few prior engineering experiences and/or self-identified as having limited prior engineering knowledge. Students also added socially engaged perspectives when their initial engineering interests and motivations were congruent with those conceptualizations of engineering. Students who entered ESB with well-established and largely technocentric views of engineering tended to maintain those orientations during the program. Our results speak to the influence that early engineering experiences can have in terms of establishing and solidifying conceptions of engineering – either as technocentric or socially engaged.

Strand 11: Cultural, Social, and Gender Issues
Poster

'I hope this program fails miserably'': Rural resistance toward queer-focused science education research

Gary Wright*, University of Missouri, USA

ABSTRACT

By employing queer theory as a theoretical lens, this autoethnographic study aims to explore and highlight the challenges and emotional labor involved in conducting queer-focused research in rural science education through a series of personal vignettes, shedding light on the broader cultural and institutional barriers to rural GSD inclusive science education.

Strand 11: Cultural, Social, and Gender Issues
Poster

Analysis of Genetic Determinism and Essentialism Discourses in Online Communities

Ji Eun Kim*, Seoul National University, Korea, Republic of
Sun Young Shin, Seoul National University, Korea, Republic of
Seung Ah Park, Seoul National University, Korea, Republic of
MinSu Ha, Seoul National University, Korea, Republic of

ABSTRACT

This study investigates the prevalence of genetic determinism and essentialism in online communities, analyzing discussions within major online communities. Genetic determinism refers to the belief that human traits are primarily determined by genes, while genetic essentialism suggests that certain categories possess immutable qualities based on genetic makeup. The research identifies four key discourses: the extent of genetic influence on various traits, the role of genetics in life success, the perceived genetic basis for social hierarchy, and the genetic homogeneity within social groups. The findings reveal a strong presence of deterministic and essentialist beliefs, which often lead to pessimistic views about life and justify social discrimination. These online discourses highlight the necessity for genetics education that addresses the complexity of gene-environment interactions and challenges oversimplified, deterministic perspectives. The study emphasizes the importance

of integrating comprehensive genomics literacy into educational curricula to foster critical thinking and reduce essentialist beliefs, ultimately promoting a more inclusive understanding of genetics.

Strand 11: Cultural, Social, and Gender Issues
Poster

Rooted in Culture, Growing Equity; An African Inspired Approach to Teach Logic Gate

Olasunkanmi Gbeleyi, Lagos State University (LASU-ACEITSE), Nigeria
Peter Okebukola, Lagos State University (LASU-ACEITSE), Nigeria
Juma Shabani, University of Burundi, Burundi
Deborah Agbanimu, National Open University of Nigeria (NOUN), Nigeria
Esther Funmilayo, Lagos State University (LASU-ACEITSE), Nigeria

ABSTRACT

In the face of escalating global inequalities, tackling their underlying causes is increasingly urgent. This study delved into the fusion of culturally relevant teaching approaches to promote gender equality in science learning. Specifically, it examined the (CTCA) and its impact on creating an equitable learning environment, focusing on computer studies, particularly the difficult topic like logic gates. The study involved 213 senior secondary year two students from three selected schools. Each school represented a cohort: one using traditional methods (control), one employing technological tool (Author 1.0), and one applying CTCA. Both male and female students participated across experimental groups, and control. The logic gate achievement test and students interview guide were used to collect data, LGAT had a reliability coefficient of 0.83. Using an explanatory sequential research design including pretest, and posttest phases, this study employed quantitative tools along with qualitative methods such as the students interview guide (SIG). Quantitative data were analyzed using ANCOVA, while the qualitative data used a thematic approach.The results indicated no statistically significant gender-based differences among groups, highlighting the potential of CTCA (presumably a method or intervention) in reducing gender disparities in STEM education, particularly within computer studies.

Strand 11: Cultural, Social, and Gender Issues
Poster

'Yes – For Us Too'': Learning in Informal Environments in a Minority Population

Tali Tal*, Technion, Israel Institute of Technology, Israel
Maha Jaramneh, Technion, Israel nstitute of Technology, Israel
Abeer Watted, Al-Qasemi Academic College of Education, Israel

ABSTRACT

The research focuses on the underutilization of informal learning environments (ILE) by the Arab minority population in Israel compared to their Jewish counterparts. The study aims to understand the views of senior educators from the Arab society regarding learning in ILE and to identify the barriers and challenges associated with the use of ILE by Arab students. Nine senior Arab superintendents for me Ministry of Education were interviewed. The research

acknowledges the importance of informal learning environments such as museums, aquariums, and nature parks in providing diverse and captivating learning experiences and fostering lifelong learning. It also addresses the disparities in access to and utilization of ILE between the Jewish and Arab students, beyond just socioeconomic factors, attributing cultural differences as a significant contributing factor. The study highlights the need to bridge the gap and promote inclusion of Arab students in informal learning environments, citing ongoing progress in narrowing the disparity and increasing opportunities for Arab children to visit major museums. The research points as well to deficit views of the Arab education system held by the interviewees. Finally, it emphasizes the importance of collecting consistent data from a broader population of educators in the Arab society.

Strand 11: Cultural, Social, and Gender Issues
Poster

High school makerspace experience and the gender gap in STEM identity and career interest

Chen Chen*, The University of Hong Kong, Hong Kong
Yuhan Li, The University of Hong Kong, Hong Kong
Gerhard Sonnert, Harvard-Smithsonian Center for Astrophysics, USA
Philip Sadler, Harvard-Smithsonian Center for Astrophysics, USA
Susan Sunbury, Harvard-Smithsonian Center for Astrophysics, USA
Sherry Lassiter, MIT, USA

ABSTRACT

The number of makerspaces worldwide has been doubling approximately every 18 months. Educators are excited about what this expansion may bring to STEM education. Past research focused more on STEM skillset preparation and less on the promise that makerspaces may inspire STEM affinity or even help close the STEM gender gap. This study used a U.S. national sample of 15,725 freshmen college students to study the relationship between high school makerspace experience and college STEM identity and STEM career interests. We found that makerspace experiences were associated with a stronger STEM identity and that they effectively closed the gender gap in STEM identity. However, only those males who often participated in makerspace activities increased their STEM career interest, meaning frequent makerspace participation widens the gender gap in STEM career interests. We offer potential explanations and implications from inside and outside of the makerspace environment.

Strand 11: Cultural, Social, and Gender Issues
Poster

Navigating with Cultural Wealth: Reframing the Narrative of Undergraduates' Journeys Toward STEM Degrees

Sheila Castro*, University of Florida, USA
Bruce Carroll, University of Florida, USA
Janice Mejia, Northwestern University, USA
Kent Crippen, University of Florida, USA

ABSTRACT
Higher education plays a crucial role in preparing and encouraging a diverse STEM workforce. Despite increased representation of minoritized individuals in STEM fields, research shows that women and other minorities (e.g., racial, ethnic, gender, socioeconomic) exit their STEM degrees at higher rates. Existing literature often focuses on deficit-based perspectives, highlighting barriers such as language proficiency and institutional challenges. This study challenges such perspectives by employing Yosso's Community Cultural Wealth (CCW) framework to investigate how minoritized students leverage their cultural capital to navigate their educational journeys. Through qualitative think-aloud interviews with six undergraduate engineering students, this case study highlights the critical roles of faculty, family, and friends in the students' educational experiences, emphasizing the importance of a supportive and inclusive environment. The research reflects the significance of recognizing and supporting the diverse forms of capital that students bring to their educational experiences.

Strand 11: Cultural, Social, and Gender Issues
Poster

Exploring Associations Between Event-Based (Mis)Recognition by STEM Authorities with STEM Identity and Career Aspirations

Amdad Ahmed Awsaf*, Florida International University, USA
Remy Dou, Florida International University, USA
Gerhard Sonnert, Harvard University, USA
Philip Sadler, Harvard University, USA

ABSTRACT
Several programs for marginalized young people have been intentionally designed to increase the diversity in STEM careers; however, the participation of racially and ethnically minoritized individuals continued to be underrepresented in STEM disciplines. Using identity theory and drawing data from an NSF-funded survey of 1,134 participants, these regression analyses examine the impact of prior educational experiences on STEM identity (i.e., seeing oneself as a STEM person) and career aspirations among individuals attending Minority Serving Institutions (MSIs). The study's findings indicate that although positive reinforcement positively correlates with the STEM identity construct, the efforts are not always supportive enough to predict STEM career aspirations for minoritized individuals. It underscores the importance of explicitly designing appropriate interventions to support STEM identity formation and STEM career pursuit.

Strand 11: Cultural, Social, and Gender Issues
Poster

Exploring Instructional Strategies Used to Promote Equity in Science Classrooms: A Systematic Literature Review

Elizabeth Ayano*, University of Georgia, USA
Julie Luft, University of Georgia, USA
Ella Yonai, University of Georgia, USA

ABSTRACT

In science education, equity aims for all students to have equal opportunities to learn science and become engaged in science and engineering practices. These opportunities depend on access to quality space and equipment and teachers to support and motivate learning, engagement, and adequate time spent on science. Achieving equity in science education. is an ongoing challenge. One of the ways to promote equity in science classrooms is to discover how science teachers foster equity in their science teaching. However, empirical research is scarce examining the effectiveness of specificinstructional strategies in enhancing equity in science classrooms. Much of the existing literature is theoretical or based on anecdotal evidence. This literature review, a systematic report on 14 empirical studies on equity in science classrooms, aims to fill this gap and provide valuable insights for educators, researchers, and policymakers in science education. We first discuss the importance of equity in science classrooms and then examine the salient features and outcomes of the instructional strategies (ISs) used to enhance equity in science classrooms. Findings revealed that various ISs used to enhance equity have yielded positive results, offering a ray of hope for the future of science education to foster equity in their classrooms.

Strand 11: Cultural, Social, and Gender Issues
Poster

Black STEM Students and Faculty within the Mid-Atlantic Region: A Systematic Literature Review

Zaki Hawkins*, American University, USA
Ihsan Hawkins*, American University, USA
Jess Edwards, American University, USA
Martinique Sealy, American University, USA
Shari Watkins, American University, USA
Brian McGowan, American University, USA

ABSTRACT

This research contributes to literature for a mixed methods study focusing on the examination of Black people across STEM disciplines within the Washington Metropolitan area. This systematic literature review provides socio-historical contextual background that informs future STEM research in this region and adds to the literature focused on the history of Black people in STEM generally. The primary objective of this systematic literature review was to identify empirically supported items (e.g. books, articles, thesis, news, law briefings) relevant to Black/African American's studying or working in STEM fields at universities in the MidAtlantic region (i.e. Washington, D.C., Maryland, Virginia, West Virginia, New York, New Jersey, Pennsylvania, and Delaware).

Strand 11: Cultural, Social, and Gender Issues
Poster

Vanquishing the Fear of Optics: Unleashing the Power of the Culturo-Techno-Contextual Approach (CTCA)

John Ogonenwe, African Center of Excellence for Innovative and Transformative STEM Education, LASU, Nigeria
Tunde Rahman, LAGOS STATE UNIVERSITY, Nigeria
Peter Okebukola*, LAGOS STATE UNIVERSITY, Nigeria
Juma Shabani, University of Burundi, Burundi
Ademola Ibukunolu, LAGOS STATE UNIVERSITY, Nigeria

ABSTRACT

Optics, a crucial branch of physics, often instils dread and apprehension among secondary school students due to its complex and abstract theories. This pervasive struggle necessitates innovative pedagogical interventions to transform students' negative attitudes and enhance their understanding. In response, this study examined the Culturo-Techno-Contextual Approach (CTCA), an educational methodology designed to revolutionize learning by integrating culture, technology, and context. CTCA employs culturally relevant examples, technological tools, and contextual learning experiences to make abstract concepts more accessible and engaging. By incorporating elements from students' cultural backgrounds and providing interactive, technology-enhanced learning opportunities, CTCA aims to transform their attitudes towards challenging subjects and boost academic performance. The study used a mixed-methods design with 116 students (61 males and 55 females) from two senior secondary schools. The experimental group, consisting of 36 males and 34 females, received instruction through CTCA, while the control group, comprising 25 males and 21 females, followed the traditional lecture-based method. Analysis of covariance (ANCOVA) was conducted with pretest scores as a covariate. Results indicated that the experimental group showed a significantly more positive attitude towards physics compared to the control group, underscoring CTCA's effectiveness in improving academic performance in optics, regardless of gender.

Strand 11: Cultural, Social, and Gender Issues
Poster

Assessing Relational Equity in Small Groups in a STEM Learning Environment

Vanessa Figueroa Weston*, Grinnell College, USA
Paul Hutchison, Grinnell College, USA

ABSTRACT

Building on prior work that aims to support instructors creating equitable collaborative small groups in STEM education classrooms, we explore how the concept ofrelational equity (Boaler 2008) can support instructors making assessments of equity. Relational equity focuses us on how students play an active role in promoting opportunities for their group members to learn. Using video data, we analyzed two small groups – one with high relational equity and one with low – of rising college freshman participating in a summer STEM program for students with traditionally under-represented identities. Our analysis reveals three indicators of relational equity: idea role orientation, competitive vs. collaborative viewpoints, and talking time. These reveal potential indicators for instructors to identify how small groups are functioningvis a vis equity so they can recognize when to intervene to support greater equity.

Strand 12: Technology for Teaching, Learning, and Research
Poster

Creating engaging learning spaces for teaching Machine Learning to adolescents

Manav Sharma*, University of Miami, USA
Ji Shen*, University of Miami, USA

ABSTRACT

There is a need for Artificial Intelligence (AI) curricula that are developmentally appropriate and appeal to students' interests (Lee and Perret, 2022). Employing a Project-based Learning framework (Krajcik and Shin, 2014) we designed a unit on Machine Learning (ML) using Google Teachable Machine for early adolescents. The curriculum incorporates interest-driven practices that connect to students' everyday life (e.g., sports, music). We implemented this in a pilot study with three participants and documented their learning progress. The findings suggest that the curriculum produces quality learning outcomes including improved knowledge about ML and the process of training ML models.

Strand 12: Technology for Teaching, Learning, and Research
Poster

Perceptions of Using Artificial Intelligence-Based Educational Tools

Sabrina Stanley*, University of North Alabama, USA
Hannah Howell, University of North Alabama, USA

ABSTRACT

Artificial intelligence (AI) can be a transformative tool in education when utilized by educators intentionally. Woodruff et al. (2023) found several gaps in the area of AI policy, training and awareness among educators in a broad, nationwide study. The principal investigators replicated this study in a southeastern United States regional area to gain a better understanding of the perceptions of AI in current in-service and pre-service teachers.Teachers are critical partners in educational research. In this study, the researchers compared in-service to pre-service teacher's perceptions of using artificial intelligence-based educational tools. A Qualtrics survey was distributed via electronic resources to current in-service and pre-service teachers in the region. The data collected was analyzed using quantitative methodology to understand the perceptions of using AI tools in an education setting.Principal investigators expect to gain a better understanding of how educators in the region perceive using AI educational tools within the K-12 classroom. This research is significant as it will serve as the foundation for understanding how current in-service and pre-service teachers are adapting to the ever-changing world of AI if it is being used positively in the classroom and to institute plans to prepare future pre-service teachers for this educational climate.

Strand 12: Technology for Teaching, Learning, and Research
Poster

Impact of Personalized Learning Approach (UDA 1.0) on students Cognitive Proficiency in ICT

Uchenna Ugwuoke*, LASU-ACEITSE, Nigeria
Peter Okebukola, LASU-ACEITSE, Nigeria
Rahman Alade, LASU-ACEITSE, Nigeria
Rasheed Sanni, LASU-ACEITSE, Nigeria
Abdurrazaq Olawale, LASU-ACEITSE, Nigeria

ABSTRACT

The growing demand for improved cognitive proficiency in education highlights the need for effective pedagogical approaches that address diverse learning needs. Traditional instructional methods often times fail to meet these needs, leading to cognitive overload and ineffective study techniques. This study investigates the effectiveness of a personalised learning approach (UDA 1.0) in improving students' cognitive proficiency in ICT. The research design was a quasi-experimental design, 118 senior secondary two ICT students were engaged from two schools in Lagos State, Nigeria. The experimental group utilized the UDA 1.0 platform, which incorporated personalized learning techniques and interactive content, while the control group received traditional lecture-based instruction. The Software Development Cycle Achievement Test (SDCAT) measured cognitive proficiency before and after intervention for both the experimental and control group. The ANCOVA output demonstrated a statistically significant difference in the cognitive proficiency [F (1,118) = 172.13; p .05]. Additionally, students reported a positive perception of UDA 1.0, noting improved understanding and engagements. This study highlights the benefits of personalised learning approaches and suggests that UDA 1.0 can be a valuable tool in addressing diverse learning needs. The findings advocate for broader adoption of interactive, personalized learning platforms in education.

Strand 12: Technology for Teaching, Learning, and Research
Poster

Curating the Future: Integrating Digital Curation for Personalized Learning in Science Education

Gal Stern, Technion - Israel Institute of Technology, Israel
Dina Tsybulsky*, Technion - Israel Institute of Technology, Israel

ABSTRACT

This study explores the implementation of Digital Curation (DC) as a teaching method to enhance Personalized Learning (PL) in middle school science education. PL is increasingly recognized as a practical educational approach tailored to individual students' unique strengths, needs, and interests. DC involves collecting, organizing, and interpreting digital content, allowing students to create personalized collections that align with their learning objectives. A qualitative case study approach was employed, collecting data from middle school science students (n=28) through lesson observations, semi-structured interviews, and analysis of student-curated collections. The findings indicate that DC significantly enhances students' critical thinking skills, promotes the development of independent and collaborative learning strategies, and fosters greater engagement and confidence in the learning process. Students actively curated digital content that resonated with their interests, leading to a deeper understanding and retention of scientific concepts. The study concludes that DC is a

powerful tool for promoting PL in science education, offering a flexible and dynamic framework that supports student autonomy and engagement. By integrating DC into science classrooms, educators can create more personalized and meaningful learning experiences, preparing students for the demands of the digital age.

Strand 12: Technology for Teaching, Learning, and Research
Poster

Is AI a Viable Coder: An Exploratory Study Using ChatGPT for In Vivo Coding

Xinyu He*, University of Georgia, USA
Ella Yonai, University of Georgia, USA
Julie Luft, University of Georgia, USA
Elizabeth Ayano, University of Georgia, USA
Joseph Deluca,University of Georgia, USA
Yuxi Huang, university of California, Irvine, USA

ABSTRACT

Generative AI (GAI) holds great potential for science education research. One potential use of GAI is to investigate how GAI can be used in in vivo coding. This exploratory study explored strategies to deal with the difficulties of using AI with in vivo coding. The research questions guiding this study are: 1) What are the differences between an AI coder and human coder during in vivo coding, and 2) How should we treat the disagreement between AI and human coders. As part of a larger project, this study used prompt engineering to customize ChatGPT to in vivo code teachers' interviews for opportunities to learn. Results showed that the AI coder had difficulties in identifying negative aspects in interviews and distinguishing teacher and student learning. We also found that example coding and human-AI discussions facilitated AI's performance. Based on the results, this study argued that including AI coder in inductive coding requires an iterative conversation with AI to update its knowledge for a viable coding process. We also suggested further studies to explore strategies about how to complicateAI's knowledge of decision-making process while coding.

Strand 12: Technology for Teaching, Learning, and Research
Poster

Technology enhanced collaborative argumentation and discourse in socioscientific issues

Sharfun Islam Nancy*, University of South Florida, USA

ABSTRACT

This paper reviews and synthesizes the literature in the area of students' collaborative argumentation on socio-scientific issues in technology-enhanced mediums and/or environments. This review focuses on current literature from 2012 to the present, identifying themes and significant research directions in this area, and, finding specific technology tools utilized in research, suggesting possible new avenues for further research. Both empirical and theoretical studies are explored in this review with a area of focus within these themes 1) SSI based argumentation focused discussion in online environment 2) Social interaction and discourse in students' learning science 3) Technology tools utilized in student's' discourse

and argumentation. The review has a multidisciplinary approach dimension centering around the SSI framework, which promotes and advocates scientific literacy for all students. This review draws on the current literature surrounding these themes and provides implications for research and practice.

Strand 12: Technology for Teaching, Learning, and Research
Poster

Exploring Equity Maps App as a Tool to Bridge Research and Practice

Mandy Dunphy*, Baylor University, USA
Alison Warren*, University of Iowa, USA
David Nelson, Asociación Escuelas Lincoln/Founder of Equity Maps App, Argentina
Brian Hand, University of Iowa, USA

ABSTRACT

This study explores the potential of the Equity Maps app as both a pedagogical tool and a research instrument to bridge the gap between classroom practice and educational research. Traditionally used to promote equitable student participation and engagement by tracking and visualizing real-time classroom discussions, the app is now being investigated for its research capabilities. Anchored in Gert Biesta's (2017) concept of equality of intelligence and Generative Learning Theory (Osborne Wittrock, 1985), this research examines how the Equity Maps app can facilitate teachers' reflective practices and support researchers in analyzing classroom dynamics. The study employed the app in two contexts—a high school biology classroom and a nature-based learning environment—to evaluate its impact on fostering equitable and generative learning environments. Findings suggest that the app is a valuable tool for both educators and researchers, providing real-time data to inform classroom interventions and research insights. However, limitations such as its focus on verbal participation and the technical requirements of the app highlight areas for future improvement. This research contributes to the ongoing advancement of science education by demonstrating how technology can enhance both teaching practices and research methodologies.

Strand 12: Technology for Teaching, Learning, and Research
Poster

Exploring LLM's Capabilities in Measuring Science PCK Using Lesson Plans and Open-ended Responses

Arif Rachmatullah*, SRI International, USA
Shaishav Tayde, SRI International, USA
Nonye Alozie, SRI International, USA
John Niekrasz, SRI International, USA
Sophia Ouyang, SRI International, USA
Marta Mielicki, SRI International, USA
Hui Yang, SRI International, USA

ABSTRACT
Pedagogical Content Knowledge (PCK) has long been a conceptual framework in science teacher education research, but its application in practice remains limited. One reason for this may be the time-consuming, subjective, and labor-intensive nature of PCK data collection and analysis. In this paper, we demonstrate the potential of large language models (LLMs) in measuring science teachers' PCK using lesson plans and synthetic open-ended responses. We iteratively trained and tested scoring models for both open-ended responses and lesson plans to assess various components of PCK. Our findings indicate that LLMs show promise in reliably measuring certain components of PCK, with human-machine reliability values approaching human-human reliability and some exceeding .80. However, LLMs performed poorly on some PCK components. Despite this, the results suggest that LLMs hold potential for advancing and scaling up science PCK research by incorporating multiple data sources.

Strand 12: Technology for Teaching, Learning, and Research
Poster

Enhancing Conceptual Understanding of Friction Force Through Dynamic Modelling by Using the ArMo Application

Tugba Yuksel*, Recep Tayyip Erdogan University, Turkey
Ibrahim Delen, Usak University, Turkey
Bahadir Namdar, Ege University, Turkey
Ince Gokhan, Istanbul Thecnical University, Turkey

ABSTRACT
This study investigates the impact of the ArMo application on students' understanding of friction force concepts through a dynamic modelling process. Developed as an innovative alternative to existing AR tools, the ArMo application offers students an interactive platform to engage in the model-based learning cycle, including model creation, testing, evaluation, and revision. The study employed a mixed-methods approach, incorporating both qualitative data from student feedback, observations, and training sessions, and quantitative data through pre- and post-tests using "Energy-Force" scale. Results indicated that students in the experimental group demonstrated significant gains in understanding friction force compared to the control group, showcasing the effectiveness of the ArMo application in fostering deeper conceptual comprehension. Furthermore, students reported positive experiences with the application, citing its interactive features and modelling notebook as enhancing their learning process. The class teacher also highlighted improved time management when using the ArMo application for modelling activities, in contrast to traditional physical models. This study underscores the potential of integrating augmented reality and model-based learning tools in science education, offering valuable insights for educators and researchers into the benefits of innovative approaches in teaching complex scientific concepts.

Strand 13: History, Philosophy, Sociology, and Nature of Science
Poster

How do Inservice Teachers Conceptualize the Value-laden Nature of Technology?

Jerrid Kruse*, Drake University, USA
Isaiah Kent-Schneider, Drake University, USA
Lucas Menke, Drake University, USA

ABSTRACT
The value-laden nature of technology recognizes the ways technologies contain and promote particular value systems. Understanding the ways technology promotes certain values equips teachers with a critical perspective for engaging with technology. Unfortunately, little is known about how teachers conceptualize the value-laden nature of technology. This exploratory study used qualitative methods to explore 49 inservice teachers' conceptions of the value-laden nature of technology. Themes related to teachers' thinking and implications for teaching and teacher education will be discussed.

Strand 13: History, Philosophy, Sociology, and Nature of Science
Poster

Tensions in Nature of Science Assessment

Sarah Voss*, Western Washington University, USA
Debi Hanuscin, Western Washington University, USA
Isaiah Kent-Schneider, Drake University, USA

ABSTRACT
Prior research has found inappropriate use of assessment to be a significant challenge to effective NOS instruction. Teachers tend not to assess for NOS (Bektas et al., 2013; Supprakob et al., 2016) or use a single assessment strategy (Bilican et al., 2012).Yet, a focus on "challenges" to NOS assessment may provide an incomplete picture of teachers' experiences assessing NOS. Rather, contextualizing "challenges" to NOS assessment within particular tensions teachers experience can provide a broader view of teachers' decision-making – and a greater understanding of why teachers choose to assess (or not assess) NOS in certain ways. This self-study used the concept of 'tensions' (Berry, 2007) as a lens to understand the experiences of an educator who was teaching and assessing NOS in middle school during a semester-long teaching experience. Aided by critical friends, the educator analyzed critical incidents (Tripp, 2003) in their practice related to NOS assessment, and constructed vignettes to represent the tensions underlying each incident. This study provides evidence that tensions are inherent to the experience of assessing NOS, and suggests tensions can be used to study NOS assessment from a more holistic and asset-based perspective.

Strand 13: History, Philosophy, Sociology, and Nature of Science
Poster

A comparative case study of PCK of NOS with a biology teacher teaching three content

Paola Núñez, Pontificia Universidad Católica de Valparaíso, Chile
Catalina Cañete, Pontificia Universidad Católica de Valparaíso, Chile
Carolina Parraguez*, Pontificia Universidad Católica de Valparaíso, Chile
Hernan Cofré, Pontificia Universidad Católica de Valparaíso, Chile

ABSTRACT
The study of Pedagogical Content Knowledge (PCK) about the Nature of Science (NOS) focuses on how teachers can effectively teach their students about how science works, how science is conducted, and how science relates to society. In recent years, theoretical models have been proposed to identify the elements that constitute a teacher's PCK. Therefore, the main aim of this research was described how does a biology teacher's personal NOS PCK (pPCKNOS) vary across three different content areas (evolution, genetics, and climate change) compared to the collective NOS PCK.To capture the personal PCK of teacher Peter, 6 semi-structured content representation interviews (CoRe) were conducted (Loughran et al., 2004) before and after teaching each subject. According to the analysis of the 6 CoRe interviews conducted we can conclude that, although there are certain idiosyncratic aspects in the PCK of NOS associated with the specific content taught when teachers include NOS in their classes, patterns emerge that are recurrent about the orientations, strategies and preconceptions that most concern the teacher.

Strand 14: Environmental Education and Sustainability
Poster

Sustainable and healthy nutrition among young people: TPB-based study

Julia Holzer*, University of Bremen, Germany
Doris Elster, University of Bremen, Germany

ABSTRACT
Nutritional habits are an important field of action for promoting ecologically sustainable development. However, it is not easy to make the right decision in terms of a healthy and sustainable nutrition. The following study attempts to uncover the extent to which young people eat sustainably and healthily. This question is considered in terms of the theory of planned behavior. The intention of young people to eat healthily and sustainably is considered, as well as other motivational factors such as attitude (ATT), subjective norm (SN) and perceived behavioral control (PBC). In addition, the level of knowledge on the topic and its influence on the intention is measured. A total of 171 students (age ø: 17.3; n= 96 ♀/ n =75 ♂) from german school completed a questionnaire. The results of the regression analysis show that the theory-internal factors (ATT, SN, PBC) together explain 53% of the intention to eat healthily and sustainably. If knowledge is also taken into account in the model, the model explains a further 2% of the intention. It is clear from these results that ATT, PBC and knowledge should form the starting points in subsequent studies in order to sensitize students to healthy and sustainable eating habits.

Strand 14: Environmental Education and Sustainability
Poster

Exploring the long-term insights gained from a climate learning experience in an innovative museum exhibit

Benjamin Janney*, University of Utah, USA
Lynne Zummo, University of Utah, USA
Marc Whiting, University of Utah, USA
Jordan Giron, University of Utah, USA

ABSTRACT
Informal science learning, particularly in public science museums, plays a crucial role in engaging the public with complex and contentious issues like climate change. As trusted institutions for learning, science museums are poised to advance trust in climate science and promote pro-climate actions across diverse audiences. To achieve this, exhibit designers and communicators must leverage research-based best practices for engaging people in authentic climate education. This study examines the lasting and revised insights of 11 participants' interviews over two months after their experience with an innovative climate exhibit. The findings reveal that specific exhibit elements led to enduring shits in participants, views on climate change, and increased willingness to engage in pro-climate coping strategies and actions. We present empirically supported implications and recommendations for the future design of climate change exhibits and education.

Strand 14: Environmental Education and Sustainability
Poster

Evaluating XR Interventions in Environmental Education: A Systematic Literature Review

K. "Ren" Mendoza*, University of Nebraska at Omaha, USA
Noah Glaser, University of Missouri, USA
Jule Krüger, University of Potsdam, Germany
Mohan Yang, Texas A&M University, USA
Kimberly Moeller, University of Missouri, USA

ABSTRACT
The integration of Extended Reality (XR) technologies in environmental education represents a potentially transformative way to engage and educate the public about ecological issues. This systematic literature review examines the expanding use of XR technologies within environmental education. It addresses key research questions regarding the extent, design, methods, and results of XR interventions, offering an in-depth analysis of their effectiveness in promoting environmental knowledge, attitudes, and behaviors. The comprehensive review was conducted following PRISMA guidelines. The search identified 968 articles, which were screened for eligibility. After deduplication and initial review, 53 articles were considered for full-text analysis, and 29 articles met the inclusion criteria. Based on the findings, the review highlights the importance of integrating XR experiences within established curricula, ensuring precise documentation and design of technologies used, grounding XR development and interventions in educational theory, and selecting appropriate methodologies for exploring critical outcomes. Findings from the literature review provides an overview of XR technology in environmental education, highlights effective practices, and suggests directions for future research.

Strand 14: Environmental Education and Sustainability
Poster

Development of Global Goals Sustainability Mindsets Instrument

Hyunju Lee*, Smithsonian Science Education Center, USA

Jackie Kolb*, Smithsonian Science Education Center, USA

ABSTRACT
Despite the increasing efforts to integrate sustainability education into K-12 science curricula, current K-12 science standards, such as the Next Generation Science Standards (NGSS), provide students a limited foundation for understanding sustainability challenges and applying their learning in daily lives. Although the NGSS addresses some sustainability issues, additional resources and frameworks are necessary to help students better understand these challenges and grow as global citizens equipped with strong sustainability competencies. While several frameworks exist for sustainability education, few are specifically designed to support the integration of sustainability into science education. Moreover, there is a lack of tools for assessing students' sustainability mindsets, even though there are various instruments developed to measure students' scientific or environmental literacy. Given that, we have developed the Global Goals Sustainability Mindsets Instrument that is based on the Global Goals Action Progression, a framework designed to integrate the United Nation's Sustainable Development Goals into science education. In this study, we share the development process of the Global Goals Sustainability Mindsets Instrument and present its validity and reliability test results. The instrument will provide anaccessible tool for educators andresearchers in K-12 science and sustainability education, enabling a deeper understanding of students' mindsets on sustainability challenges.

Strand 14: Environmental Education and Sustainability
Poster

Surfacing Local Ecological Knowledge to Establish Needs for a Community Marine Science Conservation Initiative

Hada Herring, University of Florida, USA
Julie Brown*, University of Florida, USA
Kent Crippen, University of Florida, USA
Shae Kelliher, University of Florida Marine Animal Rescue, USA
Suzanna Mickey, University of Florida Marine Animal Rescue, USA
Michael Walsh, University of Florida Marine Animal Rescue, USA
Stefanie Gazda, Cedar Key Dolphin Project, USA

ABSTRACT
This study explored the local activities, knowledge, and beliefs of community members in distinct rural coastal counties along the Gulf of Mexico, with the aim of informing the co-design of a community science and education initiative focused on aquatic wildlife and ecosystems. Using the Local Ecological Knowledge (LEK) framework, we administered questionnaires in-person, online, and over the phone to 115 adult locals between July and August 2023. Descriptive statistics and data visualizations of the findings revealed that nearly all participants engaged in pro-environmental behaviors, such as picking up trash and abiding by boat speed zones. Further, their monthly activities, such as recreational boating, working for commercial fisheries, and living on or near the water, frequently overlapped with their aquatic environment. This enabled participants to provide valuable insights into the spatial distribution and frequency of sightings of target species, including dolphins, whales,

manatees, and sea turtles. Community members demonstrated a strong sense of agency and interest in protecting these species, including through potential community science projects. This work enhances our understanding of LEK's application in marine science education and conservation initiatives, highlighting the vital role of rural community members as capable and essential science educators in these efforts.

Strand 14: Environmental Education and Sustainability
Poster

A Systematic Literature Review of Ocean Literacy in Non-formal Education Initiatives

Lisa Coe*, University of Florida, USA
Hada Herring, University of Florida, USA
Julie Brown, University of Florida, USA

ABSTRACT

The health of the ocean is essential to human wellbeing, but increasing and compounding anthropogenic pressures are putting the ocean at risk. Targeting ocean education through non-formal learning experiences has been essential, yet how these non-formal initiatives connect to ocean literacy remains largely unknown. In response, we conducted a systematic literature review of 33 studies to characterize non-formal marine science education efforts worldwide and examine how these efforts align with the Ocean Literacy Framework. The search, screening, and extraction processes of the empirical studies were guided by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) principles. Thirty-three studies were selected as data for this review. Results indicate that though non-formal programs are making connections between their educational efforts and the Ocean Literacy Framework, principles and concepts appear to be unevenly represented in this space. While recognizing limitations of our study design, we also recommend changes to the Ocean Literacy Framework that are based on trends observed in non-formal ocean education. The results of this study have specific implications for supporting non-formal educators as essential partners in reforming and reframing through effective ocean science learning experiences.

Strand 14: Environmental Education and Sustainability
Poster

Pre-service Teachers' Climate Emotions in a Course on Climate Change

Emily Olsen*, Penn State University, USA
Aubrey Grzywacz, Penn State University, USA

ABSTRACT

Little research has been done surrounding emotions and their role in environmental education (EE), specifically climate change education (CCE). An even smaller amount of research has been done in relation to climate emotions and youth ages 18-24 (Author et al., 2024), especially with pre-service teachers (Hufnagel, 2015), who are responsible for educating future generations. A single case study was conducted with a focus on investigating the nuance in the intersection of climate emotions and CCE. Data collection

about the case consisted of field memos, interviews, and artifacts to aid in the data triangulation (Yin, 2018). A primarily inductive analytic strategy was used with both a priori and in vivo codes. Simultaneous coding focusing on emotions was conducted, and then a second round consisting of pattern coding was conducted (Saldaña, 2016). The findings highlight the critical importance of relationships, including building classroom community and fostering a connection to the more-than-human world, as well as a curriculum that is relevant to the pre-service teachers' lives for the processing of climate emotions.

Strand 14: Environmental Education and Sustainability
Poster

Climate Denial in Media: Brazilian Students' Understandings of Uncertainty in Scientific Models

Mariana Monteiro, University of São Paulo, Brazil
Lúcia Sasseron*, University of São Paulo, Brazil

ABSTRACT

The unfolding climate and environmental crises and the rise of climate change denial movements demand that science education be part of the solution to the spread of misinformation about climate change. In this study we investigate how Brazilian high school students understand the relationship between uncertainty of climate models and their reliability.To this, we conducted a case study research design, in which 57 high school students evaluatedan interview given by a climate denier in which he criticizes the reliability of climate models, claiming that such models are uncertain.Organized into groups, the students presented their views on the relationship between the uncertainty of climate models and their reliability. To analyze the student responses,we organized analysis categories based on Osborne et al.(2022) ideas about the knowledge that students need to have about uncertainty to deal with science-related information in their daily lives. The results suggest that students understand that the uncertainty associated with climate models does not reduce their reliability, and that scientific models have limits but are useful for making inferences and reliable predictions.

Strand 14: Environmental Education and Sustainability
Poster

Students Beliefs towards Climate Change and its Teaching

Helin Semilarski*, University of Tartu, Estonia
Helen Semilarski, University of Tartu, Estonia
Katrin Vaino, University of Tartu, Estonia
Ana Valdmann, University of Tartu, Estonia

ABSTRACT

Climate change can impact future generations irreversibly and is currently one of society's most pressing issues. Therefore, paying significant attention to addressing climate change in education is essential and serves as the foundation for our sustainability. This research aims to map students' attitudes towards climate change and its teaching in general education schools. Data was collected from general education school students (N=90) using a

combined questionnaire. In their responses, students highlighted the potential significant role that schools and teachers in adapting to climate change and mitigating its effects, which they currently do not perceive adequately.

Strand 14: Environmental Education and Sustainability
24-Mar-25, 4:45 PM-6:15 PM
Poster

A Case Study of Leveraging Climate Change Curriculum as a means of Science Communication

Shweta Lahiri*, University of Georgia, USA
Ayça Fackler, University of Missouri, USA
Emily Miller, University of Georgia, USA
Hong Tran, Purdue University, USA
Joseph Deluca,University of Georgia, USA

ABSTRACT

Climate change is one of the most challenging socioscientific issues of the century impacting people including children. Education systems play a pivotal role in incorporating the topic of climate change in elementary curriculum to equip students with required knowledge, skills and values to understand the phenomenon. However, teachers are key players in enacting the curriculum and communicating its contents to students. We present a case study on an upper grade elementary science teacher from a school in an area impacted by climate change. In our study, we explored the influence of a climate change curriculum on the elementary science teacher's perspective on human causes within the context of science communication. Preliminary findings revealed that the teacher prioritized content knowledge about climate change and is uncertain about anthropogenic activities contributing to it. However, he acknowledged discussing the relevance of climate change to students' lives can make students more engaged in the topic. We emphasize the importance of equitable teacher participation in the development and adaptation of climate change curriculum thereby enhancing teachers' agency and empowering them.

JRST Editor's Dinner (Invitation Only)
24-Mar-25, 6:30 PM-8:00 PM
Location: Camellia 2
Social Event

Book Talk: Applying Machine Learning in Science Education Research: When, how, and why?

24-Mar-25, 7:00 PM-8:00 PM
Location: Annapolis 1

Social Event

Xiaoming Zhai, University of Georgia, Athens, USA
Kent Crippen, University of Florida, USA
Marcus Kubsch, Freie Universität Berlin, Germany
Peter Wulff, Heidelberg University of Education, Germany
Christina Krist, Stanford University, USA

ABSTRACT

This RAISE Book Talk, chaired by Kent Crippen, will explore the textbook Applying Machine Learning in Science Education Research: When, how, and why? By Peter Wulff, Marcus Kubsch, and Christina Krist, with a focus on how researchers and graduate students can effectively learn and apply ML in their own work. The session will begin with a brief presentation from the authors of the book, addressing the three core questions posed in the book title: When, how, and why to use ML in science education research. They will also provide an overview of the book's structure and practical tools, explaining how it can be used to develop essential skills in applying ML techniques. Participants will then break into small groups to discuss what graduate students and researchers need to learn in order to use ML effectively. This discussion will center around the specific technical, theoretical, and ethical competencies required for ML in educational research, drawing on both the textbook and participants' experiences. The session will close with a perspective on the book and the discussed topics by Xiaoming Zhai, followed by an open group discussion. Participants will share insights and recommendations on how to better integrate ML into science education research training, ensuring that future researchers are equipped with the necessary skills and ethical awareness. Designed for educators, graduate students, and researchers, this session will offer a collaborative environment for exploring how ML can be better integrated into research – both in training and practice.

Kiki and community: Choose your adventure social for LGBTQ+ folk and allies to build connections and community

24-Mar-25, 7:00 PM-8:00 PM
Location: Baltimore 1

Social Event

Sara Porter, University of North Carolina at Greensboro, USA
Colby Tofel-Grehl, Utah State University, Logan, USA

ABSTRACT

Join the LGBTQ+ RIG to build community and share our work related to LGBTQ+ issues in STEM. We have two options for folks to participate: a pub crawl or a craft circle. If you would like to get out of the hotel and wander the town with new friends, you can join our pub crawl. As you move from pub to pub, different folks will be invited to share their work or ideas about LGBTQ+ STEM. The second option is to stay at the hotel and join our LGBTQ+ craft circle. You can bring your craft or we will provide materials for a light-up pronoun pin. As we craft together, we will similarly share our work in LGBTQ+ STEM. The goal is to share ideas and make connections across our work for potential collaborations at NARST 2026. All are welcome!

In-Person Conference Day 3
25 March 2025

Committee Business Meetings
25-Mar-25, 7:00 AM-8:00 AM

Membership Committee Meeting
Location: Annapolis 1

Program Committee Meeting
Location: Annapolis 2

Research Committee Meeting
Location: Annapolis 3

Social Media, Website & Communications Committee Meeting
Location: Baltimore 1

Awards Committee Meeting
Location: Baltimore 2

Elections Committee Meeting
Location: Baltimore 3

Equity and Ethics Committee Meeting
Location: Baltimore 4

Professional Learning and Institutes Committee Meeting
Location: Baltimore 5

Graduate Student Committee Meeting
Location: Magnolia 1

International Committee Meeting
Location: Magnolia 2

Scholarships Committee Meeting
Location: Magnolia 3

Advancing Connections Between Research and Practice: JRST Research Worth Reading Recognition
25-Mar-25, 8:15 AM-9:45 AM
Location: Magnolia 3

Administrative Session
Tina Voss, University of Nevada, USA
Marcus Kubsch, Freie University-Berlin, Germany
Cesar Delgado, North Carolina State University, USA
Carla Zembal-Saul, Penn State University, USA
Shiang-Yao Liu, National Taiwan Normal University, Taiwan

ABSTRACT
Join us in congratulating this year's recipients of the NSTA Annual Research Worth Reading recognition. This recognition is given to three research groups whose 2024 JRST articles inspire excellent teaching innovations. Each recipient will briefly highlight the broader practical implications of their work, followed by a joint discussion. This year's recipients are:

Adler, I., & Karam, C. (2024). Djaji Mahsheye, Moghrabeye, and Labaneh: Making science relevant. Journal of Research in Science Teaching, 61(1), 103-136. https://doi.org/10.1002/tea.21866

Nation, J., & Kang, H. (2024). “We need to step it up—We are basically the future”: Latinx young women co-construct science storylines in high school chemistry. Journal of Research in Science Teaching, 61(4), 873-904. https://doi.org/10.1002/tea.21921

Krakowski, A., Greenwald, E., Roman, N., Morales, C., & Loper, S. (2024). Computational Thinking for Science: Positioning coding as a tool for doing science. Journal of Research in Science Teaching, 61(7), 1574-1608. https://doi.org/10.1002/tea.21907

Clark, H. F., Gyles, S. A., Tieu, D., Venkatesh, S., & Sandoval, W. A. (2024). Exploring science teachers' efforts to frame phenomena in the community. Journal of Research in Science Teaching, 61(9), 2104-2132. https://doi.org/10.1002/tea.21945

Exploring Connections Between Self and Science

Strand 2: Science Learning: Contexts, Characteristics and Interactions
25-Mar-25, 8:15 AM-9:45 AM
Location: Annapolis 1

Stand-Alone Paper

Student Success Stories in Urban Science Education: Exploring Science as Refuge

Kristina Salciccioli*, University of Toronto, Canada
Erminia Pedretti, University of Toronto, Canada

ABSTRACT

This qualitative interview-based study involved 17 students, who attended a high school, located in an urban centre of a mid-sized Canadian city. All participants experienced "at-risk situations" and a variety of challenging circumstances including poverty, abuse, housing instability, language barriers and issues related to racism and prejudice. In spite of these issues, over the past 9 years, 47 % of all students that pursue university from this school chose a science program (Board District, 2024). In exploring why these students chose science as a secondary pathway several explained that science represented a choice that offered a "refuge" from the struggle of their daily lives. These students viewed science as a way out of poverty, a subject and a process that reflected their personal sensibilities and a way to contribute to society. Several participant responses reflected tenants of Scientific Literacy, Nature of Science and STSE. This work offers insight to how urban students who have experienced at-risk situations understand science as a subject and process; and how they made the choice to study science at the university level.

Stand-Alone Paper

Investigating the relationships between students perspectives of future consequences and interest in a STEM career

Nespolino Antonietta, University Federico II, Italy
Silvia Galano, University Federico II, Italy
Italo Testa*, University Federico II, Italy

ABSTRACT

Previous research suggests that perspectives of future consequences predict academic achievement and overall adjustment to academic trajectory. However, few studies have investigated the relationship between perspectives of future consequences and the decision to enrol in a university course. The present study aims to address this issue with particular regard to the choice of a Science-Technology-Engineering-Mathematics (STEM) university course. We also looked at gender and age effects. Participants were 4,503 high school students attending 11th, 12th and 13th grade at 60 Italian public schools. Repeated measures analysis of variance showed that perspectives of future consequences significantly affect the choice to enrol in a university course, regardless of the chosen course. We also found that girls interested in STEM are less focused on immediate consequences than their peers, while boys interested in STEM are more focused on future consequences than their peers. Finally, we consistently found across school years that students who are not willing to enrol in a

university course are less focused on future time consequences. Our study therefore suggests to design interventions that help students reflect on their time orientation and strengthening their perceptions of future consequences to better organize their decision-making processes.

Stand-Alone Paper

Expanding Elementary STEM Education Through Teacher-Researcher Complementarity: A Rural STEM Education Research Case Study

Christine McGrail, University of North Dakota, USA
Kendi Loy, Northwood Schools, USA

ABSTRACT

This proposal describes how a second-grade teacher and a university professor collaborated to expand science and engineering learning experiences for a classroom in a rural midwest town. The partnership was the first research experience for the teacher and the first research experience in the new context for the professor.We contribute to the development of greater conceptual clarity regarding school–university research partnerships and their potential to contribute to the creation and translation of knowledge about teaching and learning.

Stand-Alone Paper

Examining Black Girls' Experiences in STEM: A Systematic Literature Review

Olayinka Mohorn*, University of Memphis, USA
Alexis Riley*, New York University, USA
Demetrice Smith-Mutegi*, Old Dominion University, USA
Monica Miles, University at Buffalo-SUNY, USA
Joi Merritt, James Madison University, USA

ABSTRACT

The purpose of this systematic literature review is to examine recent research literature (2013-2023) centering Black girls in STEM education. The experiences of Black girls have been overlooked or generalized under broader categories that do not fully capture their uniqueness, strengths and challenges that surfaces as they do STEM. Intersectionality and Critical Race Feminism are theoretical frameworks that allowed the authors to critically examine the purposes, methodologies, and motivations of research on Black girls in STEM education. The review process followed the PRISMA guidelines to ensure transparency, which eventually led to 30 articles. Findings for this study highlight interventions and counterspaces that have been developed to provide Black girls authentic and affirming ways to access STEM. To ensure that the majority of Black girls get the chance to learn STEM in affirming ways, we can not solely rely on counterspaces but must also adopt these practices within schools. This proposal has implications for policy, research, and practice in formal and informal STEM learning spaces for how to meet the needs of multi-marginalized communities.

Using data to foster deeper learning with consideration for the human elements that influence teaching practices

Strand 4: Science Teaching — Middle and High School (Grades 5-12): Characteristics and Strategies
25-Mar-25, 8:15 AM-9:45 AM
Location: Baltimore 4

Stand-Alone Paper

The role of Representations in supporting evaluating Measurement Data

Stephen Mayer*, Humboldt-Universität zu Berlin, Germany
Burkhard Priemer, Humboldt-Universität zu Berlin, Germany

ABSTRACT

Representations are able to aid students in learning, gaining conceptual understanding, and solving problems. Changes in representations can influence these processes, primarily by affecting the cognitive load. This study examines whether these effects can be found in a task where measurement data is evaluated as well. Physics students were provided with data presented in various forms of representation, including numbers, drawings and photos. This study examines how the form of representation affects the quality of the conclusions drawn from the data, and how the cognitive load the students experienced moderates this effect. The study also controls for students' skills in drawing conclusions from data and identifying patterns. A total of 529 students in grades 9 and 10 participated in the study. The results indicate that the form of representation does not affect the conclusion quality, while the experienced cognitive load significantly influences the quality of students' conclusions in a negative way. Furthermore, no moderation effect could be seen between those variables. This could suggest that data evaluation tasks can be made more accessible by using pictorial representations to decrease language barriers as they are especially not negatively affected by changes in forms of representation.

Stand-Alone Paper

Measurement Uncertainties in Secondary Education: when can the topic be introduced?

Karel Kok*, Humboldt-Universität, Germany
Burkhard Priemer, Humboldt-Universität, Germany

ABSTRACT

Despite its relevance in scientific practice, measurement uncertainty is a topic that is largely neglected in secondary education and for which there are hardly any suitable (evaluated) teaching materials. Consequently, it is a topic that many students have conceptual difficulties with. To investigate when this topic can be introduced, 154 students in grades 8-11 worked with a digital learning environment (DLE). Before and after the DLE, students answered a data comparison problem in which they had to analyze two datasets, make a decision, and justify this. Analysis of the justifications showed an increase in quality indicating a successful transfer of conceptual knowledge to the students. However, no significant

differences were found between grade levels, suggesting that the subject can be introduced as early as 8th grade.

Stand-Alone Paper

Enhancing Explanation Quality in Science Education: The Impact of Content-Based and Structural Interventions

Franziska Hagos*, Humboldt-Universität zu Berlin, Germany
Steffen Wagner, Humboldt-Universität zu Berlin, Germany
Burkhard Priemer, Humboldt-Universität zu Berlin, Germany

ABSTRACT

Scientific explanations are crucial in educational contexts, reflecting subject-specific understanding and adhering to educational standards. Despite their importance, students often struggle with constructing effective scientific explanations, frequently relying on descriptive rather than analytical components. This study investigates how content-based and structural interventions impact the quality of student explanations. We developed a comprehensive framework for evaluating explanations, focusing on relevance, appropriateness of representation, conceptual framework, and causality. The framework was tested using an acoustics phenomenon, and four quality dimensions were defined. A sample of 303 students participated in a study with a pre-mid-post design, involving content-based and structural interventions. Results showed significant improvements in explanation quality across all dimensions, with content-based interventions having a particularly strong impact. The study highlights the effectiveness of targeted interventions in enhancing explanation quality and provides a versatile scaffold for both classroom instruction and further research. This research contributes to understanding how different types of support can improve scientific explanations, offering practical insights for educators and researchers in science education.

Stand-Alone Paper

A Humanistic Stance in Looking at Teacher Experiences with Data Investigations of Extreme Weather

Asli Sezen-Barrie*, University of California Irvine, USA
Josephine Louie, EDC, USA
Emily Fagan, EDC, USA
Kevin Waterman, EDC, USA
Pam Buffington,EDC, USA
Deb Morrison, Clear Environmental, USA
Brian Fitzgerald, Mount Washington Observatory, USA

ABSTRACT

There has been a growing demand for proficiency in "data science" within contemporary scientific endeavors, while the use of authentic and complex data remains limited in many science classrooms. This study uses humanistic stance to explore the factors that affect integrating data investigations in science classroom activity on extreme weather events. Driving from multiple case studies of 6 rural science classrooms, we intend to answer the

following questionHow do rural science teachers experience to personal, cultural, and sociopolitical issues of humanistic stance of data science education?: The study's data sources include ~50 mins of teacher debrief interviews, implementation logs, and field notes from classroom observations. The layers of humanistic stance framework and constant comparative approaches were utilized for the analysis of the data. The findings shed light on how teachers attend to humanistic stance while integrating data into their science courses. The paper provides sample excerpts for themes related to personal.cultural, and sociopolitical layers of humanistic stance from rural school settings.

Applying a Knowledge-in-Pieces Perspective to Biology Education Research

Strand 5: College Science Teaching and Learning (Grades 13-20)
25-Mar-25, 8:15 AM-9:45 AM
Location: Annapolis 2

Symposium

Applying a Knowledge-in-Pieces Perspective to Biology Education Research

Julia Svoboda*, Tufts University, USA
Adrian Adams, University of Utah, USA
Molly Bolger Bolger, University of Georgia, USA
Jennifer Doherty, Michigan State University, USA
Paula Lemons, University of Georgia, USA
Matthew Lira, University of Iowa, USA
Rachel Dowdy, University of Georgia, USA
Philimon Zaagbil, University of Georgia, USA
Sugat Dabholkar, Tufts University, USA
Eric Kusi, University of Georgia, USA

ABSTRACT

Knowledge-in-Pieces (KiP) is a broad theoretical and empirical framework for studying cognition that has seldom been applied to learning in the biological sciences. This symposium brings together researchers, who have begun applying KiP approaches to learning in biology, to examine the theoretical, empirical, methodological contributions that have begun to emerge from this work. We will discuss the promising new questions that come from adopting this perspective and how they can inspire new research directions both in biology education research and in science education research more broadly. Finally, we consider the implications of KiP-based research for instruction and curriculum development in the biological sciences, focusing on how KiP intersects with asset-based orientations. While the research context of this work is at the undergraduate level, this work will also inspire new insights and questions relevant to teaching and learning biology at the K-12 level.

Addressing Science Literacy in Informal Spaces

Strand 6: Science Learning in Informal Contexts
25-Mar-25, 8:15 AM-9:45 AM
Location: Magnolia 2

Stand-Alone Paper

The Importance of Science Education, Scientific Knowledge, and Evaluation Strategies for Detection of COVID-19 Misinformation

Ayelet Baram-Tsabari*, Technion - Israel Institute of Technology, Israel
Shakked Dabran-Zivan, Technion - Israel Institute of Technology, Israel

ABSTRACT

An important goal of science education is to equip students with the scientific knowledge and evaluation skills necessary to identify misinformation, but there is no conclusive evidence regarding their impact in this respect nor the most effective evaluation strategies to achieve this aim have been presented. Study I focuses on a representative sample of the general population (n=500), where science education is compulsory up to 10th grade. Study II focused on a representative sample from the ultra-Orthodox community (n=800), where science education in school is not compulsory. Respondents in both studies were asked to recall misinformation they heard during the COVID-19 pandemic and why they did not believe it. About half of the general population and only a third of the ultra-Orthodox sample identified misinformation successfully. Science education and scientific knowledge contributed to identifying misinformation. In Study I, successful evaluation strategies consisted of assessing the plausibility of the content; in Study II, participants were more successful when assessing sources. These findings underscore the complexity of identifying misinformation in real-life situations and suggest that prior scientific knowledge and a sense of what constitutes reliable sources do not guarantee immunity to misinformation.

Stand-Alone Paper

Improving Elementary Students' Knowledge and Perceived Utility Value of Earth Science through Informal Science Education

Kim Cheek*, University of North Florida, USA
Elizabeth Broth, University of North Florida, USA
Tamara Reeves, University of North Florida, USA
Ryan Shamet, University of North Florida, USA

ABSTRACT

Informal Science Education (ISE) experiences are especially beneficial for elementary students from minoritized groups who are less likely to receive consistent, high-quality science instruction than their peers, both of which can negatively impact motivation and performance. Students from two elementary schools with high percentages of minoritized students participated in a six-session ISE program for 53 4th and 5th graders on how water and wind impact the local terrain. Participants at School A were part of an afterschool program, and participants in School B were attending a one-week STEM camp. During each session, students engaged in investigations on geomorphological processes and their

impacts on the local landscape. They also discussed the usefulness of what they were learning. Students at both schools demonstrated statistically significant learning gains pre- to posttest. A marginal, but nonsignificant trend toward greater perception of utility value pre- to posttest was observed. There was no interaction between test and school for either measure. Qualitative analysis of six students' written explanations for their responses showed an inconsistent progression toward more scientifically accurate explanations. Possible explanations for the findings are discussed and implications for ISE providers are discussed.

Exploring Socioscientific Issues in Preservice Teacher Education

Strand 7: Pre-service Science Teacher Education
25-Mar-25, 8:15 AM-9:45 AM
Location: Baltimore 2

Stand-Alone Paper

Socioscientific Issues: Perceptions of Elementary Pre-service Teachers in an Undergraduate Science Methods Course

Stephanie Arthur*, University of South Florida, USA
Ly Do, University of South Florida, USA
Melanie Kinskey, Texas A&M University, USA

ABSTRACT

Widely recognized is the call to infuse functional scientific literacy (Lederman, et al., 2024; Zeidler Sadler, 2011) into science teaching, providing K-12 students with real-world scenarios presenting a challenge in which they conduct research, analyze data, engage in thoughtful debate, and cultivate a deeper awareness of the moral and ethical implications of decisions (Zeidler, 2003; Zeidler Kahn, 2014). Implementing Socioscientific Issues (SSI) into science teaching presents meaningful and engaging topics to students on a personal level, requires evidence-based reasoning, and connects understanding scientific information with context (Sadler, 2004; Zeidler, 2003) thus providing opportunities to interact with multiple perspectives, including skepticism about claims, and pursuing ongoing inquiry (Sadler, et al., 2007). This approach contributes to the development of informed citizenship and career awareness that leads students toward a broader educated workforce (NRC, 2012; NGSS, 2016). This investigation reveals how the explicit teaching to infuse SSI in the elementary classroom impacted pre-service teachers' perception of SSI. Findings reveal pre-service teachers' perceived value of SSI and their intentions to implement SSI into their work as teachers. Furthermore, we identify instructional practices that led to shifts in pre-service teachers' perceptions of teaching SSI in their own practice.

Stand-Alone Paper

Change in Teachers SSI Teaching Beliefs Through SSI Based Instruction

Özgül Yılmaz Tüzün*, METU, Turkey
Ece Kılaç, METU, Turkey

ABSTRACT
The purpose of the study was to investigate how 10 preservice science teachers' teaching SSI beliefs were changed from at the beginning of the SSI based instruction to the end of instruction. This study also examined how their teaching SSI beliefs were changed in the context of science education and SSI teaching. This study was conducted in an Interdisciplinary Science Teaching Course, where science, technology, society, environment framework (STSE) and socioscientific issues (SSI) were integrated for the first time. Semi-structured interview protocol was used at the beginning and end of the instruction. The results revealed that PSTs' SSI teaching beliefs were changed to embracing SSI teaching for instructional strategies, and assessment themes. However, the same was not the case for the theme of teachers' teaching skills. The last theme, challenges for teachers, shows that pre-service teachers have limitations during SSI teaching such as time management, classroom management, and content knowledge.

Stand-Alone Paper
Teacher Profiles Emerging from Curriculum Design Through SSI Based Instruction
Ece Kılaç*, METU, Turkey
Özgül Yılmaz Tüzün, METU, Turkey

ABSTRACT
The purpose of the study was to investigate how 38 preservice science teachers' teaching SSI beliefs were changed during 14-week SSI based instruction. This study also examined how teacher profiles were developed accordingly changed teaching SSI beliefs. This study was conducted in an Interdisciplinary Science Teaching Course, where science, technology, society, environment framework (STSE) and socioscientific issues (SSI) were integrated for the first time. Curriculum design task applied three times during SSI based instruction was used to collect data. 3 different teacher profiles as Profile A, Profile B, and Profile C were developed at the end of the qualitative analysis. The results revealed that the curriculum design at the beginning of the course did not include SSI integration and had a traditional perspective. Towards the end of the course, as a result of shifts from Profile A to Profile B and Profile C, only 9 people with a traditional perspective remained. The change in these teacher profiles showed how PSTs' beliefs were shifting from traditional to embracing SSI teaching.

Grappling with Critical Problems of Practice within our Diverse Informal Elementary Science Teacher Education Community

Strand 7: Pre-service Science Teacher Education
25-Mar-25, 8:15 AM-9:45 AM
Location: Woodrow Wilson Ballroom

Symposium
Grappling with Critical Problems of Practice within our Diverse Informal Elementary Science Teacher Education Community

Christina Schwarz*, Michigan State University, USA
Amber Bismack, Oakland University, USA
Jessica Bautista, University of Michigan, USA
Martha Canipe, Northern Arizona University, USA
Kristin Gunckel, University of Arizona, USA
James Hancock II, Alma College, USA
Amal Ibourk, Florida State University, USA
Kathryn Lanouette, William & Mary, USA
TJ McKenna, Boston University, USA
Meenakshi Sharma, Mercer University, USA

ABSTRACT
This symposium is composed of a group of diverse elementary science teacher educators who are responding to challenges from recent years, including NASEM recommendations. In this session, we share our approaches based on our contexts and positionalities, inviting NARST attendees to grapple with current problems of practice (e.g., NRC, 2022; NRC, 2024) such as (1) increasing preservice teachers' knowledge of, interest, and, identities with science; (2) using pedagogical tools and approaches that support science teaching; (3) supporting preservice teachers in promoting equity and justice in science; and (4) expanding and reframing science content for justice. Approaches include: science and science methods coursework for preservice elementary teachers to support sense-making, understanding students' ideas, joy, and justice; transdisciplinary approaches and pedagogical tools that support teacher reflection and science teaching in schools; using storytelling to build critical consciousness, and using pedagogies of care and the ethics of hope for sustainability and justice.Our discussant will share ideas about how the panelists' work speaks to NASEM recommendations and other systemic issues. Our hope is that this symposium honors teachers and children while deepening community and advancing thoughtful interactions about elementary science teacher education in working towards meaningful, equitable and just science.

Supporting and Exploring Equitable Teaching practices

Strand 7: Pre-service Science Teacher Education
25-Mar-25, 8:15 AM-9:45 AM
Location: Baltimore 1

Stand-Alone Paper

The Impact of an Early Field Experience on Mathematics and Science Teachers' Culturally Affirming Practices

Meredith Kier*, William & Mary, USA
Lindy Johnson, William & Mary, USA

ABSTRACT
This study investigates the impact of early field experiences on developing culturally affirming practices among secondary science and mathematics teacher candidates. Situated within a summer STEM enrichment program called SPARK, the study examines how these experiences shape teacher candidates' abilities to engage with culturally diverse students. Utilizing situated learning theory, the research highlights the critical role of aligning field experiences with coursework focused on equity and inclusion. Over three years, 15 Noyce Scholars participated in varied early field experiences, where they reflected on their interactions with students and adjusted their instructional practices accordingly. The qualitative analysis of their weekly reflections revealed key themes, including the importance of building authentic relationships with students, adapting curricula to meet diverse needs, and growing as culturally responsive educators. Findings suggest that intentional early field experiences can significantly influence teacher candidates' approaches to teaching in diverse classrooms, emphasizing the need for teacher preparation programs to integrate culturally responsive pedagogies from the outset. This study offers valuable insights for teacher educators seeking to prepare candidates for the complexities of modern classrooms, particularly within the STEM fields, and contributes to the broader discourse on equity and inclusion in education.

Stand-Alone Paper

The Role of Epistemic Vexations in the Learning of Preservice Science Teachers About Responsive Teaching

Ruveyde Kaya, Florida State University, USA
Sherry Southerland*, Florida State University, USA

ABSTRACT
In this qualitative case study, the role of epistemic vexations in two elementary preservice teachers', Harper and Oakley, science learning was examined during a science methods course that engaged them in scientific explorations as a tool to consider the affordances of responsive science teaching. The findings suggest that each preservice teacher experienced different epistemic vexations, which were the precursor of how they worked through emerging pedagogical vexations and considered responsive science teaching for their future practices. Harper, who had been underserved in her past science learning experiences, used epistemic vexations as a leveraging moment to discover her resources and figure things out by herself. Taking agency in her learning led Harper to realize the utility of responsive science teaching for her learning and her students, and she did not have salient pedagogical vexations regarding responsive teaching. Oakley, in contrast, who had always succeeded in her past transmissionist science learning experiences, avoided her epistemic vexations by seeking direct answers to her questions rather than attempting to figure it out herself. Such engagement in scientific explorations resulted in severe pedagogical vexations regarding responsive teaching for Oakley.

Stand-Alone Paper

A Call for Collective Practices and Tool Development to Support Culturally Ambitious Science Teaching

Matthew Kloser*, University of Notre Dame, USA
Heather Johnson, Vanderbilt University, USA
Kirsten Mawyer*, University of Hawaii at Manoa, USA
Scott McDonald*, Penn State University, USA
David Stroupe*, University of Utah, USA

ABSTRACT

Contemporary science teacher education faces significant challenges in linking pedagogy with equity and in overcoming the isolation of teacher preparation programs. State legislation opposing equity and social justice, combined with the idiosyncratic nature of isolated programs, has led to fragmented and inefficient teacher education. Drawing on historical precedents and contemporary institutional structures, this theoretical paper advocates for collective practices and tool development as a means to better prepare science teachers as well as shape the growth of science teacher educators. Using the framework of Cultural and Critical Ambitious Science Teaching (C2AST) as a model, we propose a new paradigm for cross-institutional collaboration that respects local contexts while establishing a shared language and vision. Our framework for equity-focused science education aims to create common tools and practices that enhance pre-service teachers' critical consciousness and instructional skills. By integrating core instructional practices with culturally responsive pedagogy, we envision a more unified and effective approach to teacher preparation. This paper outlines the challenges, proposes collaborative solutions, and sets a research agenda to advance the field, emphasizing the need for long-term, diverse, and cross-institutional studies to develop a cohesive and equitable science teacher education landscape.

Advancing Inclusive and Equitable Science Education Practices

Strand 8: In-service Science Teacher Education
25-Mar-25, 8:15 AM-9:45 AM
Location: Annapolis 3

Stand-Alone Paper

Practitioners' perspectives on inclusive science education

Laura Pannullo*, University Bielefeld, Germany
Melanie Basten, University Bielefeld, Germany
Laura Ferreira Gonzáles, University of Cologne, Germany
Felix Pawlak, University of Tübingen, Germany
Bianka Wartig, University Bielefeld, Germany
Lisa Stinken-Rösner, University Bielefeld, Germany

ABSTRACT

International assessments like PISA consistently show that many students in Germany and other countries lack key competencies, with a significant portion underperforming. Germany has also not fully implemented an inclusive school system in line with the UN Convention on the Rights of Persons with Disabilities, partly due to teachers' competencies in inclusion.

Given these challenges, it's crucial to find ways to ensure all students can develop their competencies by enhancing teacher professional skills.In this study, we ask pre-service teachers about the barriers they encounter in their science teaching and how they have tried to overcome them. The aim is to identify the requirements for university teacher training with the aim of developing teacher competencies for inclusive science teaching that are in line with the criteria set out in educational policies and address the needs identified through inclusive practice. In this context, it is necessary to differentiate between subject-specific and general teaching challenges in order to collect requirements for teacher training specifically in science education.

Stand-Alone Paper

Centering Curricular Customizations on an Equity Goal to Support Science Teachers' Beliefs about Equitable Sensemaking

Maria Moreno Vera*, Boston College, USA
Austin Moore, Boston College, USA
Katherine McNeill, Boston College, USA
Renee Affolter, OpenSciEd, USA
Samuel Lee, California State University, Long Beach, USA

ABSTRACT

Educational reform calls for the transformation of the science classroom by transitioning from a skill-based instruction to one centered on fluency (Bilkstein Krannich, 2013) where students make sense of phenomena through a three-dimensional approach to science instruction (NRC, 2012). This shift requires redefining traditional roles for both teachers and students to support students' epistemic agency and equitable sensemaking practices (Kawasaki Sandoval, 2019). Teacher beliefs, however, around science teaching and learning impact the type of environment promoted in the classroom (McCoy et al., 2020), as well as the type of science that students have access to (Yoon et al., 2017). Moreover, while research shows that curricular materials influence student learning (Roblin et al., 2018), teachers' beliefs ultimately determine the classroom environment. Understanding and supporting teachers' participatory relationship with their curriculum (Remillard, 2005) may help shift the role of teachers and students in the classroom.This case study uses teacher survey answers and customized lesson plans from a year long curriculum-based professional learning (CBPL) to understand the ways in which teachers' beliefs around traditional science teaching may have evolved over the course of one year. Results show the potential of customizing with an equity goal to support students' equitable sensemaking.

Stand-Alone Paper

Science Meets Democracy: Do Teachers Vote 'Yes' on Democratic Teaching

Heba EL-Deghaidy*, American University in Cairo, Egypt

ABSTRACT

This study explored the effects of an in-service professional development (PD) programme designed for science teachers, focusing on incorporating democratic practices within elementary classrooms. The programme was developed in response to the country's shift

towards a more democratic society, emphasising the integration of democratic principles into everyday teaching and learning. Given that the field of science naturally aligns with democratic processes and decision-making, the program aimed to enhance these aspects through the nature of science (NOS). A quasi-experimental design was employed, with instruments designed to measure the study's dependent variables. These instruments were administered before and after the PD programme, in a pre/post design, to assess changes in science teachers' attitudes towards democratic practices and decision-making. Statistical analysis revealed that post-test results on both instruments showed a significant increase compared to pre-test results, suggesting that the program's specific design may have contributed to these outcomes.

Stand-Alone Paper

Leveraging emancipatory pedagogies to support science teachers of color through a Noyce teaching fellowship

Vanessa Louis*, University of Michigan, USA
Natalie King*, Georgia State University, USA

ABSTRACT

This case study examines a Noyce Fellowship that aims to recruit, retain, and provide professional development for Black and Brown science teachers during their initial five years of teaching. Nouri and Sajjadi's (2014) emancipatory pedagogies were utilized as a theoretical lens to interpret the collected artifacts and semi-structured interviews, which captured the experiences of five early career science teachers. The results highlighted three key themes: (a) the fellowship effectively attracted early-career science teachers by offering substantial financial support, (b) early-career science teachers were more likely to remain in the profession due to the tailored professional development provided by the fellowship, and (c) the fellowship retained early-career science teachers by cultivating a supportive community of peers and faculty.

Discussing the Impacts of Recent Policies on Science Education and Prospects for a More Resilient Infrastructure for How Research Can Support a More Just Education System

25-Mar-25, 8:15 AM-9:45 AM
Location: Camellia 1

Discussion Session

Organizers

Terrell Morton, University of Illinois, Chicago, USA
William Penuel, University of Colorado, USA

ABSTRACT

Recent changes in federal, state, and local policy have made it harder for scholars to engage in important work related to ensuring all students experience meaningful science education

and for us to support the children and youth, their families, and communities that are targeted by those policies. This will be a space for sharing the impact of recent federal, state, and local policy changes on the students and their families we serve and on science education research and researchers. It will also be a space to share about what has happened and might happened with grants and contracts. It will also be a space for people to share how they are organizing in response to these changes both to protect ongoing work and to imagine new, more resilient infrastructures for research and development to promote educational justice.

Initial Results from an Iterative Program Design for Educating Science Education Leaders

Strand 8: In-service Science Teacher Education
25-Mar-25, 8:15 AM-9:45 AM
Location: Camellia 2

Related Paper Set

Designing a Program for Science Education Teacher-Leaders
Elizabeth Lewis*, University of Nebraska-Lincoln, USA
Wendy Smtih, University of Nebraska-Lincoln, USA
Dan Claes, University of Nebraska-Lincoln, USA
David Harwood, University of Nebraska-Lincoln, USA
Dawn Jarmillo, RMC Research Corporation, USA
Gina Matkin, University of Nebraska-Lincoln, USA
LJ McElravy, University of Nebraska-Lincoln, USA

ABSTRACT
This proposed presentation outlines the progress and findings of a U.S. National Science Foundation Robert Noyce-funded project aimed at developing science teacher-leaders in a Great Plains state. The project sought to recruit 26 exceptional secondary science teachers and support their growth through rigorous professional development (PD) in science education, equity, and teacher leadership. The program was originally designed using the ACESSE framework for equitable science and engineering learning and a newly developed conceptual framework to explore variables influencing transformational science education leadership. Through a design-based research approach, our project has identified key strategies for recruitment, curriculum design, and leadership development, emphasizing the importance of intercultural competence and strong subject matter knowledge. Preliminary results highlight the effectiveness of the programs PD components in fostering inquiry-based, equitable science teaching practices and expanding the leadership capacity of participating teachers. This presentation will also discuss the programs adaptive design process in response to challenges, particularly those posed by the COVID-19 pandemic, and its impact on the recruitment and retention of participants.

Related Paper Set

Changes in MTFs Understanding about Science Education Leadership

Rachel Benzoni*, University of Nebraska-Lincoln, USA
Gina Matkin, University of Nebraska-Lincoln, USA
Wendy Smith, University of Nebraska-Lincoln, USA
Elizabeth Hasseler, University of Nebraska-Lincoln, USA
LJ McElravy,University of Nebraska-Lincoln, USA

ABSTRACT

This study explores the development and impact of science teacher leadership through the experiences of Noyce Master Teaching Fellows (MTFs). The research focuses on how these experienced teachers integrate knowledge from coursework and professional development (PD) workshops into their roles as science teacher leaders. We examined their evolving understanding of leadership in science education, their identification of needs and opportunities for leadership, and the challenges and successes in promoting reform-based education, especially in high-need schools. We also investigated how MTFs leadership activities and reflections contribute to their professional growth and the broader science education community. Findings suggest that MTFs view leadership as multifaceted, involving mentoring, advocacy, collaboration, and professional community building, with a strong emphasis on equity and inclusion. This research underscores the need for ongoing support and targeted PD to foster the effective development, support, and retention of science teacher leaders.

Related Paper Set

MTFs Discipline-specific Science Subject Matter Knowledge and Pursuing National Board Certification

Elizabeth Hasseler*, University of Nebraska-Lincoln, USA
Rachel Benzoni*, University of Nebraska-Lincoln, USA
Dan Claes, University of Nebraska-Lincoln, USA
David Harwood, University of Nebraska-Lincoln, USA
Elizabeth Lewis*,University of Nebraska-Lincoln, USA

ABSTRACT

Our Noyce Master Teaching Fellows (MTFs) are working to mentor science teachers in various subject areas. Having SMK in diverse subject areas increases their effectiveness as mentors (Oehrtman et al., 2009). This study delved into how the program supports the development of MTFs science SMK and how feedback from the MTFs about NBC informed program revision. For this study, we analyzed the science coursework and teaching certifications that they came into the program with and described the programmatic changes that affected their National Board Certification (NBC) and science content coursework. Most MTFs have biology and broad field science certification, so their program has been crafted so that they are taking coursework in chemistry, Earth and space science, and physics to broaden their experience and expertise. Planning for NBC support sessions for the second and third cohorts has been informed by the inconsistent attendance (average

67% attendance rate) and participation of MTFs in Cohort 1. The project PI met with two Cohort 1 representatives about this issue, which led to the revision of the program for two semesters so that MTFs would take no more than one graduate course each semester concurrent with their work on their NBC portfolios.

Related Paper Set

The Thread of Equity Throughout a Noyce MTF Program

Gina Matkin, University of Nebraska-Lincoln, USA
Rachel Benzoni*, University of Nebraska-Lincoln, USA
Elizabeth Lewis*, University of Nebraska-Lincoln, USA
Elizabeth Hasseler*, University of Nebraska-Lincoln, USA

ABSTRACT

This study examines how diversity, equity, and inclusion (DEI) was integrated within a Noyce Master Teaching Fellowship (MTF) program, especially focusing on the development of intercultural competence (ICC) among these science teacher leaders. This program employs the ACESSE model and emphasizes DEI throughout its coursework, professional development (PD) sessions, and National Board Certification (NBC) requirements. To assess the evolution of MTFs ICC, we administered the Intercultural Development Inventory (IDI) at multiple points in time to generate insights into their developmental and perceived orientations toward ICC. Our analysis indicates productive shifts towards more ethnorelative ICC orientations, reflecting increased intercultural sensitivity. Additionally, our MTFs reported enhanced self-efficacy in implementing equitable teaching practices, driven by their coursework and sessions and speakers at their annual summer PD. This research underscores the importance of continuous support alongside DEI-centered PD to develop culturally competent teacher leaders who can foster inclusive science education and advocate for equity at in secondary education and among their peers as leaders. Findings suggest that such programs can significantly impact teachers' understanding and practices, promoting greater equity in science education.

Building Scientific Literacy and Socio-Scientific Reasoning in Diverse Contexts

Strand 10: Curriculum and Assessment
25-Mar-25, 8:15 AM-9:45 AM
Location: Magnolia 1

Stand-Alone Paper

Exploring Gaps in Socio-scientific Reasoning Skills: Insights from Students in Grades 5-7

Yidi Wu, Beijing Normal University, China
Yangdan Liu*, Beijing Normal University, China
Jing Lin*, Beijing Normal University, China
Ling Liang*, La Salle University, USA

Xiufeng Liu*, University of Macau, China

ABSTRACT
This research contributes to educational practices by examining socio-scientific reasoning (SSR) among 495 Chinese students in grades 5-7. The findings challenge the stereotype of gender differences in scientific skills and emphasize the importance of students' proficiency in the perspective-taking skill of SSR. The study reveals that while students generally demonstrate moderate SSR skills, there are notable grade-level variations, particularly in understanding the complexity of socio-scientific issues. These insights highlight the need for gender-neutral, grade-specific teaching strategies that enhance advanced cognitive skills, thereby fostering informed decision-making in young students. By integrating SSR practice into classes, educators can promote a comprehensive understanding and responsible social engagement.

Stand-Alone Paper

Evaluating Singapore Secondary Students' Grasp of Scientific Practices

Yann Shiou Ong*, National Institute of Education, Nanyang Technological University, Singapore
Yew-Jin Lee, National Institute of Education, Nanyang Technological University, Singapore
Miechie Leowardy, National Institute of Education, Nanyang Technological University, Singapore

ABSTRACT
Scientific practices appeared in the Singapore Science Curriculum Framework in 2021, creating a need for assessments to evaluate students' performances in scientific practices.A 12-item survey instrument was developed for this purpose. The items mapped onto practices across the three spheres of scientific activity: investigating (4 items), evaluating (3 items), and explaining (5 items). A previous version of the instrument was reported at NARST 2024 conference. At NARST 2025 conference, we will report on the findings from implementing the revised survey instrument with 333 secondary students (Grades 7-9) from two mid-level performing schools in Singapore. As data analysis is ongoing, this paper reports the tentative findings based on a sample of the full data-set (n=33). Cohen's kappa based on independent coding by two coders suggest items are of acceptable reliability (0.62-1.00). Tentative findings suggest students generally performed better on items associated with investigating sphere practices while items in the evaluating and explaining sphere were challenging. This could be explained by students' familiarity with science investigations, compared to practices in the evaluating and explaining sphere (i.e., argumentation, explaining data trend, modeling). However, some students' responses suggest their engagement with investigations resembled "doing school" rather than "doing science".

Stand-Alone Paper

Developing an SSI-based STEAM in promoting the development of students scientific literacy and agency

Ha My Anna Mang*, Macquarie Univeristy, Australia
Hye Eun Chu*, Macquarie Univeristy, Australia

Sonya Martin, Seoul National Univeristy, Korea, Republic of

ABSTRACT
Preparing students with the scientific competencies and identity to address environmental sustainability issues such as climate change has become a pressing priority for science education. However, data trends in science performance indicates that current science educational approach such as traditional Science, Technology, Engineering and Mathematics (STEM) are failing to engage students and improve learning outcomes. Integrated socioscientific issues (SSI)-based Science, Technology, Engineering, Arts, and Mathematics (STEAM) offers a transformative way to better connect science learning to students' daily lives and empower them to act as global citizens through actions and practices. This study utilised the design-based research method to explore the development, evaluation and implementation of an SSI-based STEAM climate change program. The program development process is done in collaboration with different group of stakeholders such as researchers and teachers to ensure the practical useability of the artefact in the real-world classroom. Findings indicates that teachers believe that SSI-based STEAM has potential to be integrated well into the science curriculum. This has implications for teachers to design and adopt alternative educational approaches to reframe the way science is taught andeffectively fosters scientific literacy and student agency.

Stand-Alone Paper

Analysis of NGSS Alignment in Wildfire Science Curricula: Using Natural Disasters as Anchoring Phenomena

Spencer Eusden*, University of Nevada, Reno, USA
Li Ke, University of Nevada, Reno, USA

ABSTRACT
Natural disasters hold potential as effective anchoring phenomena for effective socio-scientific issues science curricula due to their scientific complexity, societal impacts, and increasing occurrences. The ecological and societal complexities of wildfire in the western United States give wildfire significant potential to be an anchoring phenomenon in impactful science curricula. Since the last review of existing wildfire science curricula in 2012, at least 22 Next Generation Science Standards (NGSS) aligned wildfire science curricula have been published for K-12 audiences. This study analyzes how these curricula use wildfire align with NGSS. Twenty-two existing curricula were analyzed using the NGSS as a framework. This study identifies several Disciplinary Core Ideas readily met with wildfire-themed curricula. Analysis of alignment with Science and Engineering Practices indicates existing wildfire science effectively provide opportunities to practice analyzing, evaluating, explaining, and communicating about existing data and scientific knowledge. However, these curricula are not as strong at providing opportunities for students to ask questions and conduct student-led investigations. Models were effectively used to allow students to safely replicate aspects of these low-probability, high-impact events. These findings can inform not only future wildfire science curricula but also other SSI curricula using natural disasters as a phenomenon.

Fostering Cultural Responsiveness and Social Justice among Science/STEM Teachers

Strand 11: Cultural, Social, and Gender Issues
25-Mar-25, 8:15 AM-9:45 AM
Location: Azalea 1

Stand-Alone Paper

Enacting Culturally Responsive Science Education in Rural Urban Districts: Noyce Alumni Perspectives From Two Universities

Dominick Fantacone*, SUNY Cortland, USA
Elizabeth Edmondson*, Virginia Commonwealth University, USA
Aimee Ellington, Virginia Commonwealth University, USA
Sean Nolan, SUNY Cortland, USA

ABSTRACT

Science educators today are facing new challenges and opportunities to educate the increasingly diverse population of students in their classrooms.The research presented in this paper is part of a larger research study that is investigating what effective teaching looks like through a culturally responsive lens.We apply qualitative methods using a case study design that allows for in-depth exploration of complex phenomena (Yin, 2014) from the perspective of two different programs supported by funding from the National Science Foundation Robert Noyce Track 1.By examining the practices of three teachers from a NE University and three teachers from a SE University, we seek to better understand:In what ways do graduates enact culturally responsive science teaching in their classrooms? What experiences, perspectives, and practices do teachers draw on and implement in regard to culturally responsive science teaching? The interviews reveal a rich set of cases of enactment of culturally responsive practices. We find that similarities exist in what teachers experience and how they respond, but there are also important place-based differences that influence the pedagogical decisions that educators are making when considering how to teach science with a culturally responsive approach.

Stand-Alone Paper

Cultural heritage in steam teacher professional development in Nepal

Bhaskar Upadhyay*, University of Minnesota, USA
Lindsey Smaka, University of Minnesota, USA
Samantha Barragan, University of Minnesota, USA

ABSTRACT

This qualitative paper shares the findings based on a workshop carried out with school teachers in Nepal to build teachers' capacity and understanding of how cultural heritage provides an invaluable context to teach STEAM areas and concepts. From our analysis of data from the workshop, interviews, and fieldnotes, we found that teachers modeling cultural artifact provide a tangible example for teachers to engage in STEAM teaching with greater

cultural awareness and cultural heritage could be a context for engaging in cultural justice issues in validating local cultural practices and values. The study draws from culturally relevant pedagogy and cultural justice to understand how STEAM teaching and learning could be more connected to local issues and activities in Indigenous communities in the Global South contexts.

Stand-Alone Paper

Developing Science Equity Ambassadors to Tackle Inequities in Science/STEM Education

Tara Nkrumah*, Arizona State University, USA

ABSTRACT

Culturally relevant pedagogy has been underutilized in the professional development of science teachers, yet it is crucial for making science and STEM education more inclusive. How professional development is conducted is as important as the theoretical framework in empowering science teachers to become change agents within educational systems. A culturally relevant pedagogical approach challenges exclusive, standardized teaching methods that often lack multicultural and critical perspectives. Therefore, science teachers need guidance on engaging in political acts, like justice-centered pedagogy, which are typically missing from their professional development curriculum. This qualitative study, involving 32 STEM teachers from both informal and formal learning settings across the United States, employs a critical arts-based method design for science teacher professional development (STPD) to promote the adoption of culturally relevant pedagogy. The main question explored was:How does the Theatre of the Oppressed influence the professional development of science teachers in addressing inequities in science/STEM education?Data collection methods included focus groups, equity action plans, field notes, observations, and artifacts such as Jamboard entries and homework assignments. The findings suggest that critical arts-based methods enhance science teachers' understanding of culturally relevant pedagogy as a framework that supports inclusive education.

Stand-Alone Paper

More Than Buzz Words: Teachers' motivations, understandings, and evolution in teaching science for social justice

Katherine Wade-Jaimes*, University of Nevada, USA
Maizie Dyess, University of Nevada, USA
Burak Sahin, University of Nevada, USA

ABSTRACT

A variety of approaches and terminology has been introduced in science education to address the ongoing underrepresentation and marginalization of people of color from science fields, including the concept of "social justice." In this work, we attempt to explore how in-service science teachers understand what it means to teach science through the perspective of social justice, including why teachers are motivated to begin this work and how their understandings evolve. This study explores the perspectives of a group of science teachers who engaged with a year-long series of workshops centered on teaching science for

social justice. Data, including interviews and written reflections, was qualitatively analyzed and revealed that teachers often attended the workshops without a strong interest in, or understanding of, social justice in science education. While over the course of the study teachers' understanding of social justice evolved, and many teachers, especially those with many years of experience, described social justice-oriented work they were doing in their classrooms and schools. However, teachers did not connect this work with social justice, instead describing it in terms of trying to meet their students' needs. This work indicates a need to support teachers in understanding, recognizing, and enacting socially just science teaching.

Stand-Alone Paper

Pre-Service Elementary Teacher's Perspectives of Teaching Science Equitably

Joi Merritt*, James Madison University, USA
Angela Webb, James Madison University, USA

ABSTRACT

As classroom populations have become more diverse, teaching populations, including our institution's own, are overwhelmingly White and female. Simultaneously, we prepare elementary teacher candidates (ETCs) at the same university to teach science equitably to diverse students. In this study, the authors detail the revamping of the elementary and secondary science methods course to prepare ETCs to work with students from diverse backgrounds. One hundred and forty three elementary teacher candidates participated in this study from fall 2019 to spring 2021. This action research study answers the research question: What progress do elementary teacher candidates' make in developing critical conscious during a revamped elementary science methods course? To answer this question, we analyzed TC's science teaching philosophy statements from the beginning and the end of the semester-long science methods courses. We were able to see a shift in ETCs' thinking about equitable science instruction and their development of critical consciousness.

Teachers' Perception and Practice in Digital Era

Strand 12: Technology for Teaching, Learning, and Research
25-Mar-25, 8:15 AM-9:45 AM
Location: Baltimore 5

Stand-Alone Paper

Innovative Hybrid Science Education: Integrating Citizen Science and Digital Learning for Future-Ready Teachers

Selçuk Kılınç*, Middle East Technical University, Turkey
Gökhan Öztürk, Middle East Technical Universiry, Turkey

ABSTRACT

This study explores the integration of a real-time mobile air quality monitoring citizen science project within a hybrid instructional model for pre-service science teachers.

Responding to challenges posed by the COVID-19 pandemic, the research investigates how this innovative approach impacts participants' technological proficiency, scientific literacy, environmental attitudes, and readiness for interdisciplinary teaching. Using a single-case study design with multiple data sources, the research involved 12 pre-service science teachers in a 14-week course combining online and face-to-face instruction. Data collection included interviews, focus groups, observations, research reports and validated scales.Findings reveal significant improvements in participants' appreciation of online education, technological proficiency and TPACK development, scientific literacy, environmental awareness, and interdisciplinary teaching readiness. The study demonstrates how integrating citizen science and digital learning in a hybrid model can effectively prepare future science educators to meet 21st-century challenges. Moreover, it addresses equity issues in science education by showcasing how accessible technology and citizen science projects can democratize scientific inquiry and environmental monitoring, particularly crucial during crises. This research contributes valuable insights to the ongoing dialogue about best practices in science teacher education, offering a replicable model for innovative, technology-enhanced learning experiences.

Stand-Alone Paper

Examining the Role of Human Actors within Elementary Science Digital Teaching Simulations

Jamie Mikeska*, ETS, USA
Shreyashi Halder, ETS, USA
Devon Kinsey, ETS, USA
Pamela Lottero-Perdue, Towson University, USA

ABSTRACT

Research has provided evidencethatdigital teaching simulations(hereafter, simulations)canstrengthenpreservicescience teachers'(PSTs')instructional skills and beliefs. However, little research has explored the role of the simulation specialistor "sim"whois the human actorplaying thestudent avatarswithin mixed-realityteachingsimulations.Ideally, thesim's performanceisconsistentwith guidelinesin thesimtraining materials(hereafter, sim guidelines),providingmeaningful learning opportunities for PSTs. This study examinedthealignmentbetweensim guidelinesandsim performancefor70 twenty-minute argumentation-focused sciencediscussions facilitated by36elementaryPSTs.Weassessedalignment using acodebookthat compared sim guidelines to sim performancein the discussions. We alsoinvestigatedwhether there was a relationship betweentheextent of misalignment andthe PSTs'discussion scores,which werescoredby external raters. Findings suggest strong alignment betweensim guidelines and performance.The most frequentmisalignmentswerewhensims(a) offered substantive responses to non-substantive questions and (b)did notusestudents'initial content-based ideas appropriately.Therewasnorelationship between the extent of misalignment andPSTs'discussion scores.Findings offer insight into how to develop sim guidelines and assess sim performancetobest support PST learningwhen using human-led digital teaching simulations.

Stand-Alone Paper

ChatGPT versus humans: teacher selection considerations when choosing student cluster characterization in chemistry

Shelley Rap*, Weizmann Institute of Science, Israel
Elad Yacobson, Weizmann Institute of Science, Israel
Giora Alexandron, Weizmann Institute of Science, Israel
Ron Blonder, Weizmann Institute of Science, Israel

ABSTRACT

The integration of artificial intelligence (AI) into educational settings has significantly transformed classroom management and student engagement. However, educators' preferences and boundaries regarding AI's role remain critical. This study investigates teachers' preferences for AI-generated versus human-generated characterizations when clustering students based on their problem-solving stoichiometry. Human and AI-generated characterizations were produced for student clusters derived from stoichiometry activities in a learning management system. Sixteen teachers participated in the study; they evaluated these characterizations for accuracy, completeness, and detail, and then selected their preferred descriptions. The findings revealed no definitive preference between AI and human characterizations; teachers favored AI for some clusters and human input for others. Group discussions indicated that teachers' selection criteria included its perceived accuracy, alignment with personal teaching experiences, and the emotional impact of the characterizations. This research emphasizes the importance of balancing AI capabilities with educators' insights in order to create an engaging and supportive educational environment. These insights contribute to refining AI educational tools, enhancing teacher support, and fostering positive teacher-student dynamics. This research is pertinent to the science education community, offering valuable insights for effectively integrating AI into education.

Nature of Science in Science Curriculum and Teacher Education: A Global Perspective

Strand 13: History, Philosophy, Sociology, and Nature of Science
25-Mar-25, 8:15 AM-9:45 AM
Location: Annapolis 4

Symposium

Nature of Science in Science Curriculum and Teacher Education: A Global Perspective

Wonyong Park*, University of Southampton, United Kingdom
Ryan Summers*, University of North Dakota, USA
Jacob Pleasants*, University of Oklahoma, USA
Richard Brock*, King's College London, United Kingdom
Tetsuo Isozaki*, Hiroshima University, Japan

Dina Tsybulsky*, Technion - Israel Institute of Technology, Israel
Anna Pshenichny-Mamo, Technion - Israel Institute of Technology, Israel
Haya Ben Simon*, Technion - Israel Institute of Technology, Israel
Ferah Özer, Koc University, Turkey
Çiğdem Han-Tosunoğlu, Marmara University, Turkey
Radu Bogdan Toma, University of Burgos, Spain
Olivia Levrini, University of Bologna, Italy
Martina Caramaschi, University of Bologna, Italy
Sara Satanassi, University of Bologna, Italy
Kerstin Kremer, Justus Liebig University Giessen,
Elvira Schmidt, Justus Liebig University Giessen, Germany
Ivã Gurgel, University of São Paulo,
Maurício Pietrocola, University of São Paulo,

ABSTRACT
Despite its critical role in promoting scientific literacy and combating misinformation, NOS is often underrepresented in science education policy and practice. This symposium aims to explore the discrepancies between the growing societal importance of NOS and its marginal presence in curricula and teacher education, and to discuss future directions. Through a comparative analysis of 10 countries, the session will highlight regional differences and the impact of historical, cultural and political contexts on how NOS is addressed in science education. It underscores the need for global discussion and collaboration, noting that the majority of NOS research published in English is concentrated in a few countries. The session aims to promote a cross-contextual understanding of NOS and address key questions about its role and representation in curricula and teacher education. The symposium will also explore the challenges of integrating NOS into science teacher education programs and examine successful models, with the aim of promoting a more comprehensive and equitable approach to NOS education across diverse educational landscapes.

Fostering authentic engagement: Strategies for partnered climate change education across the science education landscape

Strand 14: Environmental Education and Sustainability
25-Mar-25, 8:15 AM-9:45 AM
Location: Baltimore 3

Symposium

Fostering authentic engagement: Strategies for partnered climate change education across the science education landscape

Heidi Cian, Maine Mathematics and Science Alliance, USA
Michelle Brown, Florida International University, USA
Julie Luft*, University of Georgia, USA
Joseph DeLuca, University of Georgia, USA

Emily Miller, University of Georgia, USA
Steven Fletcher, St. Edwards University, USA
Remy Dou, Florida International University, USA
Tali Tal, Technion Israel Institute of Technology, Israel
Hong Tran, Purdue University, USA
Shweta Lahiri, University of Georgia, USA

ABSTRACT
In this symposium, we explore the researcher attitudes, behaviors, and project design structures that can position community members as knowers (or not) to authentically leverage local knowledge in place-based climate change education. We engage a panel of scholars across corners of the science education landscape to discuss the construction and execution of five research agendas that illustrate different approaches to authentic engagement around place-based climate change education. The research presented in this session spans the stakeholders of climate change education, including youth, educators, future educators, families, local industry experts, and the disciplinary field itself. The work represents efforts in both formal and informal learning spaces, and in both rural and urban community settings–touching on the diverse impacts of climate change across the United States and its possibilities in climate change education that is cognizant of local orientations towards climate-related topics. Each presentation discusses effective approaches to engaging partners authenticallyas well asnew questions or challenges that their work has exposed. We intend that attendees leave the symposium with actionable reflections and examples of place-based climate change projects that can guide critical discussion within their research teams.

A Celebration of Distinguished Contribution through Research Award Recipients: A Discussion of the Future of Science Education

25-Mar-25, 10:00 AM-11:30 AM
Location: Azalea 2

Administrative Session

Amelia Gotwals, Michigan State University, East Lansing, USA
Mei-Hung Chiu, National Taiwan Normal University, Taiwan

ABSTRACT
This Awards Committee-sponsored session will highlight the accomplishments and contributions of the Distinguished Contributions through Research Award recipient. It will provide a platform for an extended discussion of the award recipient's scholarly contributions and how their research trajectories are framed and/or intersect with the theme of NARST 2025: In praise of Science Teachers: Essential Partners in Researching, Reframing, and Reforming Science Learning. The award recipient will reflect on their contributions and

propose ideas for the future of science education, equity and social justice, scientific literacy, teaching and learning and so on.

This year's DCRA recipient is Dr. Sherry Southerland, Anne & John Daves Professor of Science Education at Florida State University, in recognition of the profound impact of her ongoing scholarship on science education research and practice, her exceptional leadership and mentorship, and her dedicated service to leading journals.

Roundtables Session 2

25-Mar-25, 10:00 AM-11:30 AM
Location: Woodrow Wilson Ballroom

Strand 2: Science Learning: Contexts, Characteristics and Interactions
WIP Roundtable

Empowering Teachers as Co-Researchers: The implementation of a community-based research project with High School Students

Sarah Fankhauser*, Oxford College of Emory University, USA
Susan Watts-Taffe, University of Cincinnati, USA
Jonathan Breiner, University of Cincinnati, USA
Nicholas Shaver, University of Cincinnati, USA

ABSTRACT

Addressing the lack of diversity in STEM professions requires engaging underrepresented high school students in meaningful STEM experiences and supporting teachers in implementing effective STEM programming. This project, "Growing and Sustaining Community Researchers in STEM," uses a Community-Based Participatory Research (CBPR) approach to foster STEM interest and identity among underrepresented high school students while positioning teachers as co-researchers. Our research question asks: In what ways do we establish partnerships and develop multi-stakeholder communities of practice? The conceptual framework draws on sociocultural learning theories, communities of practice, and the concept of a "third space" where diverse forms of knowledge intersect. Preliminary findings highlight three key outcomes: (1) the establishment of clear partnerships and team dynamics among teachers, students, university researchers, and community members; (2) the development of a shared language to facilitate collaboration; and (3) the formation of a multi-stakeholder community of practice. These outcomes contribute to teachers developing identities as engaged research team members with increased understanding of CBPR principles, improved self-efficacy in scientific collaboration, and enhanced ability to support students in authentic research practices. This project offers a model for engaged, relevant, and equitable science education that could significantly impact reform efforts in the field.

Strand 2: Science Learning: Contexts, Characteristics and Interactions
WIP Roundtable

Negotiation within Argumentation – Guiding Student Discourse

Carla McAuliffe*, IGES, USA
Donna Governor, UNG, USA
Lorraine Ramirez Villain, UNG, USA

ABSTRACT

Discourse around socioscientific issues can allow students to develop their scientific thinking and knowledge construction using argumentation. The MEL activities (Authors, 2016) are an instructional scaffold designed to facilitate students' engagement in evaluations about the connections between lines of scientific evidence and competing explanatory models (claims). Using scaffolded instruction to make these evaluations more scientific can result in students shifting toward a more scientific stance when considering the plausibility of competing models about scientific topics of social relevance and deepen their science learning of fundamental content (e.g., Authors, 2024). Our additional research using SFL (Authors, 2021) revealed that negotiation toward consensus can support students' scientific thinking during MEL activities and led us to develop a Negotiation Framework. We hope this framework can support teachers in guiding their students in negotiating toward consensus understanding of the science topics, particularly controversial topics that are relevant to addressing local, regional, and global issues of social and environmental importance. Our goal for this Work-in-Progress Roundtable is to elicit feedback from attendees on the Negotiation Framework and engage in discussions around research-based strategies others use to facilitate students' negotiation within argumentation.

Strand 1: Science Learning: Development of student understanding
WIP Roundtable

From Waste to Wisdom: The Role of Active Student Sensemaking in Addressing Complex Problem Course

Peter Locher*, American University, USA
Makennah Troy, American University, USA
Sarah Irvine Belson, American University, USA

ABSTRACT

This research investigates the process of active student sensemaking, focusing on how students engage with the issue of wasted food in a complex problem course. This study emphasizes how an educative curriculum, collaboratively built by the research team, invites all stakeholders, including students and instructors, to actively engage in the construction and reflection of new knowledge. By implementing project-based learning, the course redefines the instructor's role from a traditional teacher to an active facilitator, fostering a more dynamic classroom environment. Examining undergraduate students' perceptions and behaviors regarding food waste provides critical insights for curriculum enhancement, aligning with the conference's overarching theme, which underscores the vital role of science educators as collaborators to "research, reframe, and reform science

learning''.Utilizing the Wasted Food Education Survey (WFES) and analysis of student work, researchers assessed the course's effectiveness in enhancing student understanding and behaviors related to food waste. The analysis shows that students became more aware of food waste's environmental and social impacts, leading to a more substantial commitment to reducing waste. These initial findings underscore the significance of targeted educational interventions in fostering sustainability among undergraduates.

Strand 2: Science Learning: Contexts, Characteristics and Interactions
WIP Roundtable

Minimizing the Academic Achievement Gap Between Advantaged and Disadvantaged Students in Denmark, Norway, and Sweden

Patricia Patrick*, Columbus State University, USA
Daniel Purvis*, Columbus State University, USA

ABSTRACT

Our work-in-progress aims to explore contemporary strategies implemented by educators and administrators in Denmark, Norway, and Sweden to minimize the academic achievement gap between students from advantaged and disadvantaged socioeconomic status (SES) backgrounds. Drawing upon data from the Programme for International Student Assessment (PISA), we will examine the relationship between SES and academic performance, particularly within the context of Scandinavian countries. Using an exploratory case study design, we will conduct semi-structured interviews with educators and administrators across middle schools in Denmark, lower secondary schools in Norway, and junior high schools in Sweden. Our work is grounded in Sticht's Functional Context Theory (FCT), which emphasizes the importance of contextual factors, such as environmental and social influences on student learning. We seek to identify the strategies educators and administrators believe are effective in reducing the academic achievement gap, particularly in science education. The findings will offer insights into interventions that may support equitable education practices, contributing to the broader discourse on how SES impacts student success. We anticipate that feedback from this study will provide valuable insights for further research and policy development aimed at improving educational outcomes for disadvantaged students in science and other subjects.

Strand 4: Science Teaching — Middle and High School (Grades 5-12): Characteristics and Strategies
WIP Roundtable

Identifying Arts Integration in Science Scope (2019 to 2023) with Science Arts Integration Awareness Model

Patricia Patrick*, Columbus State University, USA
Kendel Purvis*, Columbus State University, USA

ABSTRACT

We explore the integration of the arts into middle grades science education, focusing on articles published inScience Scope from 2019 to 2023. Arts integration, which involves incorporating art forms such as visual or performance arts into educational activities, has

been shown to enrich students' learning experiences by fostering creativity, critical thinking, collaboration, and communication skills. Through a content analysis of 270Science Scope articles, we identify the types and frequency of art activities included and assess their alignment with the National Core Arts Standards (NCAS). Using the newly developed Science Arts Integration Awareness Model (SAIAM), an adaptation of Self-Awareness Theory and the Awareness Model, we analyze the motives for incorporating art activities, including increasing student engagement, fostering creativity, and promoting interdisciplinary connections. Preliminary findings indicate that visual arts are more frequently integrated than performing arts, and many activities lack alignment with the NCAS. This study provides a benchmark for understanding arts integration trends in science education, highlights gaps in current practices, and suggests areas for future improvement. The findings contribute to the ongoing dialogue on the role of arts integration in fostering a more holistic and innovative science education.

Strand 4: Science Teaching — Middle and High School (Grades 5-12): Characteristics and Strategies
WIP Roundtable

Educators' Perspectives on Integrating Data Science/Water into STEM, Physical Education and Literacy Curriculum.

Anne Degnan*, Columbia University, USA
Laureline Josset, Columbia University, USA

ABSTRACT

8 STEM, Literacy and Physical Education (PE)[1] teachers, at an urban public, single gender middle and high-school have been working in partnership with data scientists and a director of education from an engineering department at a large, research university. The purpose is tobreak through persistent barriers for Black and Latino male students in STEM/data science education pathways. The partnershiptests whether age-appropriate data and data platforms for water security, integrated with STEM and literacy can: 1.)Increase students' likelihood of choosing a datascience career; 2.) Improve students' STEM/ICT competencies, senses of self-confidence and self-efficacy; and, 3.) Increase the effectiveness of teachers to implement an interdisciplinary, integrated middle and high school core curriculum and co-curricular activities.Our researchspecifically addresses point 3 of the project.[1]These courses and the educators who teach them were selected to achieve both a horizontal and vertical alignment across middle and high school. Additionally, the structure of the school is such that students have been in classes with the full cohort/ team of teachers at some point in their middle and high school years.

Strand 4: Science Teaching — Middle and High School (Grades 5-12): Characteristics and Strategies
WIP Roundtable

Environmental Injustices and Their Role as Hyper-local Phenomenon in High School Classrooms

Justin McFadden*, University of Louisville, USA
Linda Fuselier, University of Louisville, USA

ABSTRACT
The proposed roundtable presentation stems from a Research Experiences for Teachers Sites in Biological Sciences (BIO-RETS) that engaged 8 high school science teachers in a 6-week, urban-based ecological research experience. In addition to working with a researcher, teachers also learned about and explored how issues related to environmental justice could be utilized within their classrooms. Pairing teachers with urban ecology researchers and experts in environmental justice was intended to be a mechanism for teachers to infuse high school science curricula with immediately relevant environmental justice issues. Throughout the summer, multiple data sources were generated as teachers engaged in 30+ hours of professional learning, while also spending additional time developing curriculum resources for their classroom. Two preliminary themes are emerging as analysis begins: the first beingthe description of and integration of "hyper-local" phenomenon. Many of the local phenomenon teachers explored throughout the project were driven by environmental missteps that indiscriminately have harmed the very communities that their students belong to (e.g., air quality from a coal-burning power plant). This, in addition to a theme related to students depicting aspects of "learned apathy" will be discussed as data collected thus far represent only a third of the data to be collected.

Strand 4: Science Teaching — Middle and High School (Grades 5-12): Characteristics and Strategies
Roundtable

Differences between students and teachers in the perceived relevance of a localized climate change unit

Candice Guy-Gaytán*, BSCS Science Learning, USA
Jeffrey Snowden, BSCS Science Learning, USA
Lindsey Mohan, BSCS Science Learning, USA
Emily Harris, BSCS Science Learning, USA

ABSTRACT
Anchoring student learning to locally relevant phenomena of personal or community consequence can be a productive means for achieving NGSS equity goals. In climate education, this presents a challenge for creating curriculum on a large-scale because phenomena and impacts of climate change vary within and across communities. We took up this challenge and collaborated with partner teachers to create localizable climate units, and examined how students and teachers perceived the relevance of the localized unit compared to the teachers' business-usual condition for teaching climate change.In this cohort-controlled quasi-experimental study, we used survey datato examine relevance in both conditions. Findings indicate that the localized unit influenced students' and teachers' perceptions of relevance. Teachers in the localized unit showed significantly higher perceptions of relevance overall compared to their perceptions in the business-as-usual condition. There were small but insignificant changes in students' perceptions of relevance until the localized unit was completed, at which point students showed a significantly higher perception of relevance compared to those in the BAU condition. In contrast, teachers

perceptions of relevance significantly dropped by the end of the localized unit. In the session and paper, we will further discuss the results and limitations of the study.

Strand 7: Pre-service Science Teacher Education
Roundtable

Indonesian Preservice Science Teacher's Learning of Integrated STEM Teacher Identity: Single Case Study

Anjar Putro Utomo*, University of Minnesota, USA
Gillian Roehrig, University of Minnesota, USA

ABSTRACT

Undeniably, the powerful influence of integrated STEM education worldwide has shifted how science teachers must teach science to their K-12 students. These cultural shifts in science education are complex because they necessitate identity negotiation, new norms, institutions, and processes, especially for a preservice science teacher as a powerful resource for integrated STEM education sustainability. Therefore, it would be beneficial to initially investigate the STEM learner domain mainly under the integrated STEM teacher identity framework, given the widespread tension within the majority study of STEM education training for preservice science teachers, particularly in Indonesia. This study employed a single case study with the reflexive thematic analysis. The finding reveals that the dynamic process within the STEM learner identity domain emerges as a pattern that is tightly influenced and limited by Indonesia's curriculum regulations, which is the teachers' STEM content interest. Meanwhile, recognition, competence, and performance tend to depend on the teacher's belief and attitude movement toward STEM education principles. Moreover, having positive recognition as a STEM education person does not guarantee that science teachers learning STEM education have positive competence and performance. Besides, the STEM content interest aspect in the framework is likely not indirectly associated with recognition, competence, and performance.

Strand 7: Pre-service Science Teacher Education
Roundtable

Examining the Intersection of Culture and Positional Identities on an Elementary Preservice Teacher's Identity Development

Jenna Gist*, Purdue University, USA
Jeffrey Radloff*, State University of New York- Cortland, USA
Brenda Capobianco, Purdue University, USA

ABSTRACT

This roundtable presentation examines how an elementary preservice teacher's cultural background and positional identities as a self-identified Asian, female and international student informed her science teacher identity development in a one-semester elementary science methods course. The aim of this study was to: 1) explore the extent to which culture and positional identities (e.g., race; international student status) intersected with and influenced an elementary preservice teacher's science teacher identity formation. To frame this study, researchers used intersectionality as a lens to investigate how Tasnim's

(pseudonym) race, status as an international student, and cultural experiences impacted her views of science teaching and learning and emerging identity development. This study took place during the Fall 2023 semester and utilized a single case study approach. Data were gathered via initial- and final-journey maps; autobiography- and final- reflections; initial- and final- semi-structured interviews; and other course artifacts (e.g., final electronic portfolios). Data were analyzed using open coding and thematic analysis. Findings revealed that Tasnim's science teacher identity was developed through various methods course activities and experiences, and her reflections on them intersected with her positional identities and prior experiences. Implications will be discussed for science teacher educators and identity researchers.

Strand 7: Pre-service Science Teacher Education
Roundtable

STEM Teacher Persistence: Teacher Preparation Programs that Support Identity and Belonging

Danielle Sodani*, American University, USA
Peter Locher, American University, USA
Sarah Irvine Belson, American University, USA
Carolyn Parker, American University, USA
Shari Watkins, American University, USA
Kiho Kim, American University, USA

ABSTRACT

This mixed methods study explores the experiences of STEM teacher candidates in their pre-service teacher education programs, with a focus on identity, belonging, and racial self-efficacy, and if those factors influence their persistence and retention as STEM educators. We use validated inventories to measure factors related to identity and belonging that impact scholars' persistence in their preparation programs and subsequent retention in schools serving historically resilient communities. Survey results suggest that the university, school system, and non-profit partnerships influence Noyce Scholars' persistence and retention in how programs provide preparation, induction, mentoring, and professional development, particularly for scholars with diverse identities. This initial phase demonstrates the effectiveness of these partnerships in enhancing the success and retention of STEM educators.

Strand 8: In-service Science Teacher Education
WIP Roundtable

Lichen Our Way to Better Data Literacy: Insights from a Place-Based and Bayesian Professional Development

Amanda Garner*, University of Tennessee, USA
Joshua Rosenberg, University of Tennessee, USA

ABSTRACT

This study explores how teachers think about and plan to integrate data literacy, place-based education, and Bayesian thinking into their classrooms after participating in a two-day

professional development workshop in a National Park. The workshop provided hands-on experiences and strategies for connecting science education to local environments and students' everyday lives. The study focuses on how these experiences influence teachers' planning and instructional practices. Through video analysis and post-survey responses, the study identifies three key themes: the importance of making data activities relevant through community-based learning, the emphasis on developing foundational data skills, and the varied use of technology in teaching. Teachers expressed a strong interest in adapting place-based education to make learning more engaging and relevant while recognizing challenges such as students' varying math skills and the practical difficulties of fieldwork. The findings indicate that the professional development experience effectively encouraged teachers to adopt more student-centered, inquiry-based approaches. However, ongoing research is needed to realize the potential of these strategies fully.

Strand 8: In-service Science Teacher Education
WIP Roundtable

Exploring Teacher Professional Development for Civic Science Education in Middle Grades

Maggie Demarse*, Michigan State University, USA

ABSTRACT

My study addresses this year's NARST theme of "In praise of science teachers: essential partners in researching, reframing, and reforming science learning" as it relates to centering teachers' knowledge and expertise to engage with Civic Science Education. This study utilizes case study methodology to learn how teachers take up Civic Science Education. The structure of learning for the teachers is a Professional Learning Communities (PLC) which provides a avenuefor professional learning that is driven by teacher inquiry, based on context and setting. This study seeks to explore the ways in which a PLC can support teachers in designing, enacting, assessing, and reflecting on innovative curriculum grounded in CSE, and what factors both support and inhibit this process of learning.

Strand 8: In-service Science Teacher Education
WIP Roundtable

Mechanisms of Professional Learning for 3D Science Teaching in Rural Schools

Rebecca Sansom*, Texas A&M University, USA
Michelle Hudson, Brigham Young University, USA
Heather Leary, Brigham Young University, USA
Clara Smith, Brigham Young University, USA
Max Longhurst, Utah State University, USA
Josh Stowers, Brigham Young University, USA

ABSTRACT

The Next Generation Science Standards have been widely adopted or adapted across most US states, resulting in a need for professional development for science teachers. We studied the changes in knowledge and implementation of three-dimensional science teaching among teachers participating in a year-long professional learning program for rural science

teachers in one western US state. Using data from interviews, classroom observations, and collaborative online team meetings, we found that 3D knowledge and implementation improved over the course of each cycle of technology-mediated lesson study and across multiple cycles during the year. Furthermore, teacher learning occurred during collaborative discussions with other teachers, when reflecting on classroom situations generated by engagement with new lesson plans that they co-created to address three-dimensional science teaching. This study has impacts for professional development providers to better understand the mechanisms of change for all teachers, and especially for those working with rural teachers, demonstrating that technology-mediated hybrid approaches to professional learning can produce rich outcomes.

Strand 8: In-service Science Teacher Education
WIP Roundtable

Empowering In-Service Middle School Teachers to Integrate Quantum Science: A Design-Based Approach to K-12 Curriculum

Zeynep Akdemir-Beveridge*, University of Connecticut, USA
Muhsin Menekse, Purdue University, USA

ABSTRACT

This research is part of a three-year dissertation project exploring the integration of Quantum Information Science and Engineering (QISE) into the K-12 curriculum using a Design-Based Research (DBR) approach. Collaborating with 10 in-service middle school science teachers, the study focused on co-designing quantum-infused science content. The DBR framework highlighted teachers' roles as educational innovators, essential partners in curriculum development, and key players in reflecting on instructional strategies. Recognizing the challenges K-12 science teachers face in justifying and teaching quantum concepts, this initiative underscores the importance of active science teacher engagement in the processes of idea generation, prototyping, refinement, and curriculum implementation.Qualitative data from the Teacher's Quantum Workshop (TQW) was analyzed to assess teachers' motivations and perspectives on integrating quantum concepts. Thematic analysis revealed that teachers interested in QISE consider pragmatic concerns, professional expectations, and the value of QISE, while also addressing student engagement, cognitive development, and pedagogical challenges. This study hopes to lay a foundation for future research, emphasizing the need for comprehensive teacher training in K-12 QISE education and the transformative potential of education in deepening understanding and engagement with complex subjects.

Strand 8: In-service Science Teacher Education
Roundtable

Exploring a teacher-researcher collaboration: the inside-out of the social phenomenon

Maiza de Albuquerque Trigo*, University of Luxembourg, Luxembourg
Thierry Frentz*, Ministry of Education, Luxembourg

ABSTRACT
This contribution explores a case study of a teacher-researcher collaboration focusing on primary teacher professional learning in science education in [country]. Embedded in a school-university partnership, this collaboration will be presented through the co-development and co-teaching processes of a workshop, which put science and language into dialogue, to support in-service teachers in addressing the multilingual education system. The school-university partnership occurs in the [blinded] Center, where several conditions enable the teacher-researcher collaboration to be successful. Different conceptual frameworks are used to highlight these conditions, such as third space, collaborative structures, distributed leadership, co-generative dialogues, ethics of care, community of practice, boundary spanning, and organizational learning. Grounded in sociocultural theory, data sources include video recordings, field notes, and reflective pieces and the analysis will be presented using the different conceptual frameworks (from the microlevel of the individuals to the macrolevel of the partnership), from the perspectives of the teacher and the researcher, considering our boundary spanning as the thread line. Findings reveal how the processes of boundary spanning of the teacher (towards the teacher-researcher role) and the researcher (into teacher-collaborator) were enabled by the partnership and the impact of the spanning in our own professional learning.

Strand 11: Cultural, Social, and Gender Issues
Roundtable

Motherhood in academia: An autoethnography examining motherly guilt

Andrea Phillips*, Indiana University, USA
Claire Cesljarev, Indiana University, USA

ABSTRACT
Motherly guilt is a pervasive problem, the result of cultural expectations around intensive mothering, as well as women's efforts to balance contributing to the workforce and raising children. Being a mother in academia is no exception. Grounded in a feminist perspective, the purpose of this autoethnography was to examine the authors' experiences as mothers and graduate students in science education, especially as they prepare to enter the academic job market. The findings presented in this proposal discuss the role of motherly sacrifice and prioritizing of children as a response to motherly guilt. Implications include the need for a space in academia to seek out support, solidarity, and belonging as parents, and especially mothers, as well as the need for additional understanding of what it means to be a mother in academia from a diverse representation of women.

Strand 11: Cultural, Social, and Gender Issues
Roundtable

Mapping Gender Dynamics in STEM: A scoping review of the MENA region

Aya Elkholy, Elite International School, Egypt
Heba EL-Deghaidy*, American University in Cairo, Egypt
Zahra Almasabi, Najran University, Saudi Arabia

ABSTRACT
Women are underrepresented in science, technology, engineering, and mathematics (STEM) disciplines compared to men resulting in a gender disparity. Findings from previous studies across the globe provide a complex view when looking into women's enrolment and career options. The aim of this scoping review, focusing on the 17 countries in the Middle East and North Africa (MENA) region, is to understand how gender dynamics influence women's programme enrolment, in higher education institutions, and their career choices and experiences while unpacking the factors that can help provide such understanding. Twenty-five studies were eligible for inclusion in this scoping review. These studies were used to identify the key factors across the literature while utilising an inductive analysis. The three main factors identified were: social cultural factors, institutional factors and policy driven factors . Overall, the review highlighted that women can be excluded from joining STEM fields and related careers as a result of traditional hierarchies, gender norms and perceived cultural roles, responsibilities and expectations. Recommendations are provided to support women in STEM to avoid the 'leaking pipeline' and retain women further.

Strand 11: Cultural, Social, and Gender Issues
Roundtable
The Use of Science-Related Cultural Capital among Latina Engineers
Emily Tancredi-Brice Agbenyega*, LaGuardia Community Collge, USA

ABSTRACT
The underrepresentation of women of color in science, technology, engineering, and mathematics (STEM) remains a critical issue. Theories of culturally-relevant forms of capital has been found to be a useful lens to understand why and how women of color pursue and attain STEM degrees and subsequent career goals. Specifically, forms of science capital that women of color access because of, and not in spite of, their identity have been found to provide means for women of color to successfully achieve their goals. This article draws upon data from a qualitative research study that explores the experiences of early-mid career Latina engineers and the forms of science capital they have accessed along their trajectories through undergraduate education in engineering and in the early stages of their engineering-related careers. Findings reveal that Latinas draw upon multiple forms of science-related cultural capital to overcome obstacles related to being female and non-white in a male-dominated field in a U.S. context. These findings bear implications for individual supports and institutional transformation required to foster the success of Latinas in engineering as a distinct group as well as women of color in STEM overall.

Strand 11: Cultural, Social, and Gender Issues
WIP Roundtable
Gendered experiences of impostor phenomenon: A qualitative study in STEM.
Devasmita Chakraverty*, Indian Institute of Management Ahmedabad, India

ABSTRACT
Impostor phenomenon is a psychological experience where some people disregard their achievements and feel like a fraud.It is common inscience, technology, engineering, and

mathematics. Most gender-based literature has examined differences in mean impostor phenomenon scores and other variables based on gender. More nuanced understanding of the relationship between gender and impostor phenomenon can be made using qualitative comparisons. Using Crenshaw's (1991) theory of intersectionality, this study examined the research question: "What kind of gendered differences, if any, exist when people in STEM describe impostor phenomenon?" In this US-based study, 250 one-on-one, semi-structuredphone interviews (~30-45-minutes) were conducted in 2017-2018 (convenience and snowball sampling).Using qualitative inquiry, 42 male/42 female interviewees in STEM were matched for rank (PhD student, post-doctorate, faculty). Interviewees were coded using constant comparison and analytic induction to construct themes. Findings show that both men/women experience impostor phenomenon during high school and particularly during first-year PhD. However, men describe it more as short-term, fixable, and due to personal lacking while women describe it as long-term, non-fixable, and due to environmental factors, that one cannot control. Men/women socialize and experience conferences differently. Findings reveal inherent differences in how men/women experience hardships and seek support.

Strand 11: Cultural, Social, and Gender Issues
WIP Roundtable

Including Families as a Way to Expand STEM Identity Research

Marisa Peczuh*, University of Minnesota, USA
Keisha Varma, University of Minnesota, USA

ABSTRACT

Science, technology, engineering, and math (STEM) identity has been related to a number of positive outcomes for youth engaging in STEM as well as equity goals within the field. As the number of studies focusing on this construct has accumulated, models of STEM identity have been developed to describe the various factors contributing to STEM identity. However, although some research has explored the role of families within STEM identity, this work has not been integrated into models of STEM identity. The current study addresses this gap in research by interviewing parents as participants (in addition to youth) as well as more directly investigating the ways in which families contribute to STEM identity work. Transcripts are currently being analyzed using reflexive thematic analysis (TA). This paper presents a set of deductive codes generated before analysis using previous models of STEM identity to provide a glimpse into the coding and analysis process. During the roundtable discussion, the full analysis will be completed, and members will have the opportunity to discuss findings and future directions for including families within STEM education research.

Strand 12: Technology for Teaching, Learning, and Research
Roundtable

Exploring Middle Schoolers' Learning in an AI-Integrated Paleontology Camp through Individual and Group ZPD

Chih Hsuan Lin*, University of Florida, USA
Tonika Jones, University of Florida, USA
Ray Opoku, University of Florida, USA

Gabriella Haire, University of Florida, USA
Christine Wusylko*, University of Florida, USA
Nazanin Adhami*, University of Florida, USA
Bruce MacFadden, University of Florida, USA
Victor Perez, St. Mary's College of Maryland, USA
Brian Abramowitz, University of Florida, USA
Pavlo Antonenko, University of Florida, USA

ABSTRACT

Artificial Intelligence (AI) is revolutionizing science education, yet there is limited research on the interactions that promote productive learning in AI-integrated environments. Additionally, AI curriculum materials for K-12 are scarce and mainly focus on computer science rather than science education. To address these gaps, we conducted a study in an AI-integrated paleontology summer camp involving Black girls aged 11-14. Using Vygotsky's Zone of Proximal Development (ZPD) as a framework, we explored how learners developed knowledge and skills about and with AI within both their individual and group ZPDs. Thematic analysis revealed that individual ZPDs were supported by instructor and peer scaffolding, while group ZPDs were promoted through peer interactions. This study enhances our understanding of AI-integrated learning in informal science contexts and extends ZPD theory to AI education. In future research, we plan to explore how Black boys learn about and with AI within their individual and group ZPDs and compare these findings to those of girls. We are particularly interested in whether peer scaffolding is more prevalent among girls and its implications for instructional approaches addressing gender differences in AI education. In the Roundtable session, we aim to discuss our findings, gather feedback, and share our research plans.

Strand 12: Technology for Teaching, Learning, and Research
Roundtable

Optimizing Deep Learning Frameworks and Large Language Models for Automated Science Classroom Discourse Analysis

Soon Lee*, Kennesaw State University, USA

ABSTRACT

This study systematically evaluated the performance of various Large Language Models (LLMs), including BERT, RoBERTa, GPT-4o, and OpenAI's text-embedding-3-large, within the deep learning frameworks, TensorFlow and PyTorch, for the automated analysis of classroom discourse in science education. Traditional methods of classroom discourse analysis are labor-intensive and time-consuming. Leveraging advancements in Natural Language Processing (NLP), this study focuses on optimizing LLMs for classifying classroom utterances with precision and efficiency, thereby contributing to the development of an Automated Discourse Analysis System (ADAS) for science classrooms. The research compares the accuracy, F1 scores, training times, and computational resource usage of the models across two datasets from high school science classes. Results indicate that RoBERTa implemented in TensorFlow achieves the highest performance metrics, though at a higher computational cost, while PyTorch demonstrates superior efficiency. Additionally, while GPT-4o was

expected to outperform other models due to its extensive pre-training, the study found that models using OpenAI's text-embedding-3-large model with local neural networks outperformed GPT-4o in classification tasks. These findings provide critical insights into the strengths and limitations of different LLMs and frameworks in real-world educational contexts and highlight the potential for advanced NLP models to enhance the analysis and improvement of science classroom discourse.

Strand 12: Technology for Teaching, Learning, and Research
Roundtable

Bridging Gaps in Science Education: AI-Driven Personalized Learning and Equity

Taesoo An*, Seoul National University, Korea, Republic of
Sonya Martin, Seoul National University, Korea, Republic of

ABSTRACT

This study introduces an AI-based Question Classification System (AIQCS) designed to enhance personalized science teaching by focusing on student-centered learning and equitable access to education. AIQCS supports personalized instruction by classifying and visualizing students' questions in real-time, allowing teachers to quickly assess individual understanding and tailor their teaching strategies. Through the integration of Bloom's Taxonomy, this system provides a dynamic and responsive approach to managing diverse classroom needs. To ensure its validity, AIQCS was evaluated by five experienced science teachers using a modified Content Validity Index (CVI) across eight criteria, receiving high ratings for its potential effectiveness and applicability. The system's capacity to improve student engagement, foster critical thinking, and reduce teachers' workload highlights its innovative contribution to science education. This proposal seeks to discuss the AIQCS system's design and explore its implications for addressing equity and access in diverse educational settings. Areas of focus include overcoming challenges related to AI's role in education, ensuring that all students benefit from personalized learning, and refining the system for broader applicability across different science subjects. The roundtable discussion will engage peers in exploring the practical implementation of AIQCS, addressing potential barriers, and identifying strategies to enhance its impact in real-world classrooms.

Strand 12: Technology for Teaching, Learning, and Research
Roundtable

Preservice teachers' perceptions of utilizing AI in science education with a focus on human-centered approaches

Soo Won Shim*, Illinois State University, USA
Jeongae Kang, Illinois State University, USA
Do-Yong Park, Illinois State University, USA

ABSTRACT

This study explored the impact of an AI literacy module on preservice teachers' understanding and perceptions of AI integration in science education. The module focused on improving preservice teachers' AI literacy, exploring AI tools in science teaching, and comparing traditional methods and AI-assisted learning. This mixed methods study showed

a significant difference in preservice teachers' AI misconceptions but no change in AI anxiety after experiencing the AI module. PSTs favored hands-on learning for its practical benefits, and they identified AI's potential in lesson planning. The findings emphasize the importance of balancing human-centered learning with AI-assisted learning. This study offers insights into supporting preservice teachers in developing their AI literacy while maintaining human-centered approaches in science education.

Strand 12: Technology for Teaching, Learning, and Research
Roundtable

Generative AI in Science Teacher Education

Stephanie Arthur*, University of South Florida, USA
Yvonne Franco, University of Tampa, USA
Zafer Unal, University of South Florida, USA

ABSTRACT

As generative artificial intelligence (AI) becomes increasingly ubiquitous in society at large, science teachers are grappling with how to integrate this powerful technology into the K-12 classroom. Teacher receptivity to AI faces numerous barriers in understanding and practice. Critical to the developing science teacher is the knowledge of and the skill set to leverage AI technologies for teaching and learning in the elementary science classroom. Science pre- and in-service teachers must be supported in their conceptualization of ways that AI can assist to monitor student understanding, assess to support learners' needs in innovative ways, inform planning for necessary targeted instruction, and bring science learning for all through authentic, inclusive, and interactive experiences. This ongoing study presents insights from three teacher educators' work over multiple semesters to infuse AI tools and methods throughout their methods courses and professional development workshops. Findings offer implications for methods instructors seeking to include AI curriculum that may guide the reconceptualization of methods for teaching, accommodations for AI in instruction, and ways to design professional development leading teachers to develop instructional methods in the elementary science/STEM classroom. This roundtable session will provide targeted discussion points for strategies to incorporate AI into science/STEM methods courses.

Strand 5: College Science Teaching and Learning (Grades 13-20)
WIP Roundtable

Investigation of the Inter-Rater Reliability between ChatGPT-4o and Human Raters in Qualitative Analysis.

Nikhil Borse*, Purdue University, USA
Ravishankar Chatta Subramaniam, Purdue University, USA
N. Sanjay Rebello, Purdue University, USA

ABSTRACT

Qualitative analysis in science education is typically limited to small datasets as it is time-intensive. Moreover, the services of another human are required to establish the reliability of the findings. Artificial Intelligence tools like ChatGPT can potentially substitute for human

raters if we can demonstrate high reliability as compared to human ratings. This study aimed to investigate the inter-rater reliability of ChatGPT-4o in rating audio transcripts which were coded manually in an earlier study. Participants were 14 undergraduate student groups from a university in the midwestern United States, who discussed problem-solving strategies for a project. We used prompt engineering techniques to replicate the coding process as described by the author of the earlier study with ChatGPT-4o and calculated Cohen's Kappa for inter-rater reliability. The results showed substantial agreement for three out of four coding categories, while the fourth category initially showed moderate agreement but improved with appropriate prompts. Our findings show satisfactory levels of reliability, suggesting that qualitative researchers can use tools like ChatGPT to analyze large data sets quickly.

Strand 14: Environmental Education and Sustainability
WIP Roundtable

Culturally-Relevant Field Ecology: Wildfire Mitigation and Social-Ecological Systems Resilience in Maui, Hawai'i

Jadda Miller*, University of California, Davis, USA
Heidi Ballard, University of California, Davis, USA
Cassie Kepler, Kihei Charter School, USA

ABSTRACT

Climate change and colonization have exacerbated wildfire risks globally, as evidenced by the devastating 2023 Lahaina fire in Maui, Hawai'i. This tragedy underscores the urgent need for innovative approaches to environmental education. Our study examines a novel high school field ecology program that integrates Western science with Kanaka ʻŌiwi (Native Hawaiian) Traditional Ecological Knowledge to address wildfire mitigation and social-ecological systems resilience.Using a research-practice partnership model, a high school field ecology teacher and education researchers work closely together and collaborate with cultural practitioners and ecologists to implement a culturally-relevant curriculum. The program engages 25 high school students in hands-on field investigations and stewardship activities. Students will also participate in community outreach, sharing their findings through various forms of art and media to raise awareness about wildfire mitigation strategies.Our mixed-methods study explores how participation in this program influences students' environmental science agency, connection to culture and place, and understanding of social-ecological systems resilience. We employ pre-post surveys, interviews, focus groups, and artifact analysis to assess these learning impacts. This research will contribute to the growing body of research on culturally-relevant science curricula and critical place-based learning, as well as ways that community-engaged scholarship may address pressing global environmental challenges.

Strand 14: Environmental Education and Sustainability
Roundtable

Transformative learning experience: Measurable outcome of a place-based environmental justice-oriented geoscience curriculum

Shondricka Burrell*, Morgan State University, USA

Keshiyena Pieters, Morgan State University, USA

ABSTRACT

More than poverty, racism, particularly anti-Black racism, drives environmental inequity (Miller, 2022). Historic and current land use decisions have led to a disproportionate environmental risk to benefit ratio for poor and marginalized communities with respect to exposure to high concentrations of environmental toxins (Davide, Alessandra, Roberto, 2022; Ma, 2020; Roberts et al., 2022;) which in turn affects the school-aged students living in these communities. To address this persistent pattern, an environmental justice oriented, water-quality based curriculum was developed aligned with NRC (2012) identified scientific practices and informed by the socio-cognitive constructs of transformative learning experience (perceived value, relevance, and application of science) and place-based inquiry was developed and examined for facilitating transformative science learning. Previous quantitative analysis established the efficacy of this curriculum in facilitating transformative learning for students. This current line of inquiry builds on these findings and expands this work by evaluating student generated artifacts for evidence of transformative experience (TE). Specifically, this investigation focuses on understanding the TE expressed by students completing an environmental justice informed water-quality based curriculum experience transformative learning as determined from iterative qualitative coding and analysis of student generated artifacts.

Strand 14: Environmental Education and Sustainability
WIP Roundtable

Development of an instrument to measure grade 7 students' climate change knowledge and GIS skills

Marie Johanna Univer*, University of Tartu, Estonia
Regina Soobard, University of Tartu, Estonia
Birgit Viru, University of Tartu, Estonia

ABSTRACT

Formal education is believed to be the key to raising awareness about global climate change. When interlinked with GIS-based (geographic information system) educational activities, deeper understanding of climate change mitigation can be achieved. To assess lower-secondary students' current knowledge on climate change and their GIS skills, a two-part instrument was created and piloted on 7th–9th grade students. The instrument consisted of two distinct parts – a background questionnaire and a test. Piloting results indicated students' lack of knowledge about global climate change, while misinformation and myths were prevailing (i.e. "ozone layer depletion causes global warming", etc.). GIS skills were practically nonexistent as students had never solved similar tasks before. Nearly half of the students worry somewhat about the climate change, but are not experiencing climate anxiety nor willingness to act – climate change is perceived as something distant that requires no agency and is left for experts to be solved. Piloting helped to further develop the instrument (main study planned in 2024/2025) and gave initial insight about the existing gaps in students' knowledge as well as their values and beliefs. When finalized, the

instrument will help to detect effective educational pathways for classroom GIS and climate learning.

Strand 14: Environmental Education and Sustainability
Roundtable

Needs Assessment for Leveraging Participatory Science to Enhance Participation in Conservation in the Amazon

MARTHA SIMON-PARDO*, UNIVERSITY OF FLORIDA, USA
JULIE BROWN*, UNIVERSITY OF FLORIDA, USA

ABSTRACT

Although indigenous children and youth growing up and being educated in the remote Amazon have access to the vast body of traditional knowledge essential for nature conservation, the continuation of their traditional ways of learning about naturearethreatened by the ongoing negotiation that parents, teachers, and students must navigate between Western and local knowledge systems. Furthermore, colonist approaches to science, often exploitative, have historically positioned science as dominant over indigenous knowledge, reinforcing colonialcontrol.These colonial practices persist today-with 'helicopterresearch'practices such asextractingtraditionalknowledge to obtain data-leaving communities feeling exploited and contributing to the growing divide between local communities and Western scientists.This roundtable will share ourongoingworkthataims to center belonging in science by developing the capacities of culturally diverse indigenous youth (aged 7 – 18) in the Colombian Amazon, to understand and preserve the biodiversity of local ecosystems through the protection of historical and biocultural knowledge. In collaboration with local communities,Non-GovernmentalOrganizations, teachers, and youth, theproject willutilizeParticipatory Arts andScience toharness local ecological knowledge for community-led initiatives. These initiativeswillexploreand enhanceyouth participation in conservation science and contribute to the community's autonomous scientificdevelopment.

Strand 13: History, Philosophy, Sociology, and Nature of Science
Roundtable

How Expressed Distrust in Scientists Impacts Individual Behavior

Ava Breitbeck*, Syracuse University, USA

ABSTRACT

In the wake of the COVID-19 pandemic, media pundits and government officials alike have raised concerns about whether a rise in self-reported distrust in scientistsmight shape the public's willingness to comply with science-based regulations, both in relation to COVID and in other areas. This concern is based on the assumption that the distrust expressed in surveys can also impact real-world behavior. However, existing research has not examined the extent to which expressed trust in scientists has a causaleffect on the public's adherence with scientific regulations more generally. Usinga between-groups experimental design, this study tests the hypothesis that increasing or decreasing trust in scientists causes a corresponding change in compliance with their recommendations across a range of

domains. The results show that while decreasing trust does decrease compliance, increasing trust does not cause a corresponding increase in compliance.

Understanding How Learners Seek Coherence in Science

Strand 1: Science Learning: Development of student understanding
25-Mar-25, 10:00 AM-11:30 AM
Location: Annapolis 2

Symposium

Symposium: Understanding How Learners Seek Coherence in Science

Engin Bumbacher, Haute École Pédagogique Vaud, Switzerland
Benjamin Geller, Swarthmore College, USA
Katherine Gifford, University of Illinois Urbana-Champaign, USA
Karen Hammerness, American Museum of Natural History, USA
Eric Kuo, University of Illinois Urbana-Champaign, USA
Caroline Long, University of Washington, USA
Kavita Matsko, Northwestern University, USA
Mary Short, Smithsonian Science Education Center, USA
Tiffany-Rose Sikorski, The George Washington University, USA
David Stroupe, University of Utah, USA
Daniel Levin, University of Maryland, College Park, USA

ABSTRACT

A longstanding goal of science education is to help students make connections. For many decades, the predominant approach to achieving this goal was through the design of so-called coherent curriculum materials that attempt to make connections salient to students through careful sequencing of topics and activities. However, advances in curriculum design and deeper understanding of the active process of knowledge construction have led the science education community to recognize coherence as something constructed by learners, i.e., learners seek coherence. The study of coherence seeking requires careful attention to how learners perceive, interpret, and coordinate information in science class, an area where researchers have made important progress but also continue to encounter methodological and conceptual challenges. This symposium features recent studies of coherence seeking across a range of contexts (e.g., K-12, university, and teacher preparation), to synthesize findings and discuss next steps for this expanding area of research: What do we know about how learners make connections in science, what more do we need to know, and how can we apply these findings to create meaningful science education for all learners?

Empowering Science Educators: Support Systems, Mentorship, and Professional Development Strategies

Strand 2: Science Learning: Contexts, Characteristics and Interactions
25-Mar-25, 10:00 AM-11:30 AM
Location: Annapolis 1

Stand-Alone Paper

Harnessing Personal Storytelling to Support Teachers' Initial Grasp of Understanding Computational Thinking

Khusbu Dalal*, University of Maryland, USA
Jennifer Radoff, University of Maryland, USA
Andrew Elby, University of Maryland, USA
Amy Green, University of Maryland, USA

ABSTRACT

Traditional professional development aimed at integrating computational thinking (CT) into K-12 classrooms frequently fails to link abstract technical terminology with teachers' personal experiences or real-world situations, which can impede overall teacher understanding and effective classroom implementation. This paper investigates an alternative method that employs personal storytelling to introduce CT to educators. We discovered that storytelling helped build emotional connections and prompted deeper reflections on CT concepts. Participants shared how CT appears in various settings, including teaching, parenting, and outdoor activities, which transformed their understanding and forged significant connections between theory and practice.

Stand-Alone Paper

Catalyst for Change: Validating a Support-Seeking Instrument for Science Teachers

Mayra Marquez-Mendez*, University of Nevada Las Vegas, USA
Tina Vo, University of Nevada Las Vegas, USA
Adjoa Mensah, University of Nevada Las Vegas, USA

ABSTRACT

Global education systems are grappling with challenges exacerbated by the COVID-19 pandemic, social inequities, and systemic barriers. Science teachers, pivotal in fostering scientific literacy, increasingly turn to mentorship for support. This research proposal aims to validate a support-seeking instrument designed to understand the diverse behaviors of science teachers within mentorship contexts. Conducted in a large urban school district, this research is part of a larger mixed methods studyinvolving 115 elementary and middle school science teachers. Reliability analysis using Cronbach's α demonstrated strong internal consistency (α = 0.838), affirming the instrument's robustness. Variability in mean scores and standard deviations across individual items revealed distinct support-seeking patterns, highlighting areas for targeted mentorship interventions. These findings underscore the instrument's value in enhancing mentorship programs, addressing teachers' evolving needs, and contributing to teacher retention. By improving mentorship strategies, particularly in science education, this research seeks to foster more inclusive and effective supportive

practices for science teachers, benefiting both educators and learners. The results align with broader efforts to support science teachers' well-being and professional growth and ultimately advance science literacy for all students, positioning this work as a catalyst for change in education.

Stand-Alone Paper

Prioritizing Expectations Through Professional Development on Mentorship for Physics Undergraduate Research

Heather McCall*, University of Kentucky, USA
Cameron Richards*, University of Kentucky, USA
Jennifer Wilhelm, University of Kentucky, USA

ABSTRACT

This study investigated the experiences of faculty mentors in a Research Experiences for Undergraduates (REU) Physics and Astronomy program. By examining mentor perspectives and practices, we sought to understand the challenges and successes of establishing expectations and maintaining effective communication with undergraduate researchers. A professional development session focused on these areas was implemented using CIMER mentor training curriculum. The mixed-methods study aimed to address the research questions What expectations do mentors establish compared to the realities of their experience and What effect did the professional development have on mentoring? Results indicate that mentors witnessed a growth in students' scientific skills and understanding of physics research, yet rarely did undergraduates try new ideas on their own. The primary challenges for mentors lay in balancing student independence with support and setting appropriate expectations. In addition, mentors prioritize strategies based on their experience and research interests and continue to adapt their mentorship approach through reflective practices. Findings suggest that ongoing professional development combined with peer support can enhance mentor effectiveness and student outcomes in REU programs.

Stand-Alone Paper

Working towards a Rightful Presence for minoritized teacher, student and parent in middle school engineering

Virginia Swindell*, University of North Carolina at Greensboro, USA
Edna Tan, University of North Carolina at Greensboro, USA

ABSTRACT

Given the justice-oriented challenges in engineering education that impact teachers, students-of-color and their parents, our collaborative study with a Black female teacher, Ms. B, a core group of parents and their student seek insights into the following overarchingresearch question:When co-designing and enacting a youth and community-focused curriculum in middle school engineering, how do power-dynamics shift between teacher-student-parent relationalities toward a more rightful presence for all stakeholders, in STEM teaching and learning?Drawing from research-practice-partnership co-design meetings and participatory ethnography across 5 weeks of Ms. B enacting an engineering for sustainable communities curriculum and guided by the Rightful Presence framework, this

study presents two key themes germane to rightful presence work for students, teacher and parents: 1) Teacher actively ceding control to disrupt traditional powered dynamics; and 2) Seeding new stem teacher-student-parent relationalities. We unpack the process of perturbing power dynamics in both classroom and RPP sessions, novel roles for teacher, student and parents and the STEM-based social activity that unfurled from these roles were how new rights were authored for each stakeholder, and existing injustices (e.g., student vaping) and justices (e.g., centering parents as key stakeholders in STEM teaching and learning) made visible.

Integrating cultural relevance and social justice to improve learning outcomes and promote inclusivity

Strand 4: Science Teaching — Middle and High School (Grades 5-12): Characteristics and Strategies
25-Mar-25, 10:00 AM-11:30 AM
Location: Baltimore 4

Stand-Alone Paper

Teacher Perceptions of Enacting a Lesson Woven with Choctaw Culture and Place

Stephanie Hathcock*, Oklahoma State University, USA
Juliana Utley, Oklahoma State University, USA
Kathryn Gardner-Vandy, Oklahoma State University, USA
Sarah McDowell, Maryville College, USA
Angela Just, Oklahoma State University, USA
Kirtika Panwar, Oklahoma State University, USA

ABSTRACT

Providing culturally relevant curriculum in a classroom has been shown to increase student motivation; however, teachers may not be well equipped to design and implement culturally relevant curriculum. The theory of two-eyed seeing and the pedagogical model of place-based learning may be useful tools for designing learning experiences for Native American students. The purpose of this study is to examine teacher perceptions resulting from professional development and the enactment of lessons designed to weave Native American ways of knowing with science instruction. The data consisted ofpost implementation interviews, reflective journals, and a post implementation questionnaire. The post implementation interview was designed to gain information from teachers about the implementation of a [Blinded]-developed lesson in their middle school classroom. Teachers had a lot of thoughts and ideas related to enacting the curriculum. Themes generated from this data included (1) student interest and engagement, (2) relationships, (3) culture, (4) connecting place and science, (5) pedagogy, and (6) challenges with implementation. By understanding teacher perceptions, we can better understand the complexities of developing culturally enhanced lessons for science classrooms that can support all students' engagement and learning.

Stand-Alone Paper

Breaking Down Barriers: Effects of Culturo-Techno-Contextual Approach on Learning Difficult Computer Studies Concepts

Esther Peter, Lagos State University, Nigeria
David Peter, Lagos State University, Nigeria
Peter Okebukola, Lagos State University, Nigeria
Deborah Agbanimu, National Open University, Nigeria
Franklin Onowugbeda, Lagos State University, Nigeria
Adekunle Oladejo, Lagos State University, Nigeria
Olasunkanmi Gbeleyi, Lagos State University, Nigeria

ABSTRACT

The study investigated the efficacy of CTCA in improving students' ability to understand some difficult concepts in computer studies using their cultural background to break the barrier of complexity in difficult science subjects. The sample comprises of 89 SS3 computer studies students. A pre-test was administered before the treatment to determine the student's pre-existing knowledge. The study employed a quasi-experimental research design. The experimental class had 50 subjects while the control group had 39 subjects of senior secondary school 3 computer studies students in Lagos State, Nigeria. Quantitative data were collected through achievement test with respectable instrument measures. The experimental group was taught using culturo-techno-contextual approach while the control group had their learning experiences through the lecture method.ANCOVA result showed that students taught machine language using culturo-techno-contextual approach, cooperative learning, and traditional lecture method had a statistically significant difference in terms of achievement[F (1,84) = 81.56; P0.05].The result also revealed that there is no statistically significant difference in terms of achievement and gender[F (1,84) = 1.92; P0.05]. The findings showed the potential of CTCA in improving students' performance in machine language in the computer studies curriculum.

Collaboration and Interdisciplinary Research

Strand 5: College Science Teaching and Learning (Grades 13-20)
25-Mar-25, 10:00 AM-11:30 AM
Location: Magnolia 3

Stand-Alone Paper

Developing future leaders: Interdisciplinary and professional training for graduate students in Food-Energy-Water (FEW) systems

Suhana Chattopadhyay*, University of Maryland, USA
Katya Murillo, University of Maryland, USA
Gili Ad-Marbach*, University of Maryland, USA
Amy Sapkota, University of Maryland, USA

ABSTRACT
Addressing the intertwined challenges of climate change and increasing demands for fresh water and energy in food production requires integrated solutions across science, engineering, and policy. The Food-Energy-Water (FEW) nexus emphasizes the necessity of a comprehensive approach. However, traditional STEM education often isolates disciplines, lacking in interdisciplinary and professional training essential for solving FEW nexus issues. To bridge this gap, we developed a graduate education program focusing on FEW systems, combining interdisciplinary research with professional skills development. The program includes a two-course sequence, a seminar series, a professional development workshop, a study-abroad component, and student-led committees. Over five years, 55 diverse doctoral students participated in the program, gaining skills in interdisciplinary research, communication, career preparation, and cultural competence. Our evaluation, based on mixed methods, shows significant improvements in students' interdisciplinary teamwork and communication abilities, though challenges in leadership and mentorship training were noted, especially during the COVID-19 pandemic. The program produced 21 collaborative research projects, resulting in academic publications, extension materials, grant proposals, and policy memos. This model demonstrates a successful approach to training future leaders capable of addressing global FEW nexus challenges and underscores the importance of interdisciplinary and professional development in graduate education.

Stand-Alone Paper

Experiences of Collaboration Difficulties in University STEM Laboratories: A Phenomenological Study

Sun Young Shin*, Seoul National University, Korea, Republic of
Seung Ah Park, Seoul National University, Korea, Republic of
Minsu Ha, Seoul National University, Korea, Republic of

ABSTRACT
Collaboration is essential in solving complex problems and driving innovation in STEM (Science, Technology, Engineering, and Mathematics) fields. However, conflicts and structural issues in the collaborative process can hinder research efficiency and negatively impact outcomes. This study explores the conflicts and issues in STEM collaboration and proposes solutions. Using qualitative methods, in-depth interviews were conducted with STEM researchers. The study identified key factors exacerbating collaboration complexity and impeding research efficiency, including disruption of collaboration due to a lack of shared goals, interdisciplinary communication barriers, and bottlenecks in data flow. Additionally, researcher conflicts were categorized into hierarchical organizaional structure, ambiguity in contribution evaluation and authrship conflicts, and gender bias and inequality. Researchers employed various strategies to resolve these conflicts, such as resolving conflicts generously through understanding, adopting a defensive approach to prevent exacerbating conflicts, and venting emotions through informal channels. These findings highlight the importance of setting clear objectives, promoting interdisciplinary communication, establishing a fair contribution assessment system, and creating a gender-equal research environment for successful collaboration. This study offers practical guidelines for understanding the

complexity of STEM collaboration and effectively addressing the diverse issues researchers face, providing strategic insights to improve collaboration quality in STEM fields.

Stand-Alone Paper

Students' Ideas about Convergence Research in a Complex Problems Course on Wasted Food

Alicia DeBruin, American University, USA
Hannah Jardine*, American University, USA

ABSTRACT

Convergence research combines expertise from a variety of scientific and non-scientific disciplines in academia, government, and the community to address complex societal problems, such as reducing wasted food. In this case study, student written assignments from a novel course for first-year students about wasted food were analyzed to understand students' ideas about wasted food as a complex problem and the importance of using convergence research to address it. Using a combination of qualitative coding methods, we determined students in the course recognized multidisciplinary, interdisciplinary, or convergence research are needed to address and solve wasted food. The variation in student ideas led us to develop a continuum of student understanding of the need for convergence research in addressing wasted food, with each step on the continuum moving towards convergence. Students used a small number of similar phrases in their written assignment suggesting their understanding fell within one of the categories along the continuum. The continuum can be used to measure students' understanding of convergence research and wasted food or to evaluate their progress along the continuum over time. This research may be relevant to instructors teaching courses that involve convergence research or to those developing convergence research-focused educational material.

Stand-Alone Paper

'My field is packed full of jargon.'' How Graduate Students Navigate a Convergence Research Center

Kathleen Bordewieck*, North Carolina State University, USA
M. Gail Jones, North Carolina State University, USA

ABSTRACT

This case study examined graduate students' costs when working in a convergence research center for sustainability. Although convergence science is a growing strategy to tackle complex problems in science and engineering, little is known about students' academic identity, how they navigate the multi-discipline environment, and the costs associated with graduate education in convergence research. There were 9 STEM graduate students were interviewed based on expectancy-value factors across their first two years at the convergence research center. All of the case study students were greatly impacted by working in a convergence center. Results showed that all of the participants added additional academic identities during their work, many of which were related to sustainability. Results showed the group of students experienced challenges related to their graduate work that crossed disciplinary boundaries. Students experienced navigating group

work across disciplines, in particular, how language and jargon could be a boundary. Some of the participants also experienced academic bias. The findings argue that students should be provided with increased support as they conduct convergence research.

Building Youths' STEM Identity through Informal Science Experiences

Strand 6: Science Learning in Informal Contexts
25-Mar-25, 10:00 AM-11:30 AM
Location: Magnolia 2

Stand-Alone Paper

The social networks of historically marginalized youth and how they contribute to their STEM pathways.

Preeti Gupta*, American Museum of Natural History, USA
Peter Bjorklund, University of California San Diego, USA
Rachel Chaffee*, American Museum of Natural History, USA
Anna Macpherson*, American Museum of Natural History, USA
Mahmoud Abouelkheir*, American Museum of Natural History, USA
Coral Braverman, American Museum of Natural History, USA
Jahneal Francis, American Museum of Natural History, USA
Lois Wu, American Museum of Natural History, USA
Lucie Lagodich, American Museum of Natural History, USA
Priya Hinton, American Museum of Natural History, USA

ABSTRACT

Programs in informal learning organizations become spaces where youth develop significant relationships with peers and adults and also learn how to leverage those networks and create new ones. That said, there is a need to better understand these networks so that both practitioners can engage in evidence-based practices and the work of researchers can advance our knowledge about these networks. As such, our research questions are: 1) Who are the people supporting these youth as they transition from college to the workforce? 2) What are the supports that youth leverage from their social networks (adult and peer)?3) What is the relationship between youth's social networks and their sense of well-being? We present findings from a social network analysis of 358 participants in a longitudinal study and discuss implications for strategies for practitioners as well as opportunities for researchers to advance the work based on what we have learned.

Stand-Alone Paper

Problem-Solving in the Missouri Ozarks: Case Studies in Informal Education to Promote Science Interest

Katherine Sharp*, Missouri University of Science and Technology, USA
Beth Kania-Gosche, Missouri University of Science and Technology, USA
Carly Carron, Missouri University of Science and Technology, USA

ABSTRACT
Students within rural communities often feel disconnected to science content. Such communities often have marginalized access to science engagement. A barrier for quality science education within rural communities is situating students within their learning context to fill the gap between their local rural knowledge and science content, in addition to minimal access to quality facilities and resources for science education. Within the present study, we designed and piloted a case study on mining within the Missouri Ozarks in an informal context. The case-based activity was implemented in a summer camp to investigate how CBL can be used to support science interest within rural and underserved communities. Within the findings, changes in career interest were not observed as most students had identified that they were already interested in STEM careers prior to the study. However, we did observe evidence that indicated relevant learning experiences as students established connections between the activity and the larger community. We argue that creating relevant learning experiences by situating students through CBL in informal settings can be an avenue to foster science interest among rural and underserved students.

Stand-Alone Paper

Fostering Belonging in a STEM Academic Community of Practice through a Summer Research Internship

Alexandria Muller*, University of California, Santa Barbara, USA
Jeanice Trat, University of California, Santa Barbara, USA
Wendy Ibsen, University of California, Santa Barbara, USA

ABSTRACT
Out-of-school environments, such as summer internships can help foster a sense of belonging within STEM academic communities of practice to increase retention in STEM programs. This study explores the impact of a 6-week STEM research internship at an R1 institution on high school students' perceptions of the STEM academic community of practice and their sense of belonging within it.Drawing on the theoretical frameworks of legitimate peripheral participation (Lave Wenger, 1991) and inclusive participation (Authors, 2024), we examine how hands-on research activities shape students' integration into STEM communities. We followed ten rising high school seniors as they engaged in STEM-based research projects. Data were collected through interviews, surveys, and weekly reflections, and thematically analyzed to assess changes in students' confidence, science identity, and engagement with the STEM academic community.Our findings show that participation in both peripheral and inclusive activities increased students' confidence in STEM research, strengthened their sense of belonging in their lab groups, and provided a realistic understanding of university-level STEM work. However, the role of mentors in supporting clear communication was crucial to ensuring a positive experience. This study highlights the importance of authentic STEM research opportunities in fostering a sense of belonging in STEM.

Stand-Alone Paper

Belonging and Connections: A Network Analysis of High School Students in a Science-Centered College-Readiness Program

Rachelle Pedersen*, Texas Tech University, USA
Emily Sparago*, Boston University School of Medicine, USA
Cindy Kern*, Quinnipiac University, USA

ABSTRACT

The current study utilizes social network analyses to assess how connections amongst high school students, near-peer mentors, teachers, and university faculty change throughout aCommunity(blinded for review) week-longSummer Experience (SE), a program embedded within a three-year contextualized science and college-readiness program. Using Bourdieu's Social Capital and Social Network theories, we sought to evaluate how engagement in a multi-year, design-based broad network (i.e., high schoolers, science teachers, near-peer college students, and university faculty/staff) impactsCommunitymembers' sense of belonging and connections made throughout theSE. Social network results indicated that initial individual-level characteristics, such as student status or centrality measures in the network, were associated with varying levels of belongingness; these levels became non-significant at the end of the week. Additionally, network structures of modularity or group clustering from daily surveys reflected the design-based pedagogical practices implemented in the structure of theSEschedule. Results of the study and future longitudinal work have implications for development of effective broad network, community-based college-readiness programs for high school students.

Research in Approaches to STEM Teacher preparation

Strand 7: Pre-service Science Teacher Education
25-Mar-25, 10:00 AM-11:30 AM
Location: Baltimore 2

Stand-Alone Paper

Overcoming Barriers in Interdisciplinary Education: Exploring Pre-Service Teachers' Perceptions

Niklas Kramer*, Bielefeld University, Germany
Claas Wegner, Bielefeld University, Germany

ABSTRACT

Today's transformative challenges highlight the importance of interdisciplinary education, which fosters crucial competencies like critical thinking and problem-solving to cope with the challenges. In contrast, there is a lack of interdisciplinary teaching, which can be explained by teachers' disciplinary training. A design-based research (DBR) approach is used to determine how pre-service teachers can be adequately prepared for implementing interdisciplinary teaching. The paper discusses a study to identify the barriers associated with

conducting interdisciplinary lessons, as perceived by pre-service teachers and the necessary changes in their preparation. The study involved a qualitative approach, using an open questionnaire (N=165) and semi-structured interviews (N=12). The results were analyzed using content analysis and compared with the barriers reported by in-service teachers.Six barriers were identified, including knowledge gaps, organizational hurdles, and difficulties in planning interdisciplinary lessons. The main differences to in-service teachers are a generally more open attitude towards interdisciplinary teaching but a considerably higher need for support in planning such projects. Pre-service teachers find it particularly difficult to develop suitable problem questions, find connections between relevant subjects, and structure the content and timing of the teaching. They request hybrid training formats that provide theoretical foundations and guided practical experience.

Stand-Alone Paper

Innovating Science Education: The Impact of Situated Learning on Preservice Teachers' Implementation of Engineering Design

John Ojeogwu*, Texas State Univeristy, USA
Frackson Mumba, University of Virginia, USA

ABSTRACT

This study investigates the implementation of Engineering Design Integrated Science (EDIS) by secondary science pre-service teachers (PSTs) within a situated learning framework, focusing on their ability to innovate and adapt engineering principles during student teaching. The study finds that most PSTs develop high-quality, innovative EDIS units that align with reformed practice standards, contrasting with previous research indicating a gap between the planning and classroom implementation of engineering design. Over 80% of the units evaluated were rated as good or excellent, with classroom implementations reflecting a strong adherence to educational reforms. The innovative approach adopted by PSTs in this study highlights the necessity for creativity in STEM education, fostering student engagement and enhancing learning outcomes. This aligns with the situated learning framework's emphasis on cognitive apprenticeship, where PSTs observe, engage, and reflect within authentic teaching environments, effectively bridging theoretical concepts with practical application in diverse educational settings. This study underscores the potential of structured interventions within teacher education programs to equip PSTs with the skills necessary to integrate engineering design effectively into science education, thereby meeting contemporary educational standards and addressing the evolving demands of science teaching.

Stand-Alone Paper

Elementary Preservice Teachers' Views of Investigations: A Pre/post Comparison from a Science Content Course

Ashley Thomas, Kennesaw State University, USA
Rasheda Likely, Kennesaw State University, USA
Preethi Titu, Kennesaw State University, USA
Anna Arias, Kennesaw State University, USA
Jessica Stephenson Reaves, Kennesaw State University, USA

Soon Lee, Kennesaw State University, USA

ABSTRACT
The science practice of engaging in planning and carrying out investigation is essential in elementary science, yet teachers have little opportunities to develop knowledge and ability for supporting science practice in classrooms. This qualitative case study examines elementary preservice teachers' (PSTs) ideas about the importance of investigation in elementary learning and their prior experiences with investigations. At the beginning and end of a specialized science content course for elementary teachers, 143 PSTs completed a survey about their views and experiences with science investigations. Common themes in the PSTs' responses included the importance of planning and carrying out investigations for supporting critical thinking, hands-on learning, sparking interest, and developing understanding of science ideas. The PSTs also more commonly identified the role of developing understanding through investigations on the post-survey compared to the pre-survey. The findings highlight strengths that can be built on as well as areas of potential support in the PSTs' responses about the importance of planning and carrying out investigations in elementary classroom. The analyses have implications for teacher educators and researchers for supporting PSTs' development of knowledge and practice for science practices.

Shaping Teacher Dispositions: Insights from Preservice Learning Experiences

Strand 7: Pre-service Science Teacher Education
25-Mar-25, 10:00 AM-11:30 AM
Location: Baltimore 1

Stand-Alone Paper

Elementary Pre-service Teachers' Responsiveness When Facilitating Simulated Scientific Argumentation Discussions: Before and After an Intervention

Shreyashi Halder*, ETS, USA
Jamie Mikeska, ETS, USA
Devon Kinsey, ETS, USA
Pamela Lottero-Perdue, Towson University, USA
Pavneet Bharaj, California State University Bakersfield, USA

ABSTRACT
This study examined elementary pre-service teachers' (PSTs') responsiveness to students when facilitating a simulated scientific argumentation discussion about the identity of a mystery powder based on its physical properties; the discussion aimed to engage students in argument construction and critique. Specifically, the study explored PSTs' responsiveness (a) within a digital simulated classroom environment of five student avatars played by a human actor in real time; and (b) before and after participating in an intervention involving their engagement in three digital simulations that aimed to support their ability to facilitate scientific argumentation discussions. Study participants were 36 PSTs enrolled in three

science method courses. Using existing frameworks from literature and qualitative content analysis of pre and post discussion transcripts, we identified instances of PSTs prompting argument construction and critique and coded the level of responsiveness for each instance. We used the Wilcoxon matched-pairs test to compare pre-post data. Findings show that that PSTs used significantly more moves to encourage argument critique in post versus pre discussions and fewer low-level responsiveness prompts in post discussions when prompting argument construction or critique. This study highlights the value of using avatar-based digital simulations in teacher preparation to enhance teachers' responsiveness to facilitate productive discussions.

Stand-Alone Paper

Connections between collective, personal, and enacted pedagogical content knowledge in a pre-service chemistry teacher program

Luciane Goes, Federal University of Sao Carlos, Brazil
Carmen Fernandez*, University of Sao Paulo, Brazil

ABSTRACT

This study investigates the connections between collective PCK (cPCK), personal PCK (pPCK), and enacted PCK (ePCK) among pre-service chemistry teachers within the context of a Pedagogical Residency Program (PRP) in a Latin America country. Six undergraduate chemistry students participated by developing and implementing didactic sequences during remote learning. Data were gathered through reports, audiovisual recordings, and interviews using the stimulated recall technique. Qualitative thematic analysis guided by the five PCK components proposed by Park and Oliver was employed for data analysis. The findings reveal that the development of PCK is highly individualized and influenced by both personal and collective knowledge exchanges. The study highlights the crucial role of collective meetings and reflective practices in shaping and enriching the PCK of pre-service teachers, demonstrating that participation in the PRP significantly enhances their pedagogical reasoning and teaching strategies. Additionally, the study provided opportunities to directly observe ePCK and pPCK, and to examine the PRP´s role in strengthening both pPCK and cPCK.

Stand-Alone Paper

Learning Dispositions of Pre-Service Biology Teachers and Undergraduate Biology Students regarding Animal Experimentation in Research

Jacqueline Dischereit*, Georg-August-University, Germany
Susanne Bögeholz, Georg-August-University, Germany

ABSTRACT

Animal experimentation in research (AE) is a controversial socioscientific issue (SSI), with attitudes ranging from rejection to acceptance. These attitudes are influenced by external factors (e.g., research context), and internal factors (e.g., knowledge, ethical aspects). Knowing about attitudes towards a specific SSI is significant as certain attitudes can influence the students' willingness to engage with the SSI. This study (N = 503) examines attitudes of pre-service biology teacher (PST) and undergraduate biology students towards

three contexts: AE with nonhuman primates, AE with other test animals, behavioural research with nonhuman primates. Key objectives are to identify (1) attitudes towards these contexts and (2) the internal factors underlying these attitudes. Results indicate that attitudes towards AE with nonhuman primates are most negative, while behavioural research is viewed most positively. Internal factors influence attitudes across contexts, with an overall explanation pattern emerging: attitudes in favor are mostly explained by knowledge, those against are mostly explained by ethical aspects, and ambivalent attitudes are mostly explained by conditions of AE. PST students show less favorable attitudes across contexts and explain their attitudes with more knowledge than undergraduate biology students. The findings highlight the need for tailored educational approaches to effectively address SSIs in higher education.

Stand-Alone Paper

How a Course Exploring AI Tools Influences Pre-service Teacher's Perceptions of AI

Kerry Bartlett*, University of North Carolina at Chapel Hill, USA
Janice Anderson, University of North Carolina at Chapel Hill, USA

ABSTRACT

Artificial Intelligence (AI) tools are quickly making their way into schools (Impact Research, 2023; Schiel et al., 2023). While pre-service teachers have predominately positive perceptions of AI and its impact on education, most pre-service teachers also have a severe lack of understanding of AI and how to integrate it into the classroom (Pokrivcakova, 2023). Teacher education programs must change to support future teachers' AI literacy (U.S. Department of Education, 2024; ISTE, n.d.). This research aims to determine how perceptions and attitudes towards AI among pre-service teachers are influenced by a teacher education course that includes instruction on AI tools for the classroom. A 20-question survey captured pre-service teachers' perceptions of AI before and after the course. The results showed that participating in the course significantly improved their knowledge of AI and how to use it in the classroom but did not influence their positive or negative attitudes toward AI. Reflections on five specific AI tools revealed that attitudes towards AI and intention to use the tool in the future varied depending on the tool. Further research is needed to explore how teacher education programs can leverage both instruction and specific AI tools to improve AI literacy and attitudes toward AI.

Challenges and Resilience in Early Career Science Teacher Retention

Strand 8: In-service Science Teacher Education
25-Mar-25, 10:00 AM-11:30 AM
Location: Camellia 2

Stand-Alone Paper

Newly Hired Science Teachers Cultivating Resilience: Proximal Assessments and Distal Reflections

Jose Pavez*, Western Illinois University, USA

Ella Yonai, University of Georgia, USA
Shannon Navy, Kent State University, USA
Julie Luft, University of Georgia, USA
Adepeju Prince, University of Georgia, USA
Lisa Borgerding, Kent State University, USA
Robert Idsardi, Eastern Washington University, USA

ABSTRACT
This study investigates the resilience trends of newly hired STEM teachers in high-needs schools, exploring how various personal and contextual factors influence their resilience over two years. Using an explanatory mixed methods design, the research examines quantitative survey data and qualitative interviews to analyze teachers' overall resilience trends. The study identifies three distinct resilience trajectories: teachers with a minimum resilience score at the start, middle, and end of the year. The findings reveal that individual experiences vary significantly. Key factors such as social engagement and administrative support play critical roles in maintaining or enhancing resilience, particularly during challenging periods. The study provides practical recommendations for educational leaders to implement targeted interventions that foster resilience, ultimately reducing teacher turnover and improving the stability of the science education workforce.

Stand-Alone Paper

Engaging out-of-field teachers as learners: when is it too much?

David Perl-Nussbaum*, Weizmann Institute of Science, Israel
Dana Vedder-Weiss, Ben-Gurion University of the Negev, Israel
Edit Yerushalmi, Weizmann Institute of Science, Israel

ABSTRACT
This study explores the unique challenges faced by out-of-field (OOF) teachers when engaged as learners in reform-oriented professional development (PD) programs. While there is a growing body of research on the emotional aspects of reform-oriented PD, OOF teachers are often not considered. We focus on an extreme case of resistance from an OOF teacher during a physics PD program. Using a case study approach, we conducted participant observations and stimulated recall interviews with the teacher and the facilitator to understand the challenges and emotions they faced during the incident. Findings reveal the hidden positionalities and power relations of both the teacher and the facilitator in this situation, as well as the teacher's strong sense of uncertainty. These findings stress the importance of understanding the particular challenges of OOF teachers in reformed science PD and preparing facilitators to recognize these challenges in order to better adapt reformed strategies to the needs of OOF teachers.

Stand-Alone Paper

Early Career STEM Teacher Burnout: Trends and Explanations

Shannon Navy*, Kent State University, USA
Ella Yonai*, University of Georgia, USA
Adepeju Prince, Kent State University, USA

ABSTRACT
Although it is known that early career teachers need support to reduce teacher burnout, little is known about the burnout trends over time for teachers in their first five years of teaching. To increase the knowledge in this area, this paper focuses on the burnout trends of early career science, technology, engineering, and mathematics (STEM) teachers over two years and the teachers' explanations of those trends. The participants are 25 early career STEM teachers in the United States. Data sources included three burnout surveys measuring the burnout dimensions (i.e., depersonalization, emotional exhaustion, and personal accomplishment), a pre-interview, and an end-of-year interview each year of the two-year study. Findings revealed differences in trends depending on the burnout dimension. The qualitative data revealed reasons for increases or decreases in each of the burnout dimensions as well as teacher's individual burnout trajectories which were influenced by internal and external factors. The study highlights the importance of supporting early career teachers' well-being to reduce stress and burnout.

Stand-Alone Paper

Does Remuneration and Recognition Matter in Attrition? Science Teachers' Experiences in the Teacher Incentive Allotment

Rebecca Hite*, Texas Tech University, USA
Gina Childers*, Texas Tech University, USA
Jessica Gottlieb, Texas Tech University, USA
Alexander Wiseman, Texas Tech University, USA

ABSTRACT
In 2019, the Teacher Incentive Allotment (TIA) was legislatively established with oversight from the Texas Education Agency (TEA) allowing school districts to "use TIA funds to retain their best teachers, recruit promising new teachers, and incentivize teachers to work in high-needs schools and difficult-to-staff positions" (TEA, 2023a, p. 5). To become TIA designated (as recognized, exemplary, or master), teachers meet criteria by engaging in leadership activities to denote their quality as an educator. This paper reports on the preliminary results of a survey relating the experiences of 143 classroom science teachers who are participating in the TIA. Ten items queried their opportunities for leadership, their professional perceptions (social and self) of their leadership, and if TIA participation impacted their retention as teachers. Open-ended responses supplemented each Likert item. Science teachers reported how their TIA designation increased collegiality and collaboration at their school, improved their own leadership skills, science content knowledge, and student achievement in science. Yet, some TIA teachers perceived they were underrecognized and underutilized; although they were unable to fully exercise their leadership capabilities, they were still developing their leadership abilities. Overall, TIA participation was perceived positively by sampled teachers in promoting science teacher professionalism and retention in Texas.

Strengthening Science Teaching through Mentoring, Modeling, and Professional Development

Strand 8: In-service Science Teacher Education
25-Mar-25, 10:00 AM-11:30 AM
Location: Annapolis 3

Stand-Alone Paper

Science Teachers and District Science Leaders: A Complex Pragmatic Study of Support and Instruction

Julie Luft*, University of Georgia, USA
Joseph Deluca, University of Georgia, USA
Yuxi Huang, University of California, USA
Xinyu He, University of Georgia, USA
Elizabeth Ayano, University of Georgia, USA
Ella Yonai, University of Georgia, USA
Brooke Whitworth, Clemson University, USA

ABSTRACT

Science teachers in the United States are focused on attainingNext Generation Science Standards [NGSS] (National Research Council [NRC], 2013) in their classrooms. Often guiding their instruction are district-science leaders. While DSLs are common in many school settings, little is known about how they influence science teachers in their attainment of theNGSS (NRC, 2013). In this study, we examined the work of DSLs, the experiences of science teachers, and practices of science teachers to contemplate how DSLs supported science teacher instruction. Opfer and Pedder's (2011) view nested systems, along with consideration of opportunities to learn guided the framing of this study. This pragmatic study (Creswell Creswell, 2017) followed DSLs and teachers for two years to understand how DSLs and teachers worked toward the vision of theNGSS(NRC, 2013). Three difference analyses were conducted and merged to depict how DSLs and teachers were connected to attaining the NGSS (NRC, 2013) vision. Two important findings are shared herein: DSLs have a pronounced, but distal influence, and significant negotiation of the instruction occurs at the school level. From this analysis, there are areas that can be better leveraged to cultivate a vision of the standards in science classes.

Stand-Alone Paper

Teachers'Professional Development Based on Learning Progression for Metamodelling and Modeling Practice

Yi-Xuan Liu*, Beijing Normal University, China
Xin-Hao Song, Beijing Normal University, China
Jian-Xin Yao, Beijing Normal University, China

ABSTRACT

Research on learning progressions (LPs) has evolved from a focus on core concepts to key practices in science. At present, more attention is paid to the practical impact of LPs in the classroom and their application in teachers' professional development. Based on previous

studies of LPs for meta-modelling and modelling practice (MMP), this study focused on content knowledge and Pedagogical Content Knowledge (PCK) of modelling instruction. We designed and conducted a teachers' professional development program of modelling instruction. Both the pretest and posttest instruments and the workshop were developed with reference to the LPs for MMP and the professional knowledge of modelling instruction. Analysis of the data revealed that teachers' content knowledge and PCK of modelling instruction improved significantly after the workshop.

Stand-Alone Paper

Putting it to Practice: Exploring the Practical Implementation of Educative Mentoring Concepts

Amanda Hall*, North Carolina State University, USA
Soonhye Park, North Carolina State University, USA

ABSTRACT

Science teachers are pivotal in fostering a scientifically literate society, particularly through public school classrooms with reform-oriented approaches. This study emphasizes the shift from traditional teacher-led methods to inquiry-based, student-centered pedagogy, incorporating science and engineering practices (SEPs). High-quality professional development, extended over multiple sessions and including the support of a learning community and mentorship, is crucial for effective teaching practice reform. Educative mentoring (EM) emerges as a supportive approach, emphasizing collaborative planning, reflection, and a focus on pedagogy.This comparative case study explores EM practices over a year, involving mentors guiding novice teachers in Modeling Instruction (MI) pedagogy. Data from recorded mentoring sessions and logs were analyzed inductively using a constant comparative method, revealing that mentors utilized EM in their sessions with mentees, frequently using inquiry, collaborative learning, and reflective discourse. The study found that EM principles naturally supported new pedagogy learning, highlighting the importance of reciprocal learning in mentor-mentee relationships.The findings suggest that integrating EM within professional development can enhance science teacher resilience and effectiveness in using reform-oriented pedagogy. The study contributes to understanding EM's practical application, advocating for its inclusion in teacher training to support the ongoing transition to reform-oriented science education.

Stand-Alone Paper

Investigating Cross-Grade Discussions around Science Teaching Practice in Vertical Professional Learning Communities

Jose Felipe Martinez, UCLA, USA
Matthew Kloser*, University of Notre Dame, USA
Michael Szopiak, University of Notre Dame, USA
Marlene Saint Martin Guerra, UCLA, USA
Justin Betzelberger, UCLA, USA
Richard Huyn, UCLA, USA

ABSTRACT
This study explores the impact of vertical Professional Learning Communities (PLCs) on the professional growth of K-8 science teachers in a small west coast school district. The study involved 35 teachers across two cohorts, who engaged in multi-year professional learning focused on two core disciplinary ideas from the Next Generation Science Standards (NGSS) and the scientific practice of constructing and using models. The findings reveal significant affordances of vertical PLCs, including enhanced understanding of the trajectory of student thinking across grade levels and improved alignment with NGSS content expectations. Teachers valued the opportunity to see how student knowledge and practices evolved, with younger grade teachers gaining insights into long-term learning progression. However, barriers such as time constraints and curricular differences between elementary and middle schools posed challenges to effective collaboration. The study highlights the crucial role of classroom artifacts in fostering meaningful professional discussions, though teachers expressed the need for more time to engage with these artifacts. Overall, the results underscore the potential of vertical PLCs to enhance teacher collaboration and professional learning, contributing to more coherent and effective science instruction across grade levels.

Interdisciplinary and STEM learning Pathways

Strand 10: Curriculum and Assessment
25-Mar-25, 10:00 AM-11:30 AM
Location: Magnolia 1

Stand-Alone Paper

Developing and Validating the Interdisciplinary Science Assessment of Carbon Cycling II

Hyesun You*, The University of Iowa, USA
Sunyoung Park, sunyoungpark@callutheran.edu, USA
Soo Hyun Yang*, The University of Texas at Austin, USA

ABSTRACT
Understanding natural phenomena and tackling global challenges often requires transcending the boundaries of individual scientific disciplines. This study focuses on the development and validation of the ISACC II, an assessment tool designed to measure interdisciplinary (ID) understanding of carbon cycling. We examined the dimensionality and internal structure of the assessment by comparing one-factor and two-factor models. The final two-factor path model, which differentiates between disciplinary and ID factors, demonstrated superior fit (χ2/df = 2.365, RMSEA = 0.030, CFI = 0.983, TLI = 0.982) and was selected based on both theoretical and empirical considerations, particularly the assumption that disciplinary learning directly influences ID learning. The reliability of the ISACC II was robust, with Cronbach's alpha (α) and McDonald's Omega (ω) exceeding 0.7 for most constructs. The ISACC II addresses a critical gap in science education by providing a validated tool that enhances students' ability to synthesize knowledge across disciplines. This study a

supports curriculum design and instructional strategies that emphasize the interdisciplinary learning of scientific knowledge.

Stand-Alone Paper

Advancing Ultra-Orthodox and Religious Male Students through Interdisciplinary Practical Engineering Program

Ruth Edri*, Technion - Israel institute of technology, Israel
Shahaf Rocher-Yoel, Technion - Israel institute of technology, Israel
Yehudit Dori, Technion - Israel institute of technology, Israel

ABSTRACT

The ultra-Orthodox community is underrepresented in Science, Technology, Engineering, and Mathematics (STEM) disciplines, which are not encouraged due to the school's emphasis on religious education. This study examines an interdisciplinary program designed to integrate practical engineering education with religious studies for ultra-Orthodox and religious male students. Based on Social Cognitive Career Theory (SCCT), the research investigates the program's impact on practical engineering education, career choice, and socioeconomic mobility. The research method employs a mixed-methods approach, encompassing quantitative data collected through questionnaires and qualitative data derived from interviews and open questions. Additionally, a comprehensive analysis of the curricula outlined by the Ministry of Education was conducted to provide a contextual framework for understanding the educational landscape within which the program operates. This approach enables an exploration of the program's impact from multiple perspectives. The research participants consisted of 201 students and graduates from the ultra-Orthodox program and the religious program. The findings reveal that the program positively influences students' self-efficacy, interpersonal skills, and career aspirations. Graduates demonstrate improved socioeconomic mobility and integration into the STEM workforce. The study contributes to understanding the factors that affect STEM career choices for underrepresented groups and provides a model for integrating religion and STEM education.

Stand-Alone Paper

Developing and Evaluating an Online Biomedical Curriculum on Blood Disorders for High School Students

Tingting Yang*, St. Jude Children's Research Hospital, USA
Amanda Etherington*, St. Jude Children's Research Hospital, USA
Torrean Johnson, St. Jude Children's Research Hospital, USA
Kyle Bichsel, St. Jude Children's Research Hospital, USA
Robyn Pennella, St. Jude Children's Research Hospital, USA
Eric Rivera-Peraza, St. Jude Children's Research Hospital, USA
Katherine Ayers, St. Jude Children's Research Hospital, USA

ABSTRACT

Aiming to expand community outreach and engagement efforts through online education, the research team designed, implemented, and evaluated an online curriculum focused on teaching blood disorders and cell cycle to high school students. The curriculum was

introduced in a biology class at a public charter high school in the Southeastern United States. Data collection methods included pre- and post-surveys, focus groups, and a teacher interview. Results indicated that while students generally had positive perceptions of online learning, there was significant variability in their experiences and expectations. The focus group and teacher interview highlighted the curriculum's success in engaging students through real-world relevance but also identified areas for improvement, such as enhancing navigation and providing clearer instructions. Overall, the study demonstrates the potential of a well-designed online curriculum to achieve authentic and engaged learning, while emphasizing the need for ongoing refinement to better support both student and teacher needs.

Misinformation in Science Media - Enhancing the Evaluation of Credibility in Digital Contexts

Strand 12: Technology for Teaching, Learning, and Research
25-Mar-25, 10:00 AM-11:30 AM
Location: Baltimore 5

Symposium

'Misinformation in Science Media'' - Enhancing the Evaluation of Credibility in Digital Contexts

Kerstin Kremer*, Justus Liebig University, Germany
Alexander Büssing*, Technische Universität Braunschweig, Germany
Andreas Nehring*, Leibniz University Hanover, Germany
Soraya Kresin*, Technische Universität Braunschweig, Germany
Margot Bakker,Technische Universität Braunschweig, Germany
Daniel Pimentel*, The University of Alabama, USA
Ayelet Baram-Tsabari, Technion – Israel Institute of Technology, Israel
Shakked Dabran-Zivan*, Technion – Israel Institute of Technology, Israel
Lisa Selent, Leibniz University Hanover, Germany
Catharina Pfeiffer, Leibniz University, Germany
Stefanie Lenzer, IPN - Leibniz Institute for Science and Mathematics Education, Germany
Jonathan Osborne, Stanford University, USA
Douglas Allchin, University of Minnesota, USA

ABSTRACT

In the digital age, misinformation affects various areas of society such as public health and climate change communication, as seen during the COVID-19 pandemic, where an "infodemic" of false information led to public confusion. Today's students primarily access scientific information through social media and online tools, making them more susceptible to misinformation. To counter this, science education is crucial in developing science media literacy. Citizens must not only be proficient in technology use but also understand how media processes shape information and evaluate the credibility of scientific content. Educational strategies should focus on enhancing critical thinking and understanding media

influences, with research supporting the effectiveness of interventions like training programs and prebunking. The upcoming symposium will present studies from Europe, Israel, and the U.S., exploring how students engage with science information online and how education can combat misinformation. The symposium will emphasize the importance of teaching credibility evaluation strategies to develop science media literacy.

Affordances, Imagination, and Learner Agency

Strand 13: History, Philosophy, Sociology, and Nature of Science
25-Mar-25, 10:00 AM-11:30 AM
Location: Camellia 1

Stand-Alone Paper

Affordances of citizen science for developing student understanding of the nature of science

Zoubeida Dagher*, University of Delaware, USA

ABSTRACT

Citizen science, also known as participatory science, pertains to a class of investigations that are designed to enable non-experts to contribute to large repositories of data or to analyze existing data sets. These projects are mostly initiated by professional scientists, and some are initiated or co-created by community members with scientists in response to a science- or technology-related concern. In this position paper, I argue that integrating citizen science in school science investigations provides opportunities to improve participants' understanding of science and nature of science and describe three epistemic concerns about citizen science and their educational parallels. I outline a set of conditions that contribute to designing a nuanced approach to incorporating NOS in CS projects that can be implemented and evaluated in future studies.

Stand-Alone Paper

Scientific Imagination and Scientific Modeling

Amy Farris*, Penn State University, USA

ABSTRACT

Literature in science education and the learning sciences has begun to bridge play with meaningful disciplinary engagement, especially for young learners (e.g., Ryan, 2024; DeLiema et al., 2019). However, when many educators think about science in K-12 classrooms, they are prone to overlook that mature scientific work is partly constituted by acts of imagination. Drawing on Vygotsky's (1978) emphasis on the role of the "imaginary" in play, we propose that a deeper consideration of the role of imagination in science can facilitate a deeper understanding of the function of play, creativity, and design in learners' creation of scientific models. We draw on modern philosophical conceptions ofscientific imagination(Levy Godfrey-Smith, 2019), which refers to the role of imagination in the creation and elaboration

of scientific understanding. According to Levy and Godfrey-Smith (2019), such scientific imaginings underlie the very existence of scientific models.

Stand-Alone Paper

Agential Variation Theory: Towards a Post-humanist Performative Framework for Research onStudents Learning with Representations

Song Wang*, California State University - Dominguez Hills, USA
Stanley Lo, University of California, San Diego, USA
Thomas Bussey, University of California, San Diego, USA

ABSTRACT

Current research on learning with representation in college chemistry classrooms has primarily focused on students' competence in interpreting the intended meaning of the representations. The focus on representational competence often leads to a deficit mindset about students' experienced meanings and dismissing them as mistakes due to lack of competence. With a focus on representation, this theoretical study works towards three goals: (1) to critically examine the philosophical assumptions that underpin the deficit orientation in science education research, (2) to engage with the relational ontology of agential realism and explore the potential for conducting science education research from post-humanist perspectives, and (3) to advance qualitative methodology for investigating representational practices in science education. The theoretical development in this study produces agential variation theory as a post-humanist framework for investigating student learning with representations and focuses on the emergence of meaning within representational practices. Weaving together Marton's notion of critical features, Vygotsky's notion of semiotic mediation, Barad's notion of intra-action, and interview data, the proposed framework theorizes how representations become meaningful to students. Coordinating multiple theoretical constructs and onto-epistemological standpoints can produce a multilayered reading that shows how science cultural practices both constitute and limit the possibilities of the meaning of representations.

Environment and Citizenship

Strand 14: Environmental Education and Sustainability
25-Mar-25, 10:00 AM-11:30 AM
Location: Baltimore 3

Stand-Alone Paper

Sustainability Citizenship: A European-wide Professional Development vision

Franz Bogner*, University of Bayreuth, Germany
Sofoklis Sotiriou, Ellinogermaniki Agogi, Greece

ABSTRACT

The SYNAPSES training framework is a three-year multinational research project of 8 European partners; it follows a vision to implement pre-service and in-service Sustainability

Citizenship (SC) programs within a significant European dimension. It defines as the key features of the most frequent drivers that may act as enablers for the introduction of sustainability citizenship to the formal curricula. Furthermore, it defines the context of implementation for the development of the SC competence, the green learning ecology, an integrated learning ecosystem that helps every individual to follow his/her own learning path. Teaching for SC can stimulate and lead to an action-including decreasing consumption and demand, developing sustainable food and energy sources, exploring nature-based solutions for the current challenges, using school buildings as teaching tools, and the greening of schoolyards. Arguing for a paradigm shift in the way we view education, the SYNAPSES approach could demonstrate how our education systems can create new levels of awareness and work towards a sustainable future. Based on that, the document describes the key characteristics of the Professional Development programs and presents a series of assessment strategies, teachers could use to monitor the impact of their interventions.

Stand-Alone Paper

Which factors affect the implementation of Citizen Science in school science classrooms?

Michelle Müller*, Leibniz University Hannover, Germany
Vanessa van den Bogaert, Leibniz University Hannover, Germany
Malte Foss-Jähn, Leibniz University Hannover, Germany
Pauline Klein, RWTH Aachen University, Germany
Julia Lorke,RWTH Aachen University, Germany
Till Bruckermann, Leibniz University Hannover, Germany

ABSTRACT

The conditions for the successful implementation of Citizen Science (CS) into formal science education are increasingly becoming the focus of research, because CS offers a unique opportunity to enhance scientific literacy and provide authentic science experiences. However, implementing CS presents challenges, particularly in balancing scientific and educational goals. To address these issues and to provide orientation, we applied a supply-use-effect model to analyze the factors influencing the success and hindrances of CS projects in classroom settings. Our scoping Review included a keyword search that identified a total of 2,105 articles in subject-specific and interdisciplinary literature databases, including Scopus, ERIC, and Web of Science (up to 02/2024). After a comprehensive examination of these articles according to the defined criteria, 61 articles remained. In these articles, 550 factors were identified with success factors outweighing the hindering factors (459 success; 91 hindering). The majority of these factors related to the design of the CS projects and the prerequisites needed for teachers, scientists, and intermediaries. Our findings suggest the importance of the alignment between CS projects and the curriculum and enhancing the competencies of stakeholders for effective implementation.

Stand-Alone Paper

Fostering Socioscientific Reasoning, Global Citizenship, and Cooperation in Teacher Candidates through Inter-University and Place-Based Collaboration

Banu Avsar Erumit, Recep Tayyip Erdogan University, Turkey

Arzu Tanis Ozcelik*, Aydin Adnan Menderes University, Turkey

ABSTRACT
This study aimed to enhance socioscientific reasoning skills, global citizenship values, and cooperation skills among teacher candidates from two Turkish universities—one in the western and the other in the northeastern regions of the country—by having them collaborate on local environmental issues. The implementation process included place-based visits to sites such as fishing boats, fish farms, wastewater treatment facilities, and mining sites, where TCs engaged with local experts and gathered firsthand data. The study utilized a mixed-methods approach, incorporating quantitative assessments of SSR, global citizenship values, and cooperation skills, along with qualitative data from group work responses and reflections. The results, analyzed using ANCOVA, indicated that while SSR skills improved across the experimental groups, the anticipated enhancement in cooperation skills through collaboration between TCs from different regions was not observed. The control group, which only collaborated within their class, showed higher post-test cooperation skills compared to the experimental groups. This outcome may be attributed to differences in experience levels between the NE and W groups, as well as challenges in coordinating online collaboration. The study highlights the effectiveness of place-based learning in developing SSR but also underscores the need for additional strategies to foster cooperation in geographically dispersed groups.

Sustainability education with teachers: Collaborating to support teachers, communities, and children, towards critical, visionary future-making

Strand 14: Environmental Education and Sustainability
25-Mar-25, 10:00 AM-11:30 AM
Location: Annapolis 4

Symposium

Sustainability education with teachers: Collaborating to support teachers, communities, and children, towards critical, visionary future-making

Heather Schurman, Université de Montréal, Canada
Jrène Rahm, Université de Montréal, Canada
Ayça Fackler, University of Missouri, USA
Cecilia Poon, Brooklyn College, CUNY, USA
Pieranna Pieroni, Brooklyn College, CUNY, USA
Theila Smith, Brooklyn College, USA
Christina Siry, University of Luxembourg, Luxembourg
Doriana Sportelli, University of Luxembourg, Luxembourg
Patricia Muller, École fondamentale de Beaufort, Luxembourg
Sara Wilmes, University of Luxembourg, Luxembourg

ABSTRACT
As a global community we are facing unprecedented sustainability challenges. With a view towards finding sustainable ways forward, teachers are uniquely positioned given their relationships with students, families, and communities. While it is well established that teachers value teaching about sustainability, climate change, and sustainable development, many report barriers and feel unprepared to implement sustainability-focused instruction. As teacher educators and education researchers who work to support teachers, this calls us to ask, how can we support teachers to envision and implement meaningful sustainability instruction? What would this look like if we come together in community? How can we do so in ways that are attuned to the contextualized nuances of our diverse communities?This symposium will provide space to unpack these questions as a starting point for discussion through the lens of four unique sustainability education research projects. The symposium will offer short presentations from each project, which centers community-connected, collaborative teacher-driven approaches, followed by an invitation to join panelists in small-group conversations. The symposium will offer attendees views on qualitative research methodologies, resources, and approaches to collaborative, supportive community-focused sustainability education and research through sustainability education with the goal of supporting further networking and dialogue.

Exploring the Interplay between Educational Data and Current or Future Science Educational Policy

Strand 15: Policy, Reform, and Program Evaluation
25-Mar-25, 10:00 AM-11:30 AM
Location: Azalea 3

Stand-Alone Paper

Public Opinion About Teacher Salaries: Does it Pay to be a Male Science Teacher?

Eugene Judson, Arizona State University, USA
Mohammed Ibrahim*, Arizona State University, USA

ABSTRACT
This study examined public opinion on teacher salaries, focusing on the impact of gender, grade level, and subject taught, with particular attention to STEM teacher salaries. Using an online salary sorting activity, 1,593 American adults ranked salaries for five occupations, including various teaching roles. Findings revealed that teaching roles were recommended the lowest mean salary in seven out of eight scenarios, with significant differences (p .05) favoring other occupations such as police officers, therapists, and building inspectors. Notably, the only scenario where teacher salaries were statistically equivalent to other occupations was for a male high school science teacher, indicating a higher perceived value for male STEM teachers at the high school level. Despite the general perception that K-12 teachers are underpaid, this study also highlights a disparity between public opinion and the value assigned to teacher salaries, particularly for female and non-STEM teaching roles. These insights have implications for science education policy and reform, emphasizing the need to

address public perceptions and awareness as a step toward improving compensation structures.

Stand-Alone Paper

Consistent and Comparable Educational Data: Returning to School During the COVID-19 Era

Molly Weinburgh*, Texas Christian University, USA
Melissa Demetrikopoulos, Institute of Biomedical Philosophy, USA
John Pecore, University of West Florida, USA
Zhan Shi, Texas Christian University, USA
Daniella Biffi, Texas Christian University, USA
Dean Williams, Texas Christian University, USA

ABSTRACT

As a community, science education researchers rely on being able to conduct trustworthy studies for which the findings can be compared. Science education research often relies on data reported at the local, state, and national level and on the use of ubiquitous terms in US education documents that drive data collection and analysis. This position paper focuses on a lack of common education indicators, and the use of vague terms on education policy and documents. The paper is grounded in current research conducted through a existing Noyce Track IV research project that that is using large publicly available data sets to determine how different learning modalities (i.e., online, in-person, hybrid) impacted schooling after the COVID-19 closure. The research team encountered a lack of clear terminology and inconsistent education indicators reported by school districts and states including a lack of clear and operationalized terminology for defining critical terms such as high-need districts, out of field teaching, and teacher retention. Confusing terminology hinders educational research, policy, and advocacy. Thus, this paper focuses on how policy documents fail to operationalize terms needed for science education research.

Stand-Alone Paper

Policy Analysis of Middle School Science Acceleration and High School Science Outcomes

Jon Steigerwald, Stony Brook University, USA
Angela Kelly, Stony Brook University, USA

ABSTRACT

This exploratory correlational study examined whether universal science acceleration in eighth-grade science was related to improved high school science course taking and performance. The study context was New York State public schools, where students take standardized science examinations required for graduation. Some middle schools accelerate students to taking science courses with high-stakes examinations in eighth grade. The present study compared science outcomes for students in universally accelerated schools (N=26) and selectively accelerated schools (N=60) during the 2018-19 academic year. Parametric comparisons of means indicated students enrolled in eighth grade in universally accelerated schools were more likely to enroll in Earth science and Advanced Placement (AP)

Biology, and AP Environmental Science. They also outperformed students in selectively accelerated schools on state-standardized examinations in Earth science, biology, and AP Chemistry. Results suggested that enrollment in other advanced sciences (physics, chemistry, AP physical sciences) was not related to acceleration status, not was performance in physics, chemistry, and most AP courses. A strategy of universal science acceleration may diminish the achievement gap and leads to more students taking select advanced courses, however, secondary students may need additional support to maximize the academic advantages of early exposure to high school-level science.

Stand-Alone Paper

The million learning minutes yardstick: comparing educational modalities using a time metric

Yuval Rosenberg*, Weizmann Institute of Science, Israel
Asaf Salman, Weizmann Institute of Science, Israel
Yossi Elran, Weizmann Institute of Science, Israel
Giora Alexandron, Weizmann Institute of Science, Israel
Ron Milo, Weizmann Institute of Science, Israel

ABSTRACT

Comparing STEM educational modalities is challenging but essential for informed decision-making. For example, should a lecturer focus on creating a massive open online course (MOOC) for thousands or prioritize face-to-face teaching? Should an agency fund an educational science video or a science museum exhibition? We introduce simple quantitative time metrics to improve our judgment regarding their potential impact and complement current understanding, thus facilitating decision-making. We estimated the total time allocated for learning by students and the time STEM educators and personnel spend developing and delivering these programs. An average OECD full-time teacher provides about a million minutes allocated for learning in class while working over 1,500 hours annually. Analyzing the activity of five million STEM MOOC users, we found that the median STEM course run achieves a few million minutes of total time allocated for learning, with high-quality STEM MOOCs requiring about 1,000 - 2,000 total personnel hours. We also compare university science lectures, a science museum, and other STEM education case studies. These time metrics make the large numbers that often characterize digital learning more tangible and provide real-world baselines for their scalability. Further work should examine complementary variables to predict outcomes of interest.

Strand Meetings - Meet with the Strand Coordinators

25-Mar-25, 11:30 AM-12:45 PM

Strand 1
Location: Annapolis 2

Strand 2
Location: Annapolis 1

Strand 3
Location: Baltimore 2

Strand 4
Location: Baltimore 4

Strand 5
Location: Magnolia 3

Strand 6
Location: Magnolia 2

Strand 7
Location: Cherry Blossom Terrace

Strand 8
Location: Annapolis 3

Strand 10
Location: Magnolia 1

Strand 11
Location: Azalea 1

Strand 12
Location: Baltimore 5

Strand 14
Location: Baltimore 3

Strand 15
Location: Azalea 3

A Celebration of Outstanding Doctoral Research Award Recipients, Early Career Award Recipients and new NARST Fellows: A Discussion of the Future of Science Education

25-Mar-25, 12:45 PM-2:15 PM
Location: Azalea 2

Administrative Session

Amelia Gotwals, Michigan State University, USA
Bridget Miller, University of South Carolina, USA
Daivid Owens, University of Montana, USA
Enrique Suárez, University of Massachusetts, Amherst, USA

ABSTRACT

This Awards Committee-sponsored session will highlight the accomplishments and contributions of the Outstanding Doctoral Research Award recipient(s), the Early Career Research Award recipient(s) and the new NARST Fellow(s). It will provide a platform for an extended discussion of the award recipients' scholarly contributions and how their research trajectories are framed and/or intersect with the theme of NARST 2025: In praise of Science Teachers: Essential Partners in Researching, Reframing, and Reforming Science Learning. The award recipients will reflect on their contributions and propose ideas for the future of science education, equity and social justice, scientific literacy, teaching and learning and so on. The NARST Fellows will be recognized for their ongoing contributions to NARST. This session will be organized with presentations from the panelists, followed by a question/answer segment. The board liaison will moderate the sessions. The chairs of each award subcommittee will introduce the recipients.

The ODRA recipients are:
Dr. Daniel R. Pimentel, University of Alabama
Dr. Sam Lee, California State University Long Beach

The ECRA recipient is:
Dr. Marcus Kubsch, Freie Universität Berlin

The 2025 Fellows are:
Dr. Janet Carlson, Stanford University
Dr. M. Gail Jones, North Carolina State University
Dr. Hosun Kang, University of California Irvine
Dr. Katherine L. McNeill, Boston College
Dr. Felicia Moore Mensah, Teachers College, Columbia University
Dr. Eileen Parsons, University of North Carolina, Chapel Hill
Dr. Bhaskar Upadhyay, University of Minnesota

Designing for Equitable Futures: Perspectives on Rebuilding and Healing in the Next Century of Teaching and Learning

25-Mar-25, 12:45 PM-2:15 PM
Location: Annapolis 4

Administrative Session

Khanh Tran, Purdue University, West Lafayette, USA
Maria Maulucci, Barnard College, USA
Justice Walker, The University of Texas at El Paso, USA
Tia Madkins, The University of Texas at Austin, USA

ABSTRACT

As sociocultural perspectives continue to nuance how we research and come to understand contemporary science teaching and learning, there have been justified calls to dismantle ontological and epistemic paradigms that persistently replicate social inequality both in the Academy and society at large. These calls coincide with and are often spurred by socio-political unrest that is arguably inextricably tied to how we educate our citizenry and the accompanying research generated in that process. While many would agree that these calls are necessary, they beg the question of what perspectives and theories should be taken up. This isn't very easy because society exists as a heterogeneous network of individuals and groups with sometimes competing cultural values, priorities, and needs. This diversity further complicates considerations by requiring us to ask whose values, priorities, and needs should prevail and whether any resulting tensions can co-exist constructively. In this session, panelists discuss what it might take to design institutions that rebuild and heal after dismantling—and honor the history and future of diverse people and societies. These discussions are meant to serve as starting points for longer-term discourse on moving toward more equitable futures for science teaching, learning, and research.

Empowering Asian and Pacific Islanders through Science Teaching and Learning for Public Good

25-Mar-25, 12:45 PM-2:15 PM
Location: Annapolis 2

Administrative Session

Hosun Kang, University of Irvine California, Irvine, USA
Edna Tan, University of North Carolina at Greensboro, USA
Johan Tabora, University of Illinois at Chicago, USA
Maria Varelas, University of Illinois at Chicago, USA
Anil Challa,University of Alabama, Tuscaloosa, USA
Meena Balgopal, Colorado State University, Fort Collins, USA
Bevo Wahono, University of Jember, Indonesia
Erlia Narulita, University of Jember, Indonesia
Anjar Utomo, University of Jember, Indonesia

Troy Sadler, University of North Caroline at Chapel Hill, USA

ABSTRACT
The API RIG offers a special RIG-sponsored symposium at the 2025 NARST Annual Conference. The purpose of the API-RIG sponsored session is to provide a platform for NARST members to share their perspectives and experiences in science education research centering the voices and concerns of the learners and/or educators of Asian and Pacific Islander (API) heritage. In this symposium, three teams of researchers highlight the experience of Indonesian teachers who explore integrating socioscientific issues in their instruction, a Flipinx American teacher's stories and forming identities, and Indian students' sense of belonging in biology. The panelists will engage in the conversation in response to the following questions: 1) What equity-related challenges do API learners/teachers face in your study/project? 2) How do stories/narratives/everyday experiences of API learners and teachers matter in their engagement, learning, identity work/sense of belonging in STEM? and 3) How might their stories/narratives/everyday experiences be leveraged as resources and capital to empower their STEM engagement?

Contextualizing Science Education: Cognitive, Affective, and Personal Dimensions in Learning Science

Strand 1: Science Learning: Development of student understanding
25-Mar-25, 12:45 PM-2:15 PM
Location: Camellia 2

Stand-Alone Paper

The progressive construction of personally-inflected sense-making

Sara Satanassi*, Department of Physics and Astronomy, University of Bologna, Italy
Olivia Levrini, Department of Physics and Astronomy, University of Bologna, Italy

ABSTRACT
This study introduces the concept of personally-inflected sense-making. Inspired by Bakhtin's (1981) concept of appropriation, it unpacks how sense-making in physics is reshaped with personal meaning, resonating with each learner's unique worldview. The concept has been elaborated by analyzing students' discussions in a learning environment on quantum physics, designed to value Multiple External Representations (MERs). The data analysis has been carried out by integrating the sense-making matric by Kapon (2017) and appropriation markers (authors, 2015). Our analysis illustrates how engaging with Multiple External Representations and fostering meta-representational skills creates learning environments that are both inclusive and engaging, promoting personalized yet academically robust learning experiences. This new perspective highlights the potential for fostering meaningful student learning, not only from an academic standpoint but also through personal engagement, encouraging a personal connection with science learning.

Stand-Alone Paper

Taking a Socio-Political Turn in Genetics Education

Ravit Duncan, Rutgers University, USA
Dalia Hassan*, Rutgers University, USA
Rishi Krishnamoorthy, University of Toronto, Canada
Na'ama Av-Shalom, Rutgers University, USA

ABSTRACT

Research has shown that students and adults espouse problematic deterministic and essentialist views that contribute to racial bias. Thus far instructional antidotes have focused on countering these views by promoting more complex understandings of population and multifactorial genetics. While such countering is necessary, we have argued it is insufficient and that in addition we need to focus instruction on the socio, political, and historical dimension of human genetics. Towards this end we have developed a high school genetics unit focused on the phenomenon of diabetes. In this unit students learn about the biological and genetic basis for diabetes as well as the environmental factors that are risk factors for this complex condition. In examining the role of the environment students explore the sociopolitical contexts that have resulted in dispossessed neighborhoods and stressful living conditions that create high risk environments. The unit was implemented in two high school classrooms and initial findings suggest that most students shifted away from essentialist and deterministic views of genetics. Students also developed a nascent sociopolitical awareness that recognizes environments as non-neutral and harmful, however, most students rarely connected this reality to broader sociopolitical forces like racism and how such forces create harmful environments.

Stand-Alone Paper

Mental Models of the Earth's Internal Structure in Primary and Middle School Students in Chile

Claudia Vergara*, Alberto Hurtado University, Chile
Kasandra Navarrete*, Alberto Hurtado University, Chile
Carolina Parraguez*, Pontificia Universidad Catolica de Valparaiso, Chile
Hernan Cofre, Pontificia Universidad Catolica de Valparaiso, Chile
Paola Nuñez, Pontificia Universidad Catolica de Valparaiso, Chile

ABSTRACT

Mental models are internal representations or conceptions that students construct as they make sense of their everyday interactions with the natural world. The layers of the Earth are a topic covered in the Chilean national curriculum for primary and middle school education. Studies show that both primary and middle school students hold many preconceptions about earthquakes, mountain formation, and volcanoes. In this study, we analyzed 683 drawings by students from six Chilean schools. We developed and validated a rubric to analyze the students' drawings of the Earth's internal layers and identify the location of magma within the Earth. The analysis was conducted by two independent researchers. Among the main results, most students were found to draw concentric layers without

distinguishing their thickness, number, or names. Fifth-grade students were the most likely to create drawings that reflect the internal structures, albeit without differentiating the thickness of the layers. Regarding the location of magma, most students placed it in the center or core of the Earth. The study concludes that despite living in a country with high geological risk, the mental representations of the students analyzed are similar to those found in other international studies.

Stand-Alone Paper

Does Context Matter? A Meta-Analysis of Contextualized Science Learning Research

Michael Giamellaro*, Oregon State University, USA
Joseph Taylor, University of Colorado, USA
Kathryn Watson, University of Iowa, USA
Amanda Morrison, Oregon State University, USA

ABSTRACT

Contextualization, the integration of science content with relevant real-world contexts, is a central element in modern science education. Despite widespread implementation, the effectiveness of contextualization in improving science learning outcomes remains underexplored at a macro level. This meta-analysis synthesizes findings from 75 studies, encompassing 126 outcomes, to assess the overall impact of contextualization on students' cognitive, achievement, affective, and agentic outcomes in K-12 science education. Study findings indicate that contextualized interventions have a large effect on cognitive and achievement outcomes (g = 0.86, p .01) and a smaller, yet significant, effect on affective and agentic outcomes (g = 0.22, p .05) and that this is true across grade levels. Additionally, the study identifies that learning in context is not inherently better than learning with context, and that virtual contextualization may be better than both regarding cognitive outcomes. Program duration impacts affective but not cognitive outcomes. While the contextualization approach is generally not associated with outcome differences, socio-scientific inquiry (SSI) does have a greater impact on cognitive outcomes while Science in Real Life approaches have a greater impact on affective outcomes as compared to other approaches.

Stand-Alone Paper

An Emerging Theory of School-Based Citizen Science

Patrick Smith*, Horizon Research, Inc., USA
Christine Goforth*, North Carolina Museum of Natural Sciences, USA
Sarah Carrier*, NC State University, USA
Meredith Hayes, Independent Researcher, USA
Sarah Safley, Horizon Research, Inc., USA
Danielle Scharen*, Horizon Research, Inc., USA

ABSTRACT

Citizen science (CS) conducted in formal K–12 settings has many benefits, including the potential to engage teachers and students authentically in the scientific enterprise and to make learning more meaningful. Despite these benefits and others, school-based CS (SBCS)

is not widespread. In this paper, we share a theory of SBCS that is emerging from a four-year study of efforts to integrate CS in elementary classrooms. The theory captures the complexity of SBCS and describes factors that shape the experience teachers and students have with CS. We describe the landscape of SBCS and the data we have collected on 50 fifth-grade teachers' efforts to implement SBCS. Based on our findings, we describe the emerging theory of SBCS and illustrate it with vignettes constructed from our data. Finally, we discuss recommendations for CS projects that wish to gain a foothold in K–12 classrooms and for research that can further test the theory of SBCS.

Stand-Alone Paper

Empowering Students through Open Schooling: Educational Seismology's Impact on Civic Responsibility and Science Learning Views

Yvoni Pavlou*, University of Cyprus, Cyprus
Marios Papaevripidou, University of Cyprus, Cyprus
Zacharias Zacharia, University of Cyprus, Cyprus
Gregory Milopoulos, Research and Development Department, Ellinogermaniki Agogi, Greece
Sofoklis Sotiriou, Research and Development Department, Ellinogermaniki Agogi, Greece
Gerasimos Chouliaras, Institute of Geodynamics, National Observatory of Athens, Greece

ABSTRACT

This study examines the impact of educational seismology projects on enhancing school openness and enriching students' civic responsibility and views on science learning. The sample consisted of 515 students from 33 schools, where educators and administrators received specialized training to integrate seismology into an open schooling framework. Schools developed and implemented projects involving stakeholder engagement and societal issues. The evaluation used four tools: school-developed seismology projects, a Self-Reflection Tool for measuring organizational changes, the "My Science Classes" questionnaire for student views on science learning, and the "Civic Responsibility Survey" for assessing civic awareness. Data, analyzed qualitatively and quantitatively, revealed diverse project types with varying student and stakeholder involvement. Results indicated a significant increase in perceived school openness and a positive shift in students' science learning views and civic engagement. These findings underscore the effectiveness of integrating real-world issues into science education, such as educational seismology, with important implications for curriculum design and educational policy, as they emphasize the role of project-based learning and community engagement in fostering both academic and civic excellence.

Using inclusive, responsive teaching practices in diverse science classroom settings

Strand 4: Science Teaching — Middle and High School (Grades 5-12): Characteristics and Strategies
25-Mar-25, 12:45 PM-2:15 PM
Location: Baltimore 4

Stand-Alone Paper

English Learners' Use of Home Language in a Science Classroom

Rebecca Robertson, University of Minnesota, USA
Preethi Titu*, Kennesaw State University, USA
Felicia Dawn Tibayan Leammukda*, St. Cloud State University, USA

ABSTRACT

Research suggests that by allowing English Learner (EL) students to use home languages in science class, they can better express their thinking and build content knowledge through underlying crosslinguistic awareness between languages. However, EL students, educational backgrounds and home languages vary. In this case study, grounded theory was used to explore students' perceptions of their experiences in the context of a Physical Science and Language Development class. Phenomenology was used to describe how students experience their home language within science class. Observation data, online video assignments, and small group, semi-structured interviews were used to find themes related to experiences of using home language in class. Findings indicate varied student perspectives on using their home languages in class. Some students preferred to use class time to practice English, while others found value in using their home languages to help better understand science concepts. Student ideologies regarding English-only or multilingual practices for EL students varied. The findings indicated that providing opportunities for EL students to use their home languages in an asynchronous online communication platform outside of class was an effective strategy to allow time for students to practice English during class, yet provide opportunities to translate between home languages and English.

Stand-Alone Paper

Refined Consensus Model for the teaching population who works with deaf students

Scott Cohen*, Georgia State University, USA
Patrick Enderle, Georgia State University, USA
Jessica Scott, Georgia State University, USA

ABSTRACT

Teacher preparation programs have long operated their content teaching preparation in silos to prepare teachers for specific subject teaching. However, in the case of deaf education, deaf students are the foreground content that places some subjects in the rearview, such as science. This circumstance calls to explore science teachers' experience in developing their expertise in teaching science at schools for deaf students. This study utilized the Refined

Consensus Model in a mixed method explanatory sequential design to capture salient Pedagogical Content Knowledge (PCK) components to describe the current science teachers' professional knowledge and skills. The model empirically identifies how teachers use their knowledge and skills to support deaf students' ability to learn new concepts. The study began with a quantitative research design to disseminate the survey to participants who have experience teaching a science course with deaf students to define the collective PCK understanding as a group. Following qualitative research design with the case study, two participants built rich and thick descriptions of their PCK with interviews and observation. The findings revealed the RCM model for this population with a range of teacher's knowledge and skill in teaching science with deaf students.

Stand-Alone Paper

Moving away from "very cold and detached" teaching: In-Service Secondary Science Teachers of Emergent Bilinguals

Jorge Solis*, UT San Antonio, USA
Kristen Lindahl, UT San Antonio, USA
Bedrettin Yazan, UT San Antonio, USA
Michael Mauricio*, UT San Antonio, USA
Caryn Calisi, UT San Antonio, USA

ABSTRACT

This paper focuses on NARST's Strand 4 (Science Teaching--Middle and High School) examining teaching practices of secondary school science teachers engaged in a professional development (PD) project in Texas. The research findings are related to a project centered around a research-practice partnership (RPP) supporting in-service teacher professional development (a university and three school districts). The project is a collaboration with in-service secondary school teachers, across subject areas of bilingual and multilingual classrooms, who are seeking to gain additional English as a Second Language or bilingual education certification. The case study examines how science teachers involved in the PD project orient to promoting critical sociocultural pedagogical practices within bilingual and multilingual classrooms contexts (Author, 2020; Nasir et al., 2020). Data includes transcripts of video-recordings of teacher planning conversations, classroom interactions, post-lesson reflections, and co-construction of pedagogical practices within Professional Learning Communities. This paper presents two main findings. First, both science teachers focus on lesson activities that promote collaborative learning and language and literacy development in science. Additionally, teachers discuss tensions in using critical science teaching perspectives. This research offers insight into how in-service secondary school science teachers can engage in critical sociocultural practices involving bilingual and multilingual classrooms.

Exploring Cognitive and Interpretive Processes in Undergraduate STEM Education

Strand 5: College Science Teaching and Learning (Grades 13-20)
25-Mar-25, 12:45 PM-2:15 PM
Location: Magnolia 3

Stand-Alone Paper

A Study Of Undergraduate Students Interpretations Of Tree-Thinking Using Eye Movements

Mallika Saha*, Texas State Universuty, USA
Daniel Ferguson, Texas State Universuty, USA
Kristy Daniel, Texas State Universuty, USA

ABSTRACT

Tree-thinking is the ability to correctly understand, and use phylogenetic trees. Unfortunately, students often face difficulties interpreting trees correctly for a multitude of reasons. The purpose of this study is to analyze the eye movement patterns of students to determine how introductory biology students visually access trees during interpretation tasks and identify areas in which they are struggling to interpret. We used an eye-tracking system to capture participants' eye movements (fixation duration and counts) while solving tree thinking problems. We used the results to generate heat maps illustrating the major areas of the diagrams visually accessed. By analyzing these eye movements, we have identified differences in eye movement patterns and time spent on tasks between participants who answered tasks correctly compared to participants who answered incorrectly. This study revealed that participants who misinterpreted the tree tasks were more likely to spend more time considering the task, were less focused within the tree diagram and attended to more non-informative areas of the tree rather than informative features, and were overconfident in their tree-thinking skills.By identifying elements that are causing confusion for learners, we can begin focusing on how to adapt instruction to enhance informative regions and promote more proficient tree-thinking.

Stand-Alone Paper

Exploring Meaning-Making in Undergraduate Human Anatomy and Physiology: Role of Drawing and Representation Construction

Sarah Hajama, Macquarie University, Australia
Hye-Eun Chu*, Macquarie University, Australia

ABSTRACT

Undergraduate students face difficulties in understanding Human Anatomy and Physiology (HAP) due to its complex nature and focus on passive pedagogical tools. This results in high withdrawal and failure rates in HAP courses. Specifically, students struggle to create meaningful connections between dynamic body systems and comprehend their overall functionality. To address these challenges this study explores the role of drawing as a form of representation construction, a pedagogical tool that poses an alternative to passive learning by emphasising meaningful learning. Employing an embedded mixed-methods approach,

this research utilises the Draw-and-Explain Questionnaire to assess how drawing facilitates meaning-making. Analysis of 27 students' questionnaire responses reveals that an average of 39.5% of students implement semiotic affordances in their drawings to demonstrate a moderate level of meaning-making. Notably, students with positive HAP university experiences tend to exhibit higher meaning-making capabilities through drawing. These findings advocate for incorporating drawing as a form of representation construction into HAP education, suggesting potential developments in instructional strategies and assessment tools to improve student engagement and understanding.

Stand-Alone Paper

Student Learning, Perceptions of Learning, and Perceptions of a Flipped College Physiology Classroom

Elizabeth Stansberry*, Pepperdine University, USA
Krista Lucas*, Pepperdine University, USA
Rachel Tan, Pepperdine University, USA

ABSTRACT

The flipped classroom represents an approach that defies the traditional model for higher education by designating lecture material for independent study, leaving classroom time available for interactive engagement such as group activities or experiences. In this study, we sought to understand the efficacy of such a model in a university science class, specifically investigating both students' performances as well as perceptions of their own performance and the class as a whole. Our data collection was primarily qualitative, and our findings are made up of pre- and post-class surveys, pre-exam surveys and exam grades, classroom observations, and focus groups. Our preliminary findings, composed of data from the surveys, observations, and focus group cooperative activity, indicate that the model maintained student engagement and participation, while allowing the instructor to gauge student progress on a given subject, from background knowledge to new applications. In addition, students consistently displayed the ability to incorporate previously held information into new contexts, an opportunity facilitated by the activities that took place during class time. Lastly, student responses demonstrate deeper levels of cognition in regards to their learning and methods of learning, building a foundation of skills to support new and more complicated concepts as they come.

Stand-Alone Paper

Individual differences in dispositions toward scientific uncertainty navigation during problem-based learning in cybersecurity education

Jongchan Park*, Arizona State university, USA
Ying-Chih Chen, Arizona State university, USA
Garima Agrawal, Arizona State university, USA
Yuli Deng, Arizona State university, USA
Huan Liu, Arizona State university, USA

ABSTRACT
When confronted with scientific uncertainties in problem-based cybersecurity learning, students engage in various patterns of uncertainty navigation. Students' dispositions toward scientific uncertainty navigation (DSUN) are crucial assets that can either facilitate or impede the navigation process, depending on their development. This study examines how DSUN develops—advancing, maintaining, or retreating—over time across multiple problem-based learning sessions. It also investigates factors influencing inter- and intra-individual differences in DSUN, particularly achievement goals (mastery and performance) and gender. Data were collected from 431 students enrolled in Fall 2023 Cybersecurity courses and analyzed using two latent growth models. These models assessed (a) inter- and intra-individual differences in DSUN and (b) the impact of mastery and performance goals, as well as gender, on these differences. Results revealed significant variability in DSUN changes over time, with some students showing increases, decreases, or stability. Students with higher performance goals tended to start with lower DSUN and showed slower changes, while those with higher mastery goals exhibited higher initial DSUN and faster changes. Gender did not significantly predict DSUN changes. These findings suggest that problem-based cybersecurity learning should emphasize uncertainty navigation's role in competence development, fostering a mastery goal orientation to advance DSUN.

STEM Partnerships, Interactions, and Learning in Museum Spaces

Strand 6: Science Learning in Informal Contexts
25-Mar-25, 12:45 PM-2:15 PM
Location: Magnolia 2

Stand-Alone Paper

The importance of knotworking in forming successful STEM partnerships

Eleanor Kenimer*, Michigan State University, USA
Roberta Hunter, New Jersey Audubon, USA
Gail Richmond*, Michigan State University, USA

ABSTRACT
Over the years, frequent calls have been issued about the importance of promoting partnerships between informal and formal science learning institutions (e.g. Bevan Dillon, 2010; Hofstein Rosenfeld, 1996). STEM partnerships that engage students in both formal and informal science experiences, such as outdoor education, museum education, and zoo and aquarium education, have the potential to create a richer science learning ecosystem. In this interview study we used lenses of STEM Learning Ecosystems (SLE) and Cultural Historical Activity Theory (CHAT) to look at what makes partnerships successful and sustainable. We found that the idea ofknotworkingfrom CHAT (Engestrom, 2001) was particularly salient. In this paper we discuss features of successful STEM partnerships as well as tell stories of partnerships and how engaging in knotworking or avoiding conflict led to successes and challenges.

Stand-Alone Paper

Using Natural History Museums as Professional Development for Elementary Teachers

Megan Ennes*, University of Florida, USA
Brian Abramowitz, University of Florida, USA
Melanie Giangreco, University of Florida, USA
Sadie Mills, University of Florida, USA

ABSTRACT

Museums and their collections are valuable teaching tools. However, the public typically has limited access to these resources despite their value. Research suggests that opportunities to engage in specimen-based learning can increase content knowledge and science interest of both teachers and learners as well as help scientists learn how to better communicate about their research. This study explored the impacts of a week-long professional development opportunity on the teaching self-efficacy of elementary teachers. The participants (n = 10) assisted with collections care and artifact digitization, engage with science professionals, and brainstormed ways to use collections in their classrooms. Answering a retrospective post-survey, the educators indicated they had low levels of confidence in their ability to teach using collections in their classroom prior to the workshop. The participants indicated after the workshop, they were confident in their ability to use collections to teach standards-based content in their classrooms, to explain what a collection is, and how to care for collections. They indicated that they felt the scientists they worked with made them feel valued in their research. These results suggest that engaging educators in professional development opportunities in natural history museum collections can increase their teaching self-efficacy and science content knowledge.

Stand-Alone Paper

Towards mindfulness: A Brazilian case study of a science museums response to the COVID-19 pandemic

Ana Maria Navas Iannini, Simon Fraser University, Canada
Karine Fernandes*, Simon Fraser University, Canada
Erminia Pedretti, University of Toronto, Canada

ABSTRACT

In our current times marked by social injustices and environmental crises science museums have emerged as vital advocates for public good. These institutions are increasingly addressing socioscientific issues and embracing their roles in promoting social responsibility and civic engagement around them. This qualitative case study examines how former museum professionals affiliated with different teams at the[Name of the museum] ([Where the museum is located]) navigated and responded to the COVID-19 pandemic. Informed by theory related to generation of science museums and collective mindfulness, we identified three major themes through thematic analysis centering on awareness, resilience, and relationality. These themes highlight the museums adaptive strategies, including online programming and community engagement efforts, which ensured continued relevance and institutional resilience. The findings provide a comprehensive understanding of the

museums responses to pandemic challenges, illustrating the emergence of new institutional identities and the potential for science museums to foster significant social change a hallmark of fourth generation science museums.

Exploring equity and Reflective practice to support teaching and learning

Strand 7: Pre-service Science Teacher Education
25-Mar-25, 12:45 PM-2:15 PM
Location: Baltimore 1

Stand-Alone Paper

Pre-Service Teachers' Views on Oral Presentations Assessments: The Influence of Social and Emotional Experiences.

Neha Anand*, Midway University, USA
Ella Yonai, University of Georgia, USA

ABSTRACT

Oral presentations have increasingly become a preferred assessment tool in higher education due to their potential to enhance communication and research skills while offering a more dynamic alternative to traditional assessments. However, using oral presentations (OPA) as an assessment method presents challenges, including social anxiety and the pressure to demonstrate cognitive skills publicly. This study investigates pre-service teachers' perceptions of OPAs and examines the influence of social experiences on their presentation skills. Using a mixed-methods approach, the study involved developing a valid and reliable questionnaire, following a rigorous protocol that included a literature review, expert consultations, and pilot testing. Data was collected from a diverse group of participants, including undergraduate and graduate students, as well as early-career professors, to capture a wide range of experiences with OPA. The analysis revealed key themes related to social and emotional well-being and cognitive contributions. By considering PSTs' social experiences and well-being in the design of OPA, educators can enhance the quality of assessments and foster a more inclusive and supportive learning environment. This study not only highlights the influence of social experiences on presentation skills but also underscores the need for further exploration of OPA as a critical tool in science education.

Stand-Alone Paper

Supporting early career science teachers: Reflections from a mentoring initiative

Robbie Higdon*, James Madison University, USA

ABSTRACT

Implementing any form of instructional practice can involve an intricate sequence of planning, acting, observing, and reflecting while continually making decisions to address dynamic classroom interactions. As emerging practitioners, early-career STEM teachers are tasked with accomplishing these tasks while establishing a supportive classroom

environment in the midst of facing massive challenges within public education. Over the past two decades, induction and mentoring programs have become increasingly common because of the role that they play in teacher performance (Ingersoll, Strong, 2011; Smith Ingersoll, 2004) and teaching practice (Wong Luft, 2015). Specifically, there is a link between early career teachers' participation in induction programs and their retention; the strength of the effect depends on the number and types of support that beginning teachers receive (Smith Ingersoll, 2004). This study sought to identify the strengths, misconceptions, and areas of growth for early career STEM teachers who engaged in a formalized mentoring program during their first 2 years within a 6th-12th grade public school classroom. The findings indicated that early career STEM teachers (ECTs) experience strengths, misconceptions, and challenges as they navigate the demands of being an instructional leader. A sustained mentoring program can provide the needed support to retain ECTs.

Stand-Alone Paper

Bridging Perspectives in Preservice Teacher Education: Exploring Ontological Pluralism for Critical Engagement, Inclusively, and Sustainability

Amy Green*, University of Maryland, USA
Angela Stoltz, University of Maryland, USA

ABSTRACT

The urgency of the climate crisis necessitates a paradigm shift in science education towards inclusive adaptability. Increasingly, stakeholders argue that this shift should encompass diverse perspectives, particularly Indigenous Knowledges, which offer unique insights into environmental balance, community well-being, and sustainability. This paper explores the integration of Indigenous approaches within science teacher education traditionally dominated by Western paradigms. Our focus is on enhancing environmental literacy, sustainability, and climate change education through culturally responsive pedagogies aligned with NGSS-based curricula. Drawing on experiences in preservice elementary science teacher education, we examine the pedagogical and ontological impacts of adopting ethnoscientific views through pluralistic approaches to science teaching and learning that are inclusive of nondominant worldviews. Our findings highlight the transformative potential of integrating Indigenous perspectives, fostering ecocentric values, and expanding stewardship ethics through science education. Our work seeks to challenge and transform the underlying power structures, perspectives, and practices that have contributed to environmental degradation and inequality and work towards more inclusive, equitable, and sustainable ways of making sense of human relationships with Nature in the face of a changing climate.

Stand-Alone Paper

Exploring How Equity Perceptions Are Manifested in Preservice Teachers' Practices in Elementary Science Methods Course

Wanjoo Ahn*, Michigan State University, USA
Christina Schwarz, Michigan State University, USA

ABSTRACT
This study investigates how preservice teachers' (PSTs) perceptions of equity in science education are manifested in their instructional practices. The study analyzed lesson plans from 24 PSTs and survey responses from 14 PSTs enrolled in a Spring 2024 elementary science methods course at a Midwestern university. The course integrated principles of equitable science teaching and justice-oriented science instruction, informed by Culturally Relevant Pedagogy (CRP) and Culturally Sustaining Pedagogy (CSP). By examining the alignment between PSTs' expressed perceptions of equity and their practical application in lesson plans, the study identifies both the strengths and gaps in how equity could be implemented in PSTs' teaching practices. The findings reveal that while PSTs recognize the importance of equitable practices, there are inconsistencies in fully integrating these principles into their instructional design. The study underscores the need for more targeted support in teacher education programs that foster the implementation of equity-driven teaching practices in science education.

Evolving Pedagogical Content Knowledge in Science Teaching

Strand 8: In-service Science Teacher Education
25-Mar-25, 12:45 PM-2:15 PM
Location: Annapolis 3

Stand-Alone Paper

Pedagogical Content Knowledge of Climate Change in a biology teacher: A longitudinal case study

Catalina Cañete*, Pontificia Universidad Católica de Valparaíso, Chile
Hernan Cofré*, Pontificia Universidad Católica de Valparaíso, Chile

ABSTRACT
This study investigates the development of personal PCK of CC (pPCKCC) in a biology teacher and the factors influencing the transition to enacted PCK of CC (ePCKCC). The teacher has over 20 years of experience, who participated in a professional development program on teaching climate change through argumentation. The study captures the teacher's pPCKCC through content representation interviews and enacted PCK through reflection meetings after each lesson, exploring factors influencing the transition from pPCKCC to ePCKCC. This longitudinal case study employs conceptual coding guided by PCK theory to analyze the biology teacher's PCK development over time. Inductive and deductive coding processes are applied to CoRe interviews and post-lesson reflection meetings. The analysis of the three CoRe interviews shows that teacher Adrian develops the components of strategies and curriculum by maintaining coding in these components during the three moments of study. According to reflection meetings about the lessons, he recognizes persistent student alternative conceptions about the ozone hole and ultraviolet rays and factors influencing the transition from personal to enacted PCK are identified (time, general pedagogical knowledge, and PCK of argumentation). The contributions of the study on PCK knowledge and on CC teaching are discussed.

Stand-Alone Paper

Comparing science teacher sensemaking of complex genetics using different phenomena.

Sara Porter*, University of North Carolina at Greensboro, USA
Hilleary Osheroff, Exploratorium, USA

ABSTRACT

This paper examines how science teachers make sense of complex genetics as they engage with different phenomena in professional development workshops, aiming to enhance their understanding of complex genetic inheritance beyond traditional Mendelian frameworks. With the increasing public access to personal genetic information, there's a pressing need for updated curricula that reflect the intricate nature of genetic traits. Using qualitative methods, the research focuses on three anchoring phenomena: ancestry testing via 23 Me, variation of human groups, and genetically modified organisms (GMO). Data from field notes and teacher interviews reveal how each phenomenon influenced teachers' perceptions of genetic complexity. Findings indicate that while the 23 Me and human variation workshops effectively prompted teachers to reconsider their genetic instruction practices, the GMO workshop primarily enhanced their understanding of the ethics of gene editing rather than genetic complexity. The paper provides implications for professional development designed to support teachers to align their genetics instruction with current scientific understandings.

Stand-Alone Paper

Unpacking Teacher Content Knowledge Development: The Impact of Teaching Experience and Influential Factors

Ryan Nixon*, Brigham Young University, USA
Stefan Sorge*, Leibniz Institute for Science and Mathematics Education, Germany
Hannah Dudley, Brigham Young University, USA
Alexys Skidmore, Brigham Young University, USA

ABSTRACT

Although it has been said that teaching experience is the most powerful learning experience for teachers, the development of their content knowledge through this experience is not well understood. This study examined the influence of various factors on elementary teachers' content knowledge, including years of teaching, peer interactions, curriculum materials, college science coursework, professional development, science identity, and grade-level reassignment. A survey incorporating an evolution content test, force content test, and background questions was given to 222 elementary teachers. Analysis through multiple regression showed that science identity was the most significant predictor of content knowledge, followed by college science grades. Further analysis of eleven participants with high content knowledge, despite limited college science courses and professional development, revealed they more strongly identified as science people compared to rest of the sample. These results underscore the crucial link between teachers' science identity and content knowledge, offering new insights into teacher content knowledge development. The findings suggest that nurturing elementary teachers' science identity, with a focus on specific topics and grades, could enhance their content knowledge.

Stand-Alone Paper

Understanding the Complexity of Adaptive Teaching Expertise in Advancing Knowledge Generation in Elementary Science

Jale Ercan Dursun*, The University of Alabama, USA
Jee Kyung Suh, The University of Alabama, USA
Brian Hand, The University of Iowa, USA

ABSTRACT

This study explores how Adaptive Teaching Expertise (AdTex) manifests in elementary science classrooms using a knowledge generation approach, where students actively engage in scientific inquiry. We investigate the relationship between the teacher's learning orientations and her use of epistemic tools—such as language, dialogue, and argument—to highlight the complexity of AdTex. An in-depth case study focused on a teacher committed to knowledge generation, analyzing 13 recorded lessons from an ecosystem unit taught to a fifth-grade class. We used teaching videos, vignettes, PD reflections, and teacher interviews, employing both inductive and deductive methods. Our findings reveal that the teacher employed various adaptive strategies to empower students with epistemic tools and enhance their understanding of scientific concepts. These strategies included asking open-ended questions, developing scientific vocabulary based on student understanding, normalizing negotiations, and framing students as scientists. Her philosophical orientations toward learning were strongly aligned with her practices, emphasizing student-generated knowledge and opportunities for students to lead instruction. We conclude that examining teacher practices, epistemic tool use, and learning orientations together provides valuable insight into how teachers develop and demonstrate expertise in teaching science according to the Next Generation Science Standards (NGSS) in elementary classrooms.

Understanding and Appreciating How Science Teachers Reflect Student and Community Voices through Thematic Curricula

Strand 10: Curriculum and Assessment
25-Mar-25, 12:45 PM-2:15 PM
Location: Magnolia 1

Related Paper Set

Reclaiming the "Community" in Community Colleges: A Social Justice Approach to the Biology Curriculum

Marcela Bernal-Munera*, Malcolm X College, USA

ABSTRACT

Community colleges play a significant role within the US higher education system. Yet, some scholars claim that most pursue a socially reproductive perspective influenced by neoliberal principles that address the requirements of corporations at the detriment of their civic duties. As evidence, we find two-year colleges embracing the practice of co-designing

curricula with corporate partners and referring to the process as "welcoming community members' input." The detrimental effects of this process on students in science programs are compounded by this field's discriminatory and oppressive structures. This paper studies a curriculum co-created with community activists to incorporate social justice science issues (SJSI). The paper presents an analysis of how biology community college students exhibit critical consciousness while demonstrating and integrating scientific understandings as they make meaning of a lesson plan on environmental justice. There is evidence that engagement with the curriculum prompted transformed individual intentions in students' personal and professional lives, and that community activists' participation was essential in developing/improving students' learning experience and empowerment.

Related Paper Set

We Don't Have to Reinvent the Wheel: Repurposing Learning for Ruptures in Restrictive Science Spaces

Diana Bonilla*, Northern Illinois University, USA

ABSTRACT

Science educators are faced with mounting pressures of standardized testing and external expectations of what science learning looks like and sounds like. Science has been and continues to be taught as a way to assimilate students into hegemonic norms. But conversations of equity provide opportunities to reimagine a science that engages with criticality and seeks to make the world more equitable and just. As educators, the task of transforming science spaces for emergent bilingual youth may seem impossible within restrictive science and school expectations. However, as we create an expansive vision that pushes against settled expectations we can begin to create ruptures for ourselves and our students. This study exploresthe ways a bilingual science educator created ruptures to expand what it meant to do science and sound like a scientist. The data demonstrates the wayscommon lab activities can be repurposed to challenge the assumptions embedded in conventional science classrooms. Here, re-imagined activities within a thematic unit provided opportunities for students to sensemake around a generative theme and within socio-historical contexts.The resulting ruptures were creating both by teacher planning and enactments and conversations in the classroom.

Related Paper Set

Negotiating Contesting Notions of Equity in Educational Policy to Co-Design Transdisciplinary Science Curriculum

Daniel Morales-Doyle*, University of Illinois, USA
Tomasz Rajski, Chicago Public Schools, USA

ABSTRACT

An equity rationale recently prompted a large urban district (the context for this study) to change high school graduation requirements in science. The change eliminated student choice by requiring a strict regimen of one year each in biology, chemistry, and physics. Meanwhile, the district developed their own curriculum for each of the required science courses, the use of which has been strongly encouraged but not strictly required. This paper

shares a case study of one teacher navigating these policies to teach about local environmental issues in his chemistry classes in a neighborhood school. It is guided by the research question: In a policy context that treats equity as access to conventional science disciplines, how can a teacher create space for expansive transdisciplinary visions of equity? The study draws on teacher solidarity co-design where the teacher (second author) and educational researcher (first author) were both collaborators in a larger collective supporting youth participatory science projects in science classrooms. Our analysis identified both constraints and possibilities for teacher agency with respect to transdisciplinary science teaching and district policies. A policy requiring civic engagement and teaching about the history of the chemical industry both facilitated transdisciplinary moves towards expansive notions of equity.

Related Paper Set

The Woven Copresence of Students in Transformative Science Teachers' Reflections and Stories

Alejandra Frausto Aceves*, Northwestern University, USA

ABSTRACT

In this study, I examine how the presence and voices of students as absent predecessors contributes to individual and collective science teachers' knowledge about student learning in the context of co-designing curriculum. I employed discourse analysis to interpret micro-level interactions among a collective of teachers engaging in professional conversations about classroom assessment. The unit of analysis was an extended dialogue from a co-planning institute that wastranscribed and coded fordirect and indirect voices and stories of students. I build on ideas from Goodwin to consider the co-presence of students, including through the substrates brought forth or expanded by the teachers. Applying Meretoja's work on perspective taking in storytelling, I analyzed if and in what ways the science teachers took up imagine-other or imagine-self perspective-taking as they told stories of effective science classroom assessments in order to theorize what that may afford student learning. My findings showed that teachers shared both examples of storieswithand storiesaboutstudents. By contributing a theory of co-presence that notices student voices in teacher stories as part of the practice of imagining-others, this paper adds complexity to how the field understands the process of curricular co-design as a form of solidarity.

Investigating Culturo-Techno-Contextual Approaches in Chemistry Education

Strand 11: Cultural, Social, and Gender Issues
25-Mar-25, 12:45 PM-2:15 PM
Location: Azalea 1

Stand-Alone Paper

Breaking the Barriers to Meaningful Learning of STEM in Africa: A Systematic Review of Culturo-Techno-Contextual-Approach

Taibat Olateju, Obafemi Awolowo University, (OAU), Nigeria

Adekunle Oladejo, Africa Centre of Excellence for Innovative and Transformative STEM Education, Lagos State University (LASU-ACEITSE), Nigeria
Peter Okebukola, Africa Centre of Excellence for Innovative and Transformative STEM Education, Lagos State University (LASU-ACEITSE), Nigeria
Rasheed Sanni, Africa Centre of Excellence for Innovative and Transformative STEM Education, Lagos State University (LASU-ACEITSE), Nigeria
Juma Shabani, Burundi Doctoral School, University of Burundi, Burundi
Angela Irene, National Universities Commission (NUC), Nigeria

ABSTRACT

Several studies have shown that teachers are adopting culturally relevant pedagogy to promote meaningful learning of STEM subjects for culturally, linguistically, and socially diverse populations of learners. In Africa, the culturo-techno-contextual approach (CTCA) has witnessed great exploration in STEM subjects to ensure students learn meaningfully. However, missing in the literature is a systematic review study on the use of CTCA in STEM teaching and learning. To address this gap, this systematic review sought quality research reports connecting CTCA to students' positive outcomes in science, technology, and mathematics from 2015 till date, and 20 studies were found eligible for inclusion. The findings demonstrated that CTCA has been repeatedly effective in breaking the barriers to meaningful learning of STEM subjects, helping students to understand difficult STEM concepts and improving their academic achievement. Additionally, the findings indicated several implications for practice and future research on the use of CTCA. However, it is our best hope that this review study will be a useful reference for teachers, STEM educators, and educational researchers willing to rewrite the narratives of science learning in Africa by decolonizing science education and bringing African knowledge system to the frontier of science teaching and learning.

Stand-Alone Paper

Enhancing Students' Attitude towards Chemistry using Culturo- Techno-Contextual Approach

Joy Olayemi, Lagos State University, Nigeria
Michael Ahove, Lagos State University, Nigeria
Hakeem Akintoye, Lagos State University, Nigeria
Peter Okebukola*, Lagos State University, Nigeria
Rasheed Sanni, Lagos State University, Nigeria
Adekunle Oladejo, Lagos State University, Nigeria

ABSTRACT

Chemistry, one of the core science subjects, plays a vital role in the scientific and technological advancement of any nation. Scholars have thus advocated for the need to adopt innovative teaching strategies to enhance students' attitude towards chemistry as it is imperative for academic success. The study investigated the effectiveness of Culturo-Techno-Contextual Approach (CTCA) in enhancing students' attitude towards chemistry. The study adopted a quasi-experimental pretest-posttest design involving 143 senior secondary school three chemistry students drawn from two schools in Education District I in Lagos, Nigeria.

Students' attitude towards lipids, soap and detergent questionnaire (SALSDQ) with a reliability coefficient of 0.79 was used for data collection. The data generated was analysed using ANCOVA. Results showed that a significant difference (p .05) exists in attitude of students taught using CTCA (experimental group) and those taught using the lecture method (control group) in favour of the former. Results also revealed that gender has no significant effect on students' attitude (p .05) while the interaction between treatment and gender did not attain statistical significance (p .05). The study therefore recommends the adoption of CTCA by science teachers as a pedagogical tool to enhance students' attitude.

Stand-Alone Paper

Exploring the Effectiveness of Culturo-Techno-Contextual Approach on Students' Achievement in Chemistry

Nwanneka Nwani, Lagos State University, Nigeria
Joy Olayemi, Lagos State University, Nigeria
Michael Ahove, Lagos State University, Nigeria
Hakeem Akintoye, Lagos State University, Nigeria
Peter Okebukola*, Lagos State University, Nigeria
Adekunle Oladejo, Lagos State University, Nigeria

ABSTRACT

Chemistry is a fundamental subject that plays crucial role in shaping the future of science and technology and recent research has highlight the need for innovative approaches to address students' underachievement in the subject. This study investigates the effect of Culture-Techno-Contextual Approach (CTCA) on students' achievement in chemistry. The study adopted an explanatory sequential mixed methods research design; quasi-experimental design and semi structured interview. 73 senior secondary year two chemistry students drawn from two purposively selected schools in Lagos constituted the study's sample. The two schools assigned as experimental and control groups were taught using CTCA and lecture method respectively. Lipids, soap and detergent achievement test (reliability coefficient =0.78) and an interview guide were used for data collection. Findings revealed that a significant difference (p .05) exists in achievement of students taught using CTCA and those taught using lecture method in favour of the former and also, the effect of gender on students' achievement failed to attain statistical significance (p .05). This study concludes that CTCA is golden pedagogical tool to be adopted in teaching and learning to enhance chemistry students' learning outcomes.

AR and VR in STEM Education

Strand 12: Technology for Teaching, Learning, and Research
25-Mar-25, 12:45 PM-2:15 PM
Location: Baltimore 5

Stand-Alone Paper

Preliminary investigation of Taiwanese undergraduates' approaches to learning lunar phases by holographic projection

Yang-Hsin Fan, The University of Texas at Austin, USA
Tzung-Jin Lin*, National Taiwan Normal University, Taiwan

ABSTRACT

Extant literature has confirmed the potential benefits of holographic projections for educational purposes. Yet, students' experiences of learning by holographic projection have rarely been addressed. The main purpose of this study was therefore to explore students' approaches to learning by holographic projection. A holographic projection system was devised to assist students in learning the concept of lunar phases. Phenomenographic analysis was adopted to analyze the interview transcripts of 30 Taiwanese volunteered undergraduates who experienced the holographic projection system and answered guiding questions related to lunar phases. Results revealed that five approaches, namely "Observing," "Repeating," "Complying," "Verifying," and "Integrating" were found, which can be further categorized as either surface approaches or deep approaches. In particular, it seems that one of the deep approaches "Verifying" was the most common approach that the students adopted, which indicates that the participants exhibited a specific learning purpose and operated the holographic projection to verify their hypothesis or fulfill their learning goal. The findings suggest that the application of holographic projection may be promising for creating an interactive learning environment that guides cognitive processing and enables learners to explore educational content in more depth to achieve meaningful learning.

Stand-Alone Paper

Fostering conceptual understanding with real, virtual, combined real and virtual, or VR experiments

Salome Flegr*, TU Dresden, Germany
Jochen Kuhn, LMU Munich, Germany

ABSTRACT

Science education aims to foster students' conceptual understanding. One way to achieve this is the instructional approach of inquiry learning. Inquiry learning can be implemented using real (hands-on) experiments, virtual experiments, or Virtual Reality (VR) experiments. Thereby, sequenced combinations of real and virtual experiments can be more effective for improving students' understanding than single experimentation formats alone. Whether this holds true for parallelly used combinations is yet unclear. Moreover, VR experiments might minimize the split attention effect compared to combined experimentation formats; however, this has not yet been investigated systematically. In the present study, 172 middle school students were involved in inquiry learning in a physics lesson. They worked either with

a real experiment alone, virtual experiment alone, combined real and virtual experiments, or a VR experiment. In line with our hypotheses, inquiry learning fostered students' understanding in physics, real and virtual experiments lead to similar understanding, and students in the combination condition learned more than students in the single experiment conditions. However, the VR experiment did not lead to higher understanding than the combined real and virtual experiments. In conclusion, combinations of real and virtual experiments can be recommended for inquiry learning in science education, also when used parallelly.

Stand-Alone Paper

Teaching Elementary Science Content to Future Teachers Using VR and CS Tools

Richard Bex*, Illinois State University, USA
Kent Crippen, University of Florida, USA
Minji Yun, University of Florida, USA
Darby Drageset, University of Florida, USA
Joanne Barrett, University of Florida, USA
Maya Israel, University of Florida, USA

ABSTRACT

The structure and function of the human heart exemplifies an NGSS cross-cutting concept and is a problematic topic for preservice teachers (PSTs). Virtual reality (VR) and computer science (CS) technologies, such as block coding, are promoted as promising tools for teaching such content in an interdisciplinary way. This study assessed the value of a combined VR+CS experience as a series of lessons about cardiac form and function for elementary PSTs that included physical presence as a dimension of embodiment. The lessons encompassed learning in VR and navigating the cardiovascular system with a programmable robot. Participants included 51 undergraduates enrolled in a science methods course. A within-subjects, repeated measures design was used with data collected at three points (pre-test, post-VR lesson, and post-CS lesson). The results indicate that the VR lesson was less embodied, but effective in increasing content knowledge. However, there was no increase in knowledge due to the CS lesson, which was more embodied. Participants' feedback indicated that the CS lesson was more enjoyable and useful for understanding blood flow, but the VR lesson was more effective for understanding the heart structure. This research will be of interest to those focused on content integration and emerging technologies.

Stand-Alone Paper

Unveiling the Causes of Awe in VR Among College Students

Tyler Harper-Gampp*, North Carolina State University, USA
Cesar Delgado*, North Carolina State University, USA
Khalid Alharbi, North Carolina State University, USA
Matthew Peterson, North Carolina State University, USA
Karen Chen, North Carolina State University, USA

ABSTRACT
Awe, characterized by a sense of wonder or amazement, has been shown to stimulate scientific discovery, enhance learning, and foster positive scientific behaviors. Prior work has demonstrated that virtual reality (VR) environments can induce awe among elementary, middle school, and graduate students, but research on VR's role in eliciting awe beyond physical vastness among undergraduates is limited. This study examined whether a virtual environment that lets users experience scales from the size of an atom to the size of the Sun, induces awe among undergraduates. Our findings indicate most undergraduates experienced awe, primarily due to vastness and unique affordances of VR, with minimal fear or frustration. Surprisingly, findings contrast prior literature, with no student response related to accommodation. These results highlight the potential of VR as a tool for fostering awe, suggesting the need for further research to develop instructional activities that leverage awe to enhance learning.

Equity and Indentity in Science Learning

Strand 13: History, Philosophy, Sociology, and Nature of Science
25-Mar-25, 12:45 PM-2:15 PM
Location: Camellia 1

Stand-Alone Paper

'Who Do You Imagine as Scientists?'': Intersecting NOS and Social Justice in Natural History Museums

Anna Pshenichny-Mamo*, Technion – Israel Institute of Technology, Israel
Wilton Lodge, University College London, United Kingdom
Dina Tsybulsky, Technion – Israel Institute of Technology, Israel

ABSTRACT
Natural history museums, as cultural and educational institutions and scientific research hubs, offer a uniquely, authentic environment for engagingthe public in scientific inquiry and exploration. These institutions not only facilitate a deeper understanding of scientific principles but also serve as critical spaces for addressing broader societal issues such as diversity, equity, and social justice. This study examines how the intersection between the Nature of Science (NOS) and Social Justice (SJ) is manifested in natural history museum exhibits, focusing on 'The Changing Face of Science' series at the Field Museum in Chicago, USA. Using content analysis, we analyzed the signage of four of the exhibitions that have been presented in the museum to date. During our analysis, we searched for text in signage highlighting the social-institutional aspects of NOS and SJ. Our analysis revealed seven distinct categories that describe the intersection of social-institutional aspects of NOS and SJ, highlighting how museum exhibits can convey the complex relationships between science and societal issues. These findings contribute to the broader discourse on science education by demonstrating how natural history museums can effectively integrate NOS and SJ in informal learning environments, thereby promoting a more comprehensive and socially conscious understanding of science.

Stand-Alone Paper

Facing Time Alienation through the Learning of Science

Veronica Ilari, University of Bologna, Italy
Francesco De Zuani Cassina, University of Bologna, Italy
Olivia Levrini*, University of Bologna, Italy

ABSTRACT

Our education systems, rooted in a mechanistic conception of time, emphasize a quantitative, standardized, uniform time marked by synchronized clocks. This view aligns with values of classical modernity like efficiency and linear progress but often leads to a sense of time alienation. This study investigates how science teaching can contribute to empowering students to face alienation and find ways to re-appropriate their time. For this purpose, the potential of integrating the science of complex systems into the science curriculum is explored. Essays from two datasets of secondary school students are compared to extract students' images of time and individuate a possible impact of teaching the science of complex systems: one set refers to students' descriptions of an ideal day in 2024, and the other refers to stories written after exposure to complex systems concepts. The analysis reveals two main images of time: clock time and experiential/natural time. While clock time is dominant in the first dataset, the time of nature/experience prevails in the second, suggesting that complex systems science can broaden students' conceptualization of time. Prigogine's distinction between external (chronological) and internal (with kairological moments) time is used to ground these findings into a more robust epistemological basis.

Stand-Alone Paper

'I believe they consider me a scientist": Exploring connections between NOS understandings and science identities

Renee Schwartz*, Georgia State University, USA
Heidi Turcotte*, Georgia State University, USA
Julia Grimes*, Georgia State University, USA
Robert Bennett*, Georgia State University, USA
Aihanh Maasen*, Georgia State University, USA
Sureka Taylor*, Georgia State University, USA

ABSTRACT

This study examines the relationship between undergraduate students' understanding of Nature of Science (NOS) and their science identities, aiming to explore how these concepts interact and potentially influence one another. Data were collected through questionnaires and interviews. After assessing their NOS views, the analysis reveals that all groups of students generally possess naïve views of NOS, regardless of age, gender or major. Our analysis also showed no statistical difference in science identities between groups based on age, gender, or major. Further, students' science identities were found to have no significant correlation to their NOS views when analyzed as groups. However, a qualitative analysis of individual cases provides insight into how NOS views can influence how some students see themselves as science people or scientists. Several cases revealed that NOS views, in

particular the creative and subjective NOS, relate to their science identity. Notable is how they see ambiguity and creativity within science plays a role in how they see their own place within science. The findings suggest that addressing misconceptions about NOS and implementing more inclusive teaching practices could enhance science identity among diverse student groups, potentially increasing their participation in STEM fields.

Stand-Alone Paper

Ensuring Equitable Opportunities to Improve How Blind Students Conceptualize the Nature of Science

Tina Stamper*, Indiana University, USA

ABSTRACT

This study explored the Nature of Science (NOS) conceptions held by visually impaired students. Blind and low vision students enrolled in grades K-12 were recruited to participate in a six-week, online, Saturday science program during which they engaged in tactile NOS activities and received explicit-reflective NOS instruction. In addition, students completed an open-ended questionnaire, pre- and post-NOS instruction, which assessed their understandings of various NOS aspects. Weekly exit slips, students' verbal commentary, semi-structured interviews, and the instructor's teaching journal were also used in the data collection process. Results showed, after receiving explicit-reflective NOS instruction, that students were able to improve their understandings of the creative, empirical, subjective, and tentative aspects of NOS, as well as being able to distinguish between the scientific processes of observation and inference. Results also indicated that the students found science to be fun and were willing and able to actively engage in adapted NOS activities. Based upon these findings, it is imperative that researchers understand how visually impaired students comprehend NOS ideas in order to provide these students with equitable and inclusive opportunities to increase their scientific literacy and to make informed decisions about the world around them.Keywords: NOS, blind, low vision, equity

---

Environmental Education

Strand 14: Environmental Education and Sustainability
25-Mar-25, 12:45 PM-2:15 PM
Location: Baltimore 3

Stand-Alone Paper

Environmental Health Education: A Way to Address Potential Health Risk from Pesticides in Kindergarten Students

Silvia Ramos De Robles*, University of Guadalajara, Mexico
Verónica Pérez Serrano Flores, Universidad Panamericana, Mexico
Irma García Villegas, University of Guadalajara, Mexico
Ana Alatorre Rodríguez, University of Guadalajara, Mexico
Claudia Huerta Rodea, Instituto Superior de Investigación y Docencia para el Magisterio, Mexico

ABSTRACT
This two-phase study analyzes the potential health risks to children that prevail in an agro-industrial community in the state of Jalisco, Mexico, where toxic pesticides use in agro-industrial practices, prioritizing economics over ecosystems and human health.In the first phase, most consumed fruits and vegetables among children were analyzed to identify pesticide levels. Additionally, urine samples from 21 preschoolers were tested for pesticide presence. Results shows that 87% of the fruit and vegetables samples were found to have pesticides, specifically neonicotinoids, which are toxic and present a significant danger to human health. Furthermore, the urine analysis showed that neonicotinoids were present in 86% of the samples.In the second phase, preschool teachers and parents designed and implemented school gardens based on agroecology to address the issue. We used videos, interviews, and student drawings to analyze findings in the school garden. Students were taught about food's origin and the significance of growing and consuming healthy produce. The garden involved teachers, students, and parents, promoting sustainable and ecological literacy practices.

Stand-Alone Paper

Enhancing learners' awareness about Indigenous Knowledge Systems benefits in environmental science classroom

Alvin Riffel, University of the Western Cape, South Africa
Frikkie George, Cape Peninsula University of Technology, South Africa
Keith Langenhoeven, University of the Western Cape, South Africa
Noluthando Hlazo, Cape Peninsula University of Technology, South Africa

ABSTRACT
The literature on Indigenous education highlights the importance of incorporating Indigenous Knowledge Systems (IKS) into educational practices to promote cultural diversity and equity. Scholars such as Smith (1999) and Battiste (2002) emphasize the significance of Indigenous ways of knowing and learning, arguing for their integration into curriculum and pedagogy. Additionally, research by Bishop (1997) underscores the importance of culturally relevant teaching practices in improving academic outcomes for Indigenous students. The two theoretical frameworks that underpin the study namely: Toulmin's Argumentation Pattern - TAP (Toulmin, 1985) and Contiguity Argumentation Theory - CAT (Ogunniyi, 1997). Through a combination of literature review, stakeholder consultations, and curriculum development, this research endeavors to foster cultural humility and competence among university pre-service teachers, ultimately leading to more inclusive and culturally responsive educational environments. The outcomes of this study will contribute to the broader discourse on decolonizing education and promoting social justice within the educational system.

Stand-Alone Paper

From Research to Classroom: Using Scholarly Expertise to Address the Phosphorus Challenge

Julianna Nieuwsma*, North Carolina State University, USA

M. Gail Jones*, North Carolina State University, USA
Madeline Stallard, North Carolina State University, USA

ABSTRACT

There is a growing phosphorus sustainability crisis that is relatively unknown to most of the world. Excessive phosphorus runoff from non-point sources such as agriculture fields and livestock waste is triggering eutrophication events in many of Earth's surface waters, endangering human health and aquatic ecosystems. While other sustainable challenges have received attention from the educational community, there is a shortage of educational research on this topic. Twenty researchers with expertise in phosphorus sustainability were interviewed to gather their knowledge and views on teaching and learning about phosphorus sustainability. Qualitative analysis revealed a variety of perspectives and a consensus of recommendations for teaching and learning phosphorus sustainability. Key themes included integrating systems thinking and interdisciplinary learning into lessons and empowering learners to partake in pro-environmental behavior. Participants also identified potential challenges for educators, such as a lack of empathy from learners due to an overload of environmental issues, the complexity associated with phosphorus sustainability, and constraints in terms of time and space to incorporate lessons into the current curriculum. Recommendations for future research and implications are discussed.

Stand-Alone Paper

Understanding interdisciplinary teaching and learning: Middle school case study of environmental sustainability education

Xavier Fazio*, Brock University, Canada

ABSTRACT

Students require competencies that enable them to deal with an increasing scientific and technological society. Engaging students in authentic activities nested in school communities is a powerful curricular opportunity. This curricular innovation helps students become more engaged in learning science, promotes interdisciplinarity, and improves their capabilities for citizenship. Even with STEM integration efforts, more robust research on authentic learning environments and interdisciplinary teaching of complex environmental sustainability topics has been lacking in school settings. This presentation will describe an empirical effort to understand interdisciplinarity observed in a middle school so as to advance a case-based approach for investigating interdisciplinary teaching and learning practices that address important environmental sustainability topics. This focus draws attention to interdisciplinary environmental sustainability science topics (e.g., health, climate change, energy) that are critically significant yet teachers struggle to find a place for these in science curriculum. Findings from this in-depth exploratory case study demonstrate how teachers and students can meaningfully participate in a local interdisciplinary environmental sustainability science curriculum, while also identifying challenges to interdisciplinary planning. This study provides recommendations for educators and researchers and will be of interest to NARST members wanting to support interdisciplinary science.

Limitations and constraints
Strand 14: Environmental Education and Sustainability
25-Mar-25, 12:45 PM-2:15 PM
Location: Baltimore 2

Stand-Alone Paper
Rural Families Learning Geosciences Concepts in an Outdoor Children's Garden
Heather Zimmerman*, Penn State University, USA
Susan Land, Penn State University, USA
Bryan Brightbill, Penn State University, USA

ABSTRACT
Our project uses a sociocultural-historic view of place and of geosciences learning. The analysis is on the experiences of 29 rural families (46 adults, 60 children) using an augmented reality app in an outdoor Children's Garden. Data include matched 29 pre- and post-interviews and 19 full video recordings of families' engagement. Our results suggest that the families learned geosciences concepts during the 30–40-minute outdoor intervention. We also found a connection between talking more about science during the experience (i.e., engaging with the discussion prompts) and learning more concepts related to the geological time. We also a positive correlation between observational (perceptual talk) and overall conceptual learning. This work's significance is that it found talk patterns based on rural families' experiences with an augmented reality app in an outdoor learning space, building important design principles for environmental education interventions.

Stand-Alone Paper
Constraints when Engaging with Locally Held, Landscape-Based Climate Knowledge in Map-based, Adult Peer-to-Peer Community Learning
Heather Killen*, University at Buffalo, USA

ABSTRACT
Climate change is shifting local climates and ecologies; however, adults are offered minimal opportunities to learn about and engage with these local shifts. Furthermore, it can be difficult for community educators to engage adults with climate education, especially in communities that tend to be skeptical of climate change. This work uses the context of collaborative map building to engage six residents of a conservative-leaning, rural community with their local ecology and climate. Guided by the practices and perspectives of critical data science, we aimed to center local knowledge of changes to local ecology and climate to build an online, public map of a local landscape feature, a creek and associated nature trail. While the community mapping group brought both local landscape and local climate knowledge into the design space, analysis indicated that they struggled to engage with climate knowledge in a way that led to collective understanding. This work demonstrates that community members can hold valuable local ecological and landscape knowledge, but that community-based educators must carefully scaffold contexts to allow

participants to see their knowledge as valuable and worthy of sharing via tools, like maps, that facilitate peer-to-peer learning.

Stand-Alone Paper

A taxonomy of encounters and experiences to assist educators who leverage wildlife to engage learners

Bryan Nichols*, Florida Atlantic University, USA

ABSTRACT

This session will introduce participants to the Significant Wildlife Encounters and Experiences Taxonomy (SWEET), a framework to help classify wildlife-related encounters, experiences, and content. In the SWEET, wildlife encounters occur in the same time and place with at least one living individual animal (captive or free-living). Experiences involve at least one living individual but are separated by either time, space, or both. More generic wildlife-related content (e.g., a general lesson on whales) does not emphasize real-world individuals. Although researchers and educators often use these terms interchangeably, there are pedagogical, moral, and logistical implications that make more careful consideration and classification worthwhile. Animals can be highly engaging to learners of all ages, and many educational activities incorporate wildlife, including dissections, wildlife cams, bird watching, biofacts, storytelling, and tracking. However, it can be challenging to develop responsible programs and clarify significant impacts. While natural settings for quality encounters might be increasingly hard to access, technology is expanding the potential for educationally rich wildlife experiences. SWEET can help clarify program strengths, gaps, potential assessments, and new directions, while helping pinpoint the more impactful elements of wildlife programs. Participants will get the chance to consider SWEET in their own research or educational contexts.

Towards a More Robust and Justice-Oriented Genetics Education

Strand 1: Science Learning: Development of student understanding
25-Mar-25, 2:30 PM-4:00 PM
Location: Annapolis 2

Symposium

Towards a More Robust and Justice-Oriented Genetics Education

Ravit Duncan*, Rutgers University, USA
Deb Kelemen, Boston University, USA
Léa Tân Combette, Boston University, USA
Kostas Kampourakis, University of Geneva, Switzerland
Dalia Hassan, Rutgers University, USA
Michal Haskel-Ittah, Weizmann Institute of Science, Israel
Niklas Gericke, Karlstad University, Sweden
Malka van Dijk, Weizmann Institute of Science, Israel

Anat Yarden, Weizmann Institute of Science, Israel
Gregory Radick, University of Leeds, United Kingdom
Rishi Krishnamoorthy, University of Toronto, Canada
Dalia Hassan, Rutgers University, USA
Na'ama Av-Shalom, Rutgers University, USA
Phyllis Illari, University College London, United Kingdom
Federica Russo, Utrecht University,
Giora Alexandron, Weizmann Institute of Science, Israel
Asaf Salman, Weizmann Institute of Science,
Moriah Ariely, Weizmann Institute of Science,

ABSTRACT
Genetics education is a prominent feature of biology standards, instruction, and assessment around the globe with clear relevance of such education towards genetic and genomic literacy for personal and civic engagement. However, making sense of the genetics taught at school and encountered in the public arena is not trivial for children or adults. Misunderstandings abound and some of these are particularly problematic, namely essentialist and deterministic views of genetic phenomena. Genetic essentialism is the belief that human groupings (e.g., races, genders) represent biologically and genetically distinct human kinds, and genetic determinism is the belief that genes alone determine traits. Over the past decade there has been a concerted effort to better understand how such beliefs develop, how they impact students' understandings of trait differences across human groups, and what can be done instructionally to address and counter these problematic views. In this symposium we bring together a group of leading scholars from multiple countries who have been engaged in research on students' understandings of genetics to share perspectives regarding the problem of essentialist and deterministic views of genetics, the social implications of such views, and what we can do about them as researchers and educators.

Partners in Project and Place-Based K-12 STEM Learning: A Model for Ambitious Teaching and Learning

Strand 2: Science Learning: Contexts, Characteristics and Interactions
25-Mar-25, 2:30 PM-4:00 PM
Location: Annapolis 1

Related Paper Set

The Teaching School: Examining STEM Teacher Learning in Embedded, Extended, and Place-Based Teacher Education

Rachael Gordon, University of Michigan, USA
Elizabeth Moje, University of Michigan, USA
Bridget Maher*, University of Michigan, USA
Alistair Bomphray, University of Michigan, USA
Michaela O'Neill, University of Michigan, USA

ABSTRACT
Ongoing calls to strengthen and diversify our nation's STEM workforce outline the need for recruitment and retention of STEM teachers trained in ambitious and socially just teaching practices. Due to traditional time constraints, and spatial and conceptual divides between university and K-12 settings, developing ambitious and socially just STEM teaching practices that center students and community in project-based learning experiences requires reimagining traditional teacher education models. This begs the question, how might a unique reform model of teacher education serve to achieve this goal? To that end, this qualitative paper explores pedagogical support structures within a unique case of a STEM teacher education reform model that makes use of extended, embedded, and place-based supports called The Teaching School. This paper examines questions, such as:How do beginning STEM teachers engage in structures aimed to support the development of socially just STEM teaching practices?And,How do such structures support and constrain project-based learning and socially just STEM teaching practices?Analysis suggested that dedicated time for integrated professional development and curriculum co-writing supported teachers' development, while lack of shared time across all teachers constricted further growth. We offer implications for STEM teacher education structures within school settings.

Related Paper Set

Tracing elementary student learning and literacies in residents' classrooms in science PPBL

Bridget Maher*, University of Michigan, USA

ABSTRACT
Elementary science learning fosters curiosity, critical thinking, and foundational interest and efficacy in pursuing science in the future (Duschel et al., 2007). However, we also know the elementary classrooms, especially in grades K-3, experience truncated instruction and shortened time on science learning, and those patterns are even more inequitable for racial and ethnic minority students (Curren Kitchin, 2019). This paper responds to the call for elementary project- and place-based learning (PPBL) curriculum by presenting a case of resident teachers'(those in their first 3 years) enactments of PPBL in grades K through 3, situated within a larger university-school partnership/Teaching School model. The authors and presenters on this paper include university partners and the resident elementary teachers whose classrooms were the focus of the curriculum co-development, enactment, and research. We found that despite existing tensions about available time for science teaching and learning, teachers in our partnership did enact robust PPBL teaching that resulted in meaningful affordances and learning. One of the largest affordances was the cadre of resident teachers who supported each other in the enactment of teaching in justice-centered ways and student learning and literacy practices that resulted and were strengthened by the PPBL curriculum.

Related Paper Set

Tracing high school students' engineering learning and literacies in residents' classrooms over time

Emily Rainey*, University of Pittsburgh, USA
Bridget Maher*, University of Michigan, USA
Elizabeth Moje, University of Michigan, USA

ABSTRACT
We seek to add to the disciplinary literacy and teacher education literature by bringing a justice-focused literacy lens to the longitudinal analysis of the teaching and learning within three early career high school engineering teachers' classrooms set within a novel university-school partnership context. We ask: (1) How did three focal early career engineering teachers teach students engineering literacies? (2) How, if at all, did students' talk and work reflect their developing engineering literacies?Data include routine video artifacts of classroom activity; planning artifacts; student work and culminating projects; and one-on-one interviews with the focal teachers collected over three years.

Related Paper Set

Centering Students and Community: Designing and Engaging in Human-Centered Engineering and Design

Sneha Rathi*, Detroit Public Schools Community District, USA
Hunter Janness*, Detroit Public Schools Community District, USA
Rachael Gordon, University of Michigan, USA
Elizabeth Moje, University of Michigan, USA

ABSTRACT
Althoughseveral K-12 engineering curricula have been developed over time to increase students' understanding of and engagement with engineering practices, very few center students' interests and communities in ways that allow for meaningful development of and engagement with disciplinary tools to address community concerns. This qualitative paper explores high school teachers' experiences both designing and implementing student- and community-centered human-centered engineering and design courses within an embedded, extended, and place-based model of teacher education. Specifically, we explore the alignment and sophistication of students' engineering experiences from 9th through 12th grade, posing the following questions:How do students' use of engineering and design tools develop over time across a high school engineering curriculum? How do community-based partnerships shape students' engagement with human-centered engineering and design?And, what elements of community-based partnerships enable authentic, high quality engineering and design learning experiences for youth?Findings highlight the importance of drawing on community partners to enable authentic, high-quality engineering experiences for youth. We offer implications for student- and community-centered engineering curriculum design.

Transforming STEM Learning Through Socioscientific Engagement

Strand 5: College Science Teaching and Learning (Grades 13-20)
25-Mar-25, 2:30 PM-4:00 PM
Location: Magnolia 3

Stand-Alone Paper

Collaborative Causal-Loop Modeling as a Support Socioscientific Decision-Making

Eric Kirk*, University of North Carolina at Chapel Hill, USA
Heewoo Lee, University of North Carolina at Chapel Hill, USA
Troy Sadler, University of North Carolina at Chapel Hill, USA

ABSTRACT

Preparing students to confront socioscientific issues (SSI) is challenging. High-quality decision-making is often cited as an important outcome of SSI-based instruction, yet relatively few studies have focused on student decision-making, or how scientific practices may support this. This research addresses this gaps by exploring the factors undergraduate students consider important when evaluating potential solutions to an emerging pandemic and how these considerations change following a collaborative modeling activity. Using a convergent mixed-methods design, we analyzed students' essays with Latent Dirichlet Allocation (LDA) to identify frequently mentioned topics. Our findings revealed that students considered a range of ideas, including technoscientific interventions, humanistic concerns, cultural influences, and the complexity of SSI. Following the modeling activity, there were significant differences in the topics featured in students' essays. These results suggest that collaborative causal-loop modeling can broaden students' thinking about a problem and potentially enhance decision-making. This research contributes to the understanding of decision-making in SSI contexts and highlights the potential of modeling activities to support student thinking, even in large-enrollment courses. The findings align with a vision of science literacy that embraces using science for civic participation and invites further research at the intersection of SSI and modeling.

Stand-Alone Paper

Using A Socio-scientific Issues Framework for Implementing Citizen Science Projects in an Undergraduate Biology Class.

Muhammad Ijaz*, University of Massachusetts-Dartmouth, USA
Hamza Malik, Lloyd Center for the Environment, USA
Stephen Witzig, University of Massachusetts-Dartmouth, USA

ABSTRACT

This study explores the role of citizen science projects in engaging undergraduate students in addressing locally relevant environmental issues based on the perspectives and experiences of faculty members who implement such projects. Through qualitative interpretative phenomenological analysis, the research investigates how citizen science can foster active student participation in real-world environmental inquiries. The findings reveal that citizen science projects effectively engage students in both in-class and out-of-class activities when integrated into classroom instruction, promoting goal-oriented learning. The

study underscores the potential of citizen science as a pedagogical tool for enhancing scientific literacy and addressing environmental challenges, offering insights for educators and policymakers on incorporating citizen science into higher education curricula utilizing the Socio-scientific Issues (SSI) Framework.

Stand-Alone Paper

Professional development for faculty to engage students as scientists using a socioscientific issues-based approach

Stephen Witzig*, University of Massachusetts - Dartmouth, USA
Muhammad Ijaz, University of Massachusetts - Dartmouth, USA
S.M. Mushfiquer Rahman Ashique, University of Massachusetts - Dartmouth, USA
Hamza Malik, The Lloyd Center for the Environment, USA
Rachel Stronach, University of Massachusetts - Dartmouth, USA
Kathryn Kavanagh, University of Massachusetts - Dartmouth, USA
Robert Gegear, University of Massachusetts - Dartmouth, USA

ABSTRACT

Science faculty at universities are required to teach college-level courses in their discipline despite their lack of pedagogical training to do so. This a problem because research shows that half of the students initially majoring in STEM fields leave for non-STEM majors by their second year in college. Our research addresses this critical need for faculty support by studying a program that provides targeted research-based faculty development utilizing a socioscientific issues (SSI) based approach to engage students as scientists through citizen/crowd-sourced science.This qualitative research was guided using case study methodology, included forty faculty from thirteen institutions, and investigated the following research question: In what ways do faculty, and future faculty, incorporate citizen science into their instruction using a socioscientific issues based instructional model? Through our investigation, we have established the following three assertions: (1)Faculty attended to the SSI framework recommendations by presenting the issue first and connecting to students' lives; (2)Faculty grappled with how best to incorporate citizen/community science projects into their courses to address their issue; and, (3)The workshop created a sense of community that the faculty looked forward to foster.We hope this study sparks discussion and look forward to receiving feedback.

Stand-Alone Paper

Towards a Transformational STEM Consciousness: A Mixed Methods Study on a Liberatory STEM Outcome

Juan Garibay, University of Virginia, USA
Lindsay Wheeler, University of Virginia, USA

ABSTRACT

The purpose of this sequential, exploratory mixed methods study was to develop a theoretically and empirically grounded scale called Transformational STEM Consciousness, defined as an awareness of and capacity for students to critique STEM fields for their contributions to current inequities in conjunction with pursuing and using STEM to address

social/racial inequities. To develop survey items, interviews were conducted with 26 students at a research-intensive institution about STEM and social/racial justice. Many students, especially those from racial/ethnic minoritized backgrounds, discussed the importance of using STEM to address social/racial inequities and held critiques of STEM fields for their contributions to past/present inequities. From these interviews and prior theory, we developed five survey items and used both a 1-factor and 2-factor confirmatory factor analyses (CFA) to test the item's construct validity on a racially diverse sample of 268 students enrolled in social justice in STEM courses across 11 U.S. universities. Strong model fit estimates determined a one-factor structure and resulted in a 5-item measure called the "Transformational STEM Consciousness Scale" (TCS-STEM). The concept of Transformational STEM Consciousness has the capacity to unite and advance the conceptualizations and measurements of various forms of social justice outcomes in STEM.

Exploring Science Learning Through Outdoor and Real-World Experiences

Strand 6: Science Learning in Informal Contexts
25-Mar-25, 2:30 PM-4:00 PM
Location: Magnolia 2

Stand-Alone Paper

Nature-Based Learning as a Context for Science Inquiry: Benefits and Challenges from Students Perspective

Yetunde Mabadeje*, University of Iowa, USA
Kay Ramey, University of Iowa, USA
Mandy Dunphy, Baylor University, USA

ABSTRACT

This qualitative study ventures into thewilds of nature-based learning. Despite documented health and academic outcomes of nature-based science learning, students' perspectives on its challenges and benefits areunderexplored. Tobridge this gap, we examined students' views through qualitative surveys and focus group interviews during a weeklong nature-based learning program. Guided by experiential and place-based learning theories, we analyzed survey responses and focus group interviews from140 fifth and sixth grade students.We identified three major themes for challenges: physical demands, preparation and logistics, and discomfort. For benefits, themes included exploration and freedom, connection with nature, and interest and skill development. The study concludes with recommendations for implementing strategies to support positive student experiences.

Stand-Alone Paper

Encountering Freedom: A Comparative Case Study of a Formal Classroom and Nature-based Informal Learning Environment

Mandy Dunphy*, Baylor University, USA
Kay Ramey, University of Iowa, USA

Brian Hand, University of Iowa, USA
Ted Neal, University of Iowa, USA

ABSTRACT

This study explores the concept of subjectification—the process of becoming an autonomous, responsible agent—within the contrasting contexts of a formal classroom and a nature-based learning environment. Utilizing a comparative case study approach, the research focuses on a group of fifth-grade students and their teacher as they transition between these two learning environments. The study is grounded in Gert Biesta's philosophical framework of education as a means of subjectification and the Generative Learning Theory (GLT), which emphasizes the active role of learners in constructing meaning. Through observations, audio, and video recordings, as well as focus group interviews and surveys, the study examines how dialogue, language, and teacher-student interactions shape students' opportunities to engage as subjects in their learning process. The findings reveal significant shifts in the teacher's approach, from a teacher-centered, directive style in the formal classroom to a more dialogic and inquiry-based method in the nature-based environment. These shifts facilitated greater student autonomy and engagement, highlighting the potential of informal learning environments to enhance subjectification. The study contributes to the growing body of literature on nature-based learning and offers valuable insights for science educators seeking to create more generative and student-centered learning experiences.

Stand-Alone Paper

Students as Researchers Scientists: Connecting Real-world Experiences Scientific Concepts through a Coastal Ecology Summer Program

S.M. Mushfiquer Rahman Ashique*, University of Massachusetts Dartmouth, USA
Hamza Malik*, Lloyd Center for the Environment, USA
Rachel Stronach, Lloyd Center for the Environment, USA
Stephen Witzig, University of Massachusetts Dartmouth, USA

ABSTRACT

Summer environment educationalprograms aim to enhance environmental stewardship among students. However, challenges persistin linkingtheoretical conceptsto real-world experiences and applications. Research shows students often struggle with this connectionaffecting comprehension and application of learned concepts. Our study investigates a program that combines hands-on activity with field trip to address this issue. Employing qualitative exploratory methods, we explored the following research question:In what ways, if any, does a student-centered environmental education summer program utilize a hands-on activity followed by a field trip to a local state park to inform students about coastal bird's habitat, threats, and human connections?We collected data through observations, student artifacts, and informal conversations with instructors. Our analysis led to three key assertions: (1)Hands-on activity and a field trip to a local park facilitate students' ability to connect educational content to real-world experiences; (2) Both components significantly enhance student engagement andfacilitate the connection of scientific concepts to a specific context that students can relate to; (3) This approachfosters a sense of

empowerment among students, enabling them to take on the role of scientists and researchers addressing real-world issues. We hope these findings spark discussion and welcome feedback on our research.

Stand-Alone Paper

Gardening During a Global Pandemic: Time for Nesting, Neighbors, Nature and Knowledge

Elysa Corin*, Institute for Learning Innovation, USA
Eric Jones, UT Health Houston, USA

ABSTRACT

People react to extreme events in a variety of ways. Beyond the need for infrastructural, economic, physical and psychological repair due to the impact of an extreme event (disasters, terrorism, humanitarian crises), there also exists the potential for alteration of individuals' daily or typical activities. Such changes might involve responsibilities, relationships with various kinds of people, or choices about what to do with leisure time. In this session, we share data from a 2022 sample of 349 adult plant/gardening hobbyists who live in the same community, and we focus on the impact of the global COVID-19 pandemic's stressors and disruptions on their participation in gardening. Results examine the relationship between community members' score on the COVID Stressor Scale with their responses to questions probing how their participation may have changed during the COVID pandemic and how likely they were to turn to plants and gardening to cope with stress. Benefits of and the shift in the nature of their free-choice activity are discussed. Findings illustrate that benefits were experienced by plant/garden enthusiasts across participant demographics, by gender, age, race, and socioeconomics which speaks to the broad appeal of this activity and its importance in supporting participants' well-being.

Research, Methods and Assessment in Preservice Teacher Education

Strand 7: Pre-service Science Teacher Education
25-Mar-25, 2:30 PM-4:00 PM
Location: Baltimore 1

Stand-Alone Paper

Humanized Science, Humanized Teaching: Examining How a Research Experience Supported one Pre-Service Teacher's Practice

Matthew Adams*, Michigan State University, USA
Lulu Bogun, Michigan State University, USA
David Stroupe, University of Utah, USA

ABSTRACT

This study examines how Research Experiences for Teachers (RETs) can serve as a potential site through which pre-service teacher's (PST) can humanize science. Additionally, we explore how the process of humanizing science supported one PST's emerging practices and

perspectives in the clinical component of their teacher preparation program. Through our analysis of interviews and observations across both experiences, we assert 3 primary findings: (1) In spending time in the laboratory, the PST deepened their understanding of both the practices and culture of a scientific lab; (2) In deepening their understanding of the cultural practices of academic science, the PST was better positioned to nuance the cultural practices of school science; (3) Weekly reflective journals supported the PST in contextualizing the lessons from their laboratory experiences in their clinical. Implications of this study suggests that RETs can serve as a powerful learning site for pre-service teachers to develop a humanizing perspective as a science teacher.

Stand-Alone Paper

Fostering Productive scientific Discourse Through Talk Moves: Focus on undergraduate courses for pre-service science teachers

Hadeel Edrees Dabbah*, Ben-Gurion University of the Negev, Israel
Orit Ben-Zvi Assaraf, Ben-Gurion University of the Negev, Israel

ABSTRACT

Productive scientific discourse (PSD) is crucial for fostering collaborative and meaningful learning. Despite its importance, implementing PSD may challenge preservice science teachers (PSTs). Through ethnography and discourse analysis of 922 interactive discourse episodes, we examined the use of talk moves to identify potential seeds of PSD in Arabic-speaking science courses. While overall discourse was often lecturer-directed, specific interactions between lecturers and students demonstrated opportunities for more productive engagement. Students, for example, demonstrate elements of PSD through actions like responding to and expanding upon their classmates' ideas. Similarly, lecturers contribute by utilizing follow-up questions, encouraging students to share their thoughts, expanding and clarifying ideas, and demanding scientific justifications. We see such pedagogical elements as an important basis for developing PSD, and have therefore chosen to call them "seeds." These "seed moments" stimulated increased student participation and expanded discourse beyond lecturer-student interactions to include conversations between the students themselves. Our results argue for the importance of looking at the intermediate spaces that may exist between binary divisions such as dialogic/non-dialogic, productive/unproductive and authoritative/dialogical. Instead, we offer an analysis of episodes whose context was sometimes not all that productive, but which carry interactive features that could constitute seeds for PSD.

Stand-Alone Paper

Assessment of pPCK Competency Profiles Using a Language Model and Machine Learning

Jannis Zeller*, Paderborn University, Germany
Josef Riese, Paderborn University, Germany

ABSTRACT

Pedagogical Content Knowledge (PCK) as a central component of teachers professional competence is established as a highly active area of research. Personal PCK (pPCK), as a

linking part at the core of PCK in the context of the Refined Consensus Model of PCK, is typically assessed through test instruments and questionnaires. Such instruments often rely on a mixture of closed- and open-format tasks to cover a variety of PCK-subscales and cognitive activities. Recent explorative analyses using an established German pPCK test instrument also uncovered the existence of prototypical PCK competency profiles. However, the use of open-ended tasks necessitates considerable human effort to evaluate test edits. To enable a transfer of such test instruments in an effective and scalable assessment for the formative and summative evaluation of learning opportunities or the generation of individual feedback, automation is required. The present study employs a language model trained for the automated scoring of test edits using a dataset of N=846 edits from the aforementioned PCK test instrument by pre-service teachers. The results demonstrate the usability of such an approach not only for scoring, but also for using the outcomes to provide feedback w. r. t. the subscales, cognitive activities, and competency profiles.

Stand-Alone Paper

A cluster analysis of pre-service physics teachers' attitudes towards digital media

David Weiler*, Eberhard Karls Universität Tübingen, Germany
Jan-Philipp Burde, Eberhard Karls Universität Tübingen, Germany
Rike Große-Heilmann, Universität Paderborn, Germany
Andreas Lachner, Eberhard Karls Universität Tübingen, Germany
Josef Riese, Universität Paderborn, Germany
Thomas Schubatzky, Universität Innsbruck, Austria

ABSTRACT

The use of digital media in the classroom can improve science teaching and learning. However, the extent to which teachers incorporate digital media into their lessons is significantly influenced by their attitudes toward these tools, including factors such as motivation and self-efficacy. Against this backdrop, physics pre-service teachers (PSTs) attitudes towards the use of digital media in teaching was assessed before and after a university seminar on the effective use of digital media in the physics classroom. Using a cluster analysis with the k-means algorithm, we identified four distinct attitude clusters among the physics PSTs. These clusters – optimists, realists, undecided individuals, and rejecters – mirror those observed in studies of in-service teachers. Furthermore, our results indicate that attending the university seminar on digital media has a significant impact on PSTs' attitudes towards the use of digital media in their future teaching practices.

Empowering Teachers: Computational Thinking and Quantum Education

Strand 8: In-service Science Teacher Education
25-Mar-25, 2:30 PM-4:00 PM
Location: Annapolis 3

Stand-Alone Paper

Empowering Teacher-Driven Computational Thinking Integration through Collaborative Partnerships

Andrew Elby*, University of Maryland, USA
Amy Green*, University of Maryland, USA
Jennifer Radoff, University of Maryland, USA
Khusbu Dalal, University of Maryland, USA

ABSTRACT

Recently, there has been a growing emphasis on training teachers to integrate computational thinking (CT) practices into disciplinary instruction. However, many current approaches involve a "top-down" method, where CT concepts and teacher training are dictated by external CT "experts," often in an abstract and generalized manner, rather than being developed collaboratively or contextually with the teachers. These approaches typically treat CT as a set of abstract concepts, which can fail to promote a holistic understanding of the purposes and disciplinary value of CT. Consequently, teachers may feel less inclined to integrate CT into their regular teaching practice beyond the confines of professional development sessions. Furthermore, teachers are frequently positioned as novices awaiting the transmission of relevant CT knowledge rather than as agentive knowledge-builders with valuable expertise. This can undermine their autonomy, ownership, adaptability, and long-term commitment to implementing CT effectively in their teaching practice. We propose an alternative, "bottom-up" approach to supporting teachers in CT integration through a collaborative partnership between researchers and practitioners. We share evidence that this partnership led to understanding CT as inherently contextualized and productive for disciplinary problem-solving.

Stand-Alone Paper

Exploring Factors Influencing Elementary Teachers Future Implementation of Computer Science Curricula Integrated with Math/Science

Dilara Kara-Zorluoglu*, University of Nevada Las Vegas, USA
Hasan Deniz, University of Nevada Las Vegas, USA
Ezgi Yesilyurt, Weber State University, USA
Erdogan Kaya, George Mason University, USA
Refika Turgut, University of South Carolina-Upstate, USA
Elif Adibelli-Sahin, Development Workshop, Turkey

ABSTRACT

This study used Expectancy-Value Theory to examine the motivation of elementary school teachers to implement an integrated computer science curriculum after three weeks of implementation. The case study was conducted with three elementary school teachers who

taught 4th and 5th grades. The data was collected during the spring semester of 2024 using semi-structured interviews via Zoom and field observation. The results showed that the participants found the program beneficial for teaching robotics and coding using curriculum topics. The program contributed to both students and teachers in terms of career planning and social/emotional aspects. In addition, teachers made efforts to improve the teaching and learning process. The costs they attached to the program in terms of resources and support offer suggestions for future studies to increase teachers' motivation towards implementing coding skills in their current curriculum. The findings of this study will create an opportunity for both teachers and researchers to develop integrated lesson plans by considering classroom practices.

Stand-Alone Paper

Qualitative Analysis of Precollege Teachers' Attitudes Towards Teaching Quantum Information Science and Technology

Michele Darienzo, Stony Brook University, USA
Angela Kelly*, Stony Brook University, USA
Tzu-Chieh Wei, Stony Brook University, USA
Dominik Schneble, Stony Brook University, USA

ABSTRACT

Quantum information science and technology (QIST) is a rapidly emerging discipline with limited availability of a qualified workforce for the development of new technologies, and there has been an international imperative to expose precollege students to QIST. This study employed a case-study approach to understand how teachers who had participated in a 12-hour professional learning workshop shifted their QIST knowledge, self-efficacy, and pedagogical beliefs. The theoretical framework was drawn from psychosocial studies that suggested teachers may facilitate students' knowledge and self-efficacy through their own disciplinary mastery and pedagogical content knowledge. Qualitative data were collected and coded for each of the six case study participants through extended individual interviews.The teachers described experiences from the QIST professional learning workshop, and three main themes emerged: (1) effective methods for increasing their own understanding of QIST topics; (2) anticipated challenges in implementing QIST in their classrooms; and (3) strategies for students to become interested in QIST and consider post-secondary QIST study. Findings indicated that the teachers shared intentions for implementing QIST topics through multiple representations and hands-on strategies, although they anticipated tensions related to lack coherence with existing standards, lack of instructional time, and insufficient student preparation in mathematics and science.

Stand-Alone Paper

Teacher Knowledge of Quantum Information Science and Technology and Pedagogical Self-Efficacy

Andrea Zinn, Stony Brook University, USA
Angela Kelly, Stony Brook University, USA
Tzu-Chieh Wei, Stony Brook University, USA
Dominik Schneble, Stony Brook University, USA

Michele Darienzo, Stony Brook University, USA

ABSTRACT
There is a growing global need for a workforce trained in quantum information science and technology (QIST), a discipline that is rarely addressed in precollege science curricula. University quantum physics and physics education researchers designed and initiated a four-week, twelve-hour QIST professional development workshop forN=55 inservice secondary school science, mathematics, and computer science educators. A STEM integration framework guided the workshop structure, which incorporated a situated cognition model for learning classical and quantum concepts, identifying recent advances in quantum technologies, planning curricula, and differentiating among QIST sub-fields including communication, computation, simulation, and quantum metrology and sensing. The pre-/post-research design identified significant QIST knowledge gains overall as well as in the subdomains of classical physics, quantum physics, and quantum computing. Teachers also improved their QIST pedagogical self-efficacy overall, as well as in sub-domains of knowledge about QIST academic pathways and careers; promoting QIST relevance; QIST pedagogy and STEM integration; and facilitating QIST understanding among students. This professional learning model shows promise in strengthening teachers' QIST pedagogical content knowledge so they may facilitate student engagement in quantum computing, a field that involves conceptual change and is often considered abstract, counterintuitive, inaccessible, and suitable only for the academically elite.

Exploring the Systemic Nature of Curriculum Development and Implementation in Elementary Science

Strand 10: Curriculum and Assessment
25-Mar-25, 2:30 PM-4:00 PM
Location: Magnolia 1

Related Paper Set

Iterative Design of Wondering Elementary's Assessment System: Promises and Challenges

Amelia Gotwals*, Michigan State University, USA
Christie Morrison Thomas, Michigan State University, USA
Amanda Dahl, Michigan State University, USA

ABSTRACT
When assessment systems are designed to invite, value, and build on students' prior learning experiences, family and community funds of knowledge, and linguistic resources, they can serve as powerful tools to support responsive teaching and student learning, This is particularly important in early elementary when children have not yet learned to read and write independently. However, how to best support teachers enacting assessment in these ways is not clear. In this paper, we describe some of the iterative design decisions that we made in building the Wondering assessment system. We used design-based research to

iteratively design, pilot, and refine assessment tools in the Wondering K-5 instructional materials. Through analysis of surveys and interviews, we found that teachers found it challenging to interpret the various ways that students could demonstrate their sensemaking in ways that allowed them to provide feedback and make instructional decisions. Based on this challenge identified by teachers, we built several supports, one of which was identifying key formative assessment moments and providing teachers with ideas to look for paired with possible next steps to take. This paper will share the design principles underlying these assessment supports that may be applicable across contexts.

Related Paper Set

Design Considerations in Integrating Mathematics for Scientific Sensemaking in Elementary Science

Cathery Yeh*, The University of Texas at Austin, USA
Amy Johnson, The University of Texas at Austin, USA
Lauren Rigby, The University of Texas at Austin, USA

ABSTRACT

Despite the close relationship between mathematics and science, science curricula often lack explicit support for the integration of mathematical concepts for scientific sensemaking. This paper explores the opportunities and challenges of designing educative features that integrate mathematical supports for science learning. Using design-based research, the study iteratively developed, piloted, and refined six OpenSciEd Elementary curriculum materials for grades K-5, to support students' mathematical application in science. Data from the field-tested and redesigned curriculum materials, feedback from 290 classrooms, and notes from weekly meetings with curriculum writers were analyzed to identify mathematical applications and challenges. Findings reveal that the key mathematical applications in K-5 units involved analyzing and interpreting data, employing mathematical and computational thinking, and utilizing geometric and quantitative and qualitative reasoning. Analysis of teacher feedback and student work revealed a need for improved support in measurement and data concepts. The curriculum redesign addressed these needs through five key features: standards alignment, pedagogical guidance, examples and illustrations, differentiation strategies, and discussion prompts. The paper discusses the tensions in designing to supportmathematics applicationversus designing formathematics learningin science curriculum and offer recommendations that support mathematics and science learning as integrative educative featured.

Related Paper Set

Designing Curriculum-Based Professional Learning for Elementary Science Teachers: Addressing Instructional Shifts and Supporting Sensemaking

Susan Gomez Zwiep*, BSCS Science Learning, USA
Janna Mahfoud, BSCS Science Learning, USA
Amy Belcastro, BSCS Science Learning, USA

ABSTRACT
Elementary science teachers often struggle to align their instructional practices with the Next Generation Science Standards (NGSS), primarily due to experiences with traditional science education, which emphasized "known-answer questions" and overlooked the diverse sense-making abilities of underserved communities. To address these challenges, a curriculum-based professional learning (PL) program was developed to enhance teachers' science knowledge, confidence in grade-level content, understanding of student idea development, and ability to incorporate classroom practices that leverage the cultural and linguistic resources of all students. The PL was conducted across eight states, involving 370 K-5 teachers who completed pre- and post-PL surveys. The curriculum-based PL focused on four key elements: Community Building, Lesson Immersion, Classroom Video Analysis, and Unit Storylining, all centered around the instructional materials that teachers would use in their classrooms. Results showed an increase in teacher confidence in using the curriculum but also in creating a classroom culture conducive to collective sense-making. However, participants noted that the PL did not sufficiently address the instructional shifts required by NGSS, suggesting a need for more explicit support. This study provides valuable insights into the design of curriculum-based PL that can effectively support elementary teachers in adopting NGSS-aligned practices while identifying areas for further improvement.

Related Paper Set

Teachers' sensemaking of educative features in OpenSciEd Elementary Curriculum

Kennedy Hay*, Oakland University, USA
María González-Howard*, University of Texas - Austin, USA
Amber Bismack*, Oakland University, USA
Leticia Garza, University of Texas - Austin, USA
Carla Robinson, University of Texas - Austin, USA

ABSTRACT
Educative curriculum materials can shift teachers' understandings and pedagogy, helping them learn about and integrate new practices into their instruction. With the emergence of NGSS-aligned open-source educative curriculum being developed for grades K-5 it is critical to understand how such materials might support teachers in shifting the ways elementary students learn science. Addressing this void, this exploratory study investigated the question: What is the nature of K-5 teachers' sensemaking of educative features within an NGSS-aligned open-source elementary science curriculum? Twenty-two K-5 teachers from across the US were interviewed around their sensemaking of key educative features embedded within the OpenSciEd Elementary curriculum. Findings revealed that teachers used and made sense of the different educative features in varied ways, with some differences existing between the K-2 and 3-5 grade bands. Also, different factors affected teachers' uptake, such as the perceived usefulness and individual classroom and teacher needs. These findings suggest thatteachers' perceptions of different educative features have implications for whether and how they problematized their practice. These findings indicate the importance of valuing and taking up the voices, experiences, and needs of elementary teachers when developing educative curriculum. This can lead to more actionable and generative support for elementary science teaching.

Related Paper Set

Organizational Contexts of the Implementation of New OpenSciEd Elementary Science Instructional Materials

Christa Haverly*, Northwestern University, USA
Jason Buell*, Northwestern University, USA
Yang Zhang, Northwestern University, USA
Yaying Wu, Northwestern University, USA
Brian Reiser, Northwestern University, USA

ABSTRACT

The uptake of new instructional materials will vary for many reasons, including factors both inside and outside of the classroom. This paper seeks to identify organizational contexts that enable or constrain implementation of elementary science curricular materials. With the field test of a set of K-5 science curriculum materials as a constant, we interviewed state, district, and school leaders, as well as classroom teachers, to learn about contextual factors that influence elementary science implementation. We used a framework for understanding organizational contexts to identify where the work of implementation is taking place and potential areas where mixed messages across domains lead to incoherence in the work. The paper describes two school districts where the work of curriculum implementation is largely focused within only one domain. In the third case, the district leveraged multiple domains of work to support implementation. We argue that by leveraging work in multiple domains, the third district is more likely to build coherence across the system that is supportive of the implementation of new curricular materials. This paper demonstrates the importance of designing systems that do not overly rely on a single domain of the framework and/or singleton enthusiastic teachers or school or district leaders.

Fostering Inclusive Praxis Within and Beyond the Science Classroom

Strand 11: Cultural, Social, and Gender Issues
25-Mar-25, 2:30 PM-4:00 PM
Location: Azalea 2

Stand-Alone Paper

Challenges in the study of inclusive science education – Results of a Delphy Study

Lisa Stinken-Rösner*, Bielefeld University, Germany
Jürgen Menthe, University of Hildesheim, Germany
Elizabeth Watts, Bauhaus-Universität Weimar, Germany
Felix Pawlak, Eberhard Karls University of Tübingen, Germany

ABSTRACT

p.p1 {margin: 0.0px 0.0px 0.0px 0.0px; font: 12.0px Helvetica}The study of inclusive science education poses researchers with new challenges andtasks. There is an inherent complexity within this field as it requires an understanding ofscience subject matter and the normative

demands of inclusive pedagogy. A Delphi studywas conducted to systematically survey research challenges that arise in the research ofinclusive science education from the perspective of experts. In the Delphi study,challenges for research on inclusive science education were identified using anexploratory approach in the first round. In the course of the following rounds, a consensuscould be reached for eight challenges (50 % agreement, IQR 1, SD 1.5). Theseincluded challenges from the literature, e.g. a lack of suitable research instruments. Theresults also showed a change or an overcoming of challenges documented in earlierarticles. Alongside the progress made in the research field of inclusive science education,challenges still need to be addressed, such as the discrepancy between existingtheoretical approaches and actual teaching practices. Future research must addressthese issues.

Stand-Alone Paper

'Our ideas were reflected in the stage": Investigating Fictive Kinships in a Community-Based STEM Program

Ti'Era Worsley*, Northern Virginia Community College, USA
Rasheda Likely, Kennesaw State University, USA

ABSTRACT

This study investigates the characteristics of fictive kinship within a community-based informal STEM learning environment. By employing a conceptual framework of Black Love, this study explores how fictive kinship can be nurtured within STEM spaces to humanize and support Black youth. Using participatory design research, the study engages youth in a collaborative design project to construct a stage. Through the development of the stage, the importance of relational dynamics and shared decision-making was centered within the interactions between educators and students. Data sources include focus group interviews, fieldnotes, and student-made artifacts analyzed using a grounded theory approach. The findings reveal that fictive kinship serves as a critical tool for fostering supportive, collaborative environments where power dynamics are reduced, and youth are positioned as knowledge builders. The study underscores the significance of creating STEM spaces that honor the cultural wealth and lived experiences of Black youth, offering a model for more inclusive and equitable STEM education.

Stand-Alone Paper

Seeking Gender Equity in an Out-of-School Computer Science Program

Lydia Burke*, University of Toronto, Canada

ABSTRACT

Computer science has had a long history of equity-related issues, particularly as it relates to the underrepresentation of women and people from low-income backgrounds in higher education and careers. This study used a critical gender-equity framework, in combination with Bronfenbrenner’s (1994) ecological model of human development (adapted be Michell et al. for computer science education) to examine the challenges and affordances of a summer program offered an award-winning charitable organization (GirlTech), that nurtures the computing-related skills of girls and gender non-conforming youth from lower socio-

economic backgrounds. The organizational approach of GirlTech's summer program was analyzed alongside surveys and in-depth interviews with past program attendees. The study revealed how GirlTech's close partnership with e-commerce organizations supported development of both hard and soft skills (i.e., learning coding language alongside networking and developing other job market skills). The benefit of these real-world experiences was tempered by certain program limitations that are also explored in the paper's analysis. The study provides insights into ways that educators can support learners to develop sustained relationships with STEM, irrespective of their career choices.

Stand-Alone Paper

Generating Third Spaces of Science Learning for Urban Middle School Children in Indias Public Schools

Nivedha Sundar*, Indiana University, USA
Gayle Buck, Indiana University, USA

ABSTRACT

The goal of this study is to understand the first and second spaces of science of the urban middle school children in the public schools in the city of Chennai, India in a manner that informs and supports the construction of a third space that may be used to improve science learning for marginalized children in these schools. This study is an initial step in understanding the context, experiences, discourses, and culture of the students through the conceptual framework of the third space. The knowledge generated from this study will be used in designing future research studies focused on enhancing the science learning experiences of children in India's public schools.

Stand-Alone Paper

Empowering Science Praxis: Lessons from Socially Just Science Teacher of Color

KELLYANN RAMDATH*, University at Buffalo, USA

ABSTRACT

This mini-project seeks to pilot interview questions for a larger dissertation study. The larger study seeks to understand empowerment through the perceptions, conceptions and experiences of Science Teachers of Color (ToC) in diverse urban settings. Using qualitative research methods such as interviews, observations and artifactsto center the voices and perspectives of Science ToC. Our group monthly meetings discuss critical incidents of empowerment from teachers' classrooms. These explorations are based on their perspectives from the Dimick (2012) empowerment framework. The inquiry group provides a place for reflection, care, collaboration and understanding of experiences of Science ToC working towards a more socially just science experience for their students and themselves. I aim to understand the question: How do science ToC in a social justice teacher inquiry group conceptualize empowerment and put it into praxis in hyper-diverse classrooms? This mini-project study adds to the literature on empowerment, ToC and social justice praxis in science education. It provides support that the larger dissertation would be important, for the teachers as a place to feel supported, learn and grow. As well as informing science education

research in asset base pedagogy, professional development needs and conceptions of social justice from practitioner perspective.

Venturing Beyond Boundaries to Explore Inclusive Practices in Science Education Across Contexts

Strand 11: Cultural, Social, and Gender Issues
25-Mar-25, 2:30 PM-4:00 PM
Location: Azalea 1

Related Paper Set

Connecting With Values in STEM Education: Integrating Indigenous and Western Learning in K-12 Classroom

Jennifer Jenkins*, Edith Bowen Laboratory School, USA
Breanne Litts*, Utah State University, USA
Melissa Tehee, Utah State University, USA
Darren Parry, University of Utah, USA
Stuart Baggaley, Edith Bowen Laboratory School, USA
Kenden Quayle, Utah State University, USA
James Cawley, Centerstar, USA

ABSTRACT

Issues of (mis)representation of cultures across K-12 education remains a challenge, especially for representations of Indigenous communities. In part, this is due to the reality that most publicly available resources for K-12 education, especially in STEM, are not created by the Indigenous communities whose cultures are being represented. In this paper, we join educators, designers and scholars who are working to expand culturally sustaining/revitalizing learning experiences in K-12 classrooms. As a team of Tribal Knowledge Holders, K-12 Educators, cultural technologists, and university researchers, we created a cultural representation and teaching resources to support respectful stewardship of Indigenous representations in classroom learning, especially in STEM contexts. In this paper, we share our design process of creating a digital interactive narrative experience, Pemmican Experience, and our implementation of this learning experience across two sixth-grade classrooms. Findings provide insights for value-centered pedagogy as an approach to bridge Indigenous and Western knowledge through interdisciplinary and experiential learning. Insights further share how value-centered pedagogy can serve as an anchor for technology-mediated knowledge-sharing in K-12 STEM education contexts. This study provides resources and practices for integrating Indigenous and Western perspectives not only for science educators but also for K-12 educators across disciplines.

Related Paper Set

Community-led curriculum design: Community teacher perspectives on place-based education

Dayna DeFeo, University of Alaska Anchorage, USA

Trang Tran*, University of Alaska Anchorage, USA
Abby Rhinehart, University of Alaska Anchorage, USA

ABSTRACT

In our project, we delved into integrating place-based and local contexts into the curriculum and co-developed science curricula centered on community priorities. Our study adopted a phenomenological case study approach to gather the perspectives of three elementary teachers and seven community members involved in curriculum development. The analysis revealed the initial challenges faced by teachers, such as limited resources and time constraints, as well as how the locally developed curriculum helped them recognize the value of place-based teaching in connecting with the communities, students, and the land. Community members reflected on the importance of place in curriculum design, emphasizing the value of incorporating local knowledge and experiences in educational materials. Overall, the analysis highlights the positive impact of community-led curriculum design on teachers, students, and community members, fostering a more profound sense of belonging, connection, and student agency.

Related Paper Set

Fostering Familial Presence through an Identities-in-Practice Perspective

Wisam Sedawi*, University of Michigan, USA
Angela Calabrese Barton, University of Michigan, USA

ABSTRACT

Supporting familial presence in STEM education requires forging new parent-teacher relationships and hybrid epistemologies to bridge home and school. This study employs the Identities-in-Practice framework to investigate how relationships among mothers, teachers, and students foster emerging epistemologies and new social learning practices. Through participatory critical design ethnographic methods, we collaborated with an urban public-school teacher and four 6th-grade classrooms of immigrant students and families to adapt and implement a STEM curriculum focused on engineering for sustainable communities. Our findings reveal how evolving relationships among mothers, teachers, and students yielded three practices that support familial presence: first, integratingfamilies stories into STEMallowed teachers and mothers to collaborate as allies, incubating new epistemologies, shifting roles between learners and explorers of family capital, creating new educational resources, and adapting the curriculum. Second, the adapted curriculum createdculturally sustaining spacesfor students, providing access to diverse science learning environments and ideas, embodying various epistemologies and identities-in-practice. Lastly, mothers and the teacher, byauthoring new identities, disrupted normative practices, enhancing students learning experiences and fostering their agency. By elevating parental presence, we argue that empowering new identities-in-practice legitimizes participants across various epistemologies in the science class and advances justice in science learning.

Related Paper Set

Graduate Student Mentors' Navigation of Uncertainty in a Field Science Camp

Priyanka Parekh*, Northern Arizona University, USA

Ron Gray*, Northern Arizona University, USA

ABSTRACT
This paper examines the navigation of uncertainties by graduate mentors in a field sciences camp for a diverse undergraduate student group. The study conceptualizes the field camp as a third space in terms of disciplinary and practice domain and location, exploring the mentoring practices in this unique context. The research focuses on the mentorship practices of four graduate students who mentored twenty-three undergraduates during a month-long camp in a remote abandoned ranch in a national forest. The authors conducted a thematic analysis of the post-camp interview transcripts of the graduate students, identifying instances of uncertainty navigation in areas such as balancing academic knowledge and practical skills, incorporating multiple epistemic practices and perspectives—such as Indigenous and Traditional Ecological Knowledge— and ascertaining success in learning and mentoring. The findings highlight graduate student mentors' productive navigation of uncertainty in addressing these challenges. The paper emphasizes the importance of embracing uncertainty, questioning assumptions, and developing critical thinking in educational settings, especially in complex and interdisciplinary environments. The implications of the research contribute to the ongoing discourse on reimagining interdisciplinary equitable science education.

Future STEM Teachers Preparation in the AI Era

Strand 12: Technology for Teaching, Learning, and Research
25-Mar-25, 2:30 PM-4:00 PM
Location: Baltimore 4

Stand-Alone Paper

Preparing in-service science teachers for the AI era: insights from an "AI literacy" academic course

Ron Blonder*, Weizmann Institute of Science, Israel
Mutlu Cukurova, University College London, United Kingdom
Giora Alexandron, Weizmann Institute of Science, Israel

ABSTRACT
This study presents the design, implementation, and evaluation of an "AI literacy" academic course tailored for in-service STEM teachers, utilizing UNESCO's AI Competency Framework for Teachers (AI-CFT). The course, conducted over a semester with a blend of synchronous and asynchronous sessions, aimed to enhance science teachers' understanding and trust in generative AI (GAI) technologies for implementation in their teaching. Through a mixed-methods approach, including quantitative Likert-scale questionnaires and qualitative analysis of teachers' reflections and assignments, we assessed the course's impact on teachers' perceptions, confidence, and pedagogical practices regarding AI. Findings indicate that teachers found the course essential for preparing them for future educational challenges, with many advocating for its mandatory inclusion in professional development

programs. The analysis revealed a significant improvement in reported beeing Knowledgeable about AI and Confident in using it. However,the level of trust was maintained after participating in the course.This research contributes to the growing discourse on AI in education, highlighting the necessity for targeted professional development that aligns with contemporary technological advancements. The insights gained from this course can inform future efforts to enhance teacher PD in AI, ultimately fostering a more informed and capable teaching workforce in the digital age.

Stand-Alone Paper

Exploring Preservice Biology Teachers' Technology-Related Beliefs: A Network Analysis

Sarah Wilken*, University of Münster, Germany
Benedikt Heuckmann, University of Münster, Germany

ABSTRACT

Teachers' beliefs are a crucial factor for successful integration of technology in (science) classes. The prognostic value of beliefs regarding technology integration, or their domain-generic nature, is often the research focus. This is problematic because prior studies have demonstrated that the structure of beliefs (belief system) is profoundly influenced by the specific topic under consideration. A belief system connects beliefs and impact the decision-making processes and the changeability of beliefs, yet it remains relatively understudied. To address this gap, we conducted a three-stage mixed-methods study to investigate preservice biology teachers' domain-generic and domain-specific beliefs. The survey instruments included open-ended questions (n=156), group discussions (n=23), and semi-structured interviews (n=12). These data collection methods were employed to gain comprehensive insights into the complex structure and relationships of beliefs. The data were initially analyzed using open-coding methodology, which identified 17 belief categories. The relationships between these beliefs were then analyzed using a network analysis in R.The findings indicate that preservice biology teachers hold a variety of beliefs regarding technology integration. Furthermore, these beliefs are highly connected, indicating that domain-specific and domain-generic beliefs are strongly interrelated. This finding has implications for future research on beliefs and for the training of science teachers.

Stand-Alone Paper

Exploring Challenges and Solutions in Implementing Computational Thinking in Elementary Science Education for Future Teachers

Yuanhua Wang*, West Virginia University, USA
Ugur Kale, Indiana University, USA

ABSTRACT

Computational thinking (CT) is a vital skill for the 21st century, as it enhances students' problem-solving abilities and digital literacy. It is imperative to prepare preservice teachers (PSTs) to teach CT effectively. Utilizing a Research-Practice Partnerships framework, this qualitative study examines the integration of CT into teacher education by focusing on how elementary PSTs implement CT-infused lessons in their science teaching during their

placements. The analysis identifies: (1) the challenges PSTs face in teaching CT; (2) potential solutions that enable them to overcome these challenges; and (3) the feasibility of implementing these solutions in real classroom settings. Furthermore, the findings offer valuable insights into PSTs' experiences and emphasize the role of collaborative partnerships in enhancing CT instruction, ultimately leading to more effective teaching practices in elementary education.

Stand-Alone Paper

A Longitudinal Investigation of Prompting Strategies among Pre-Service-Chemistry-Teachers in a Course on Generative Artificial Intelligence

Martin Sigot, University of Graz, Austria
Sebastian Tassoti*, University of Graz, Austria

ABSTRACT

The advent of generative artificial intelligence prompts educational researchers to carefully assess science learning experiences using this new technology. In this study, we aim to incorporate basic prompting strategies in students' interactions with generative AI. We developed a course that addresses the use of ChatGPT and instructed the students in a specific prompting technique. Over 5 months, we collected nearly 2000 conversations of students with ChatGPT. The analysis of these prompts shows that students sustainably incorporated the strategies we taught during the semester in their prompting during and also after the semester. Here, we want to present and discuss these results to give tertiary level science educators an idea of how to implement teaching about prompting in their curricula.

Using Digital Tools in STEM Learning

Strand 12: Technology for Teaching, Learning, and Research
25-Mar-25, 2:30 PM-4:00 PM
Location: Baltimore 5

Stand-Alone Paper

Leftovers From COVID-19: Pre-Service Teachers Leveraging Digital Tools to Enhance Science Discourse

Bryan Brown*, Stanford University, USA
Lisa Archuleta*, Stanford University, USA
Polly Diffenbaugh, Stanford University, USA
Brandi Cannon-Force, Stanford University, USA

ABSTRACT

Using "the chat" became an integral part of teaching during COVID instruction. Leveraging Cole's Activity theory which suggests that the tools used in educational environments shape the nature of learning, we explore how new science teachers leverage digital tools. Using a qualitative exploration of teacher's learning we contrasted pre-and post year interview

perspectives on learning. Our results indicated that across the year teachers used digital communications tools to promote engagements, reduce social pressure, and to enhance metacognitive awareness for their students. The results implicate the need to explore how modern technologies shape the language and culture of science classrooms.

Stand-Alone Paper

Design Considerations of an AI-Powered Teacher Dashboard for Science Practical Work

Edwin Chng*, National Institute of Education, Singapore
Bertrand Schneider, Harvard Graduate School of Education, USA

ABSTRACT

With mass teaching, individual teachers find themselves having to monitor the experimental actions of multiple students in a typical science laboratory. However, with suitable computer vision models, teachers can be instructionally supported to manage larger groups of students during practical work. Nevertheless, the approach by which such artificial intelligence (AI) outputs can be delivered has not been investigated considerably. To this end, this research aims to utilize qualitative methods to involve practitioners in the designof an AI-powered teacher dashboard. 17 science teachers of varying years of teaching experience in science laboratories were recruited for this study. Their collective qualitative insights revealed that 1) teachers ought to be presented with germane information that was already pre-processed from raw computer vision outputs so as to increase utilization rate, 2) user choice on how and what information is to be aggregated and presented is a critical dashboard feature, and 3) unambiguous ethical statements and adequate educational steps on the use of the AI-powered dashboard must be included for every teacher user. Ultimately, it is our hope that these uncovered design considerations can lead to the creation of an AI-powered dashboard that is frequently utilized and of pedagogically valuable.

Stand-Alone Paper

Enhancing Mathematical Modeling in Science Education through Simulation-Based Learning Environments.

Benjamin Stöger*, Technical University of Munich, Germany
Claudia Nerdel, Technical University of Munich, Germany

ABSTRACT

The increasing integration of digital tools and visual aids in educationalsettings is notably transforming how complex topics can betaught. Mathematical models, particularly in explaining scientic phenomena,are essential for bridging theoretical concepts with real-worldexperiences. However, the inherent complexity of these models is oftenchallenging for learners. Advancements in technology like interactivesimulations, may oer a more intuitive tool for understanding such complexconcepts. This study investigates the potential of such simulationsto enhance the learning of mathematical modeling in science education.Therefore students were divided into three groups: one working with ananimation, another interacting with a simulation, and the third experienceda simulation with added scaolding features. The research aimedto evaluate which approach most eectively facilitates

learning. By analyzingthe performance across the groups, the study seeks to determinethe extent to which simulations can aid in grasping mathematical modelingin science education and the impact of supplementary scaoldingfeatures on this learning process.

Stand-Alone Paper

Students' learning in a MOOC guided by in-field and out-of-field teachers

Guy Raviv*, Technion - Israel Institute of Technology, Israel
Asnat Zohar, Technion - Israel Institute of Technology, Israel
Shulamit Kapon*, Technion - Israel Institute of Technology, Israel

ABSTRACT

Many countries suffer from a shortage of teachers, and are forced to assign teachers to teach topics for which they do not have sufficient expertise. Studies on students' learning in out-of-field (OOF) teachers' classrooms report that these students tend to have lower levels of dispositions, participation and achievements than students taught by in-field (IF) teachers. To what extent can the Massive Open Online Course (MOOC) revolution contribute to alleviating the OOF teaching problem?We designed a MOOC in kinematics for secondary school students, and an accompanying online professional development course to support the implementing teachers. We present findingsfrom the implementation of three pilot chapters in the 9th grade in 32 classrooms taught by IF and OOF teachers. The analysis employed data mining and learning analytics of the logfiles of the students' work. The findings highlight the critical role of teachers in their students' learning, even when the learned content is fully covered by a MOOC, and show that MOOCs have the potential to improve the quality of instruction in classrooms taught by OOF teachers. However, further research is needed to understand how to better support their implementation, specifically for the instruction of challenging content.

Disciplinary Expertise and Perspectives

Strand 13: History, Philosophy, Sociology, and Nature of Science
25-Mar-25, 2:30 PM-4:00 PM
Location: Camellia 1

Stand-Alone Paper

Cascading Mentorship and Nature of Scientist for a High School STEMM Internship

Bridget Mulvey*, Kent State University, USA

ABSTRACT

High school internships support college and career readiness. This work is a case study of mentoring in a year-long high school science internship in a medical school research group, part of an NSF grant. Informed by nature of scientist and a conceptualization of mentorship as a network of support, considering the assigned faculty mentor as well as the broader research group's contributions. Participants include three high school seniors, three core research group members, and four collaborators. Data included interviews and lab and

meeting observations of interns and medical school personnel, intern monthly blog posts, and intern final presentations at school. Findings include the importance of questions, humor, vulnerability, varied visual and language aids, college/ life advice, and connections to other scientists/opportunities. Varied backgrounds and levels of expertise in the group promoted respect for and interest in the interns' contributions; this has implications for acculturation and nature of scientist. The presentation will share characteristics of the research group members, the high school internship and the interns to support implications of this work for other high school internships and for high school science teaching and learning, as well as the functioning of higher education STEMM research groups.

Stand-Alone Paper

Nature of Science from the Perspectives of Science Practitioners across Different Disciplines

Ceren Soysal*, Middle East Technical University, Turkey
Ceyhan Cigdemoglu, Atılım University, Turkey
Ömer Geban, Middle East Technical University, Turkey

ABSTRACT

This study aims to examine how science practitioners across various fields reflect the nature of science (NOS) in their descriptions of science. Furthermore, we inquiry how their descriptions align with FRA-to-NOS approach. Participants were 14 science practitioners who are faculty members and do their research across various fields. These purposively selected cases were actively working at Turkish universities. Based on the available NOS frameworks, semi-structured interviews including 8 open-ended questions were conducted with these science practitioners who were from applied/pragmatic, social, and natural sciences fields. Findings revealed that the descriptions were closely looked like tenets included in Reconceptualized Family Resemblance Approach to Nature of Science (RFN) framework (88%). Further analysis according to RFN demonstrated that cognitive-epistemic systems were reflected slightly more than social-institutional systems categories by science practitioners. Besides, three more categories: description of science, ethics and junk science, science communication in post-truth era emerged as noteworthy concerns.

Stand-Alone Paper

The Nature of Engineering: Bridging Gaps in Understanding Between Engineering Experts and Pre-service Science Teachers

Tamar Ginzburg, Technion - Israel Institute of Technology, Israel
Miri Barak, Technion - Israel Institute of Technology, Israel
Sibel Erduran, University of Oxford, United Kingdom

ABSTRACT

Science education has become broader and more interdisciplinary, expecting teachers to integrate engineering concepts and practices. However, the complexity of engineering, combined with a lack of appropriate background and training programs, are serious barriers. Recognizing the role of pre-service teachers (PSTs) in curriculum implementation, it is important to equip them with an expert-like understanding of the nature of engineering

(NOE). Hence, the goal of our study was to examine potential gaps in NOE understanding between engineering education experts and PSTs and to provide cognitive-epistemic and social-institutional heuristics for bridging the gap. The study utilized the Family Resemblance Approach (FRA) as a theoretical and methodological framework. Applying the dual-analytic approach, data were collected through semi-structured interviews among seventeen engineering education experts and forty-three PSTs who answered open-ended questions. Findings show that the NOE understanding by experts consists of social-institutional attributes with embedded practices that involve collaboration, ethical considerations, and societal impact that reflect the integrated and interdisciplinary nature of engineering. In contrast, the NOE understanding of PSTs incorporates more fundamental aspects, focusing on aims and methods, while overlooking societal impact. Utilizing the FRA, we propose heuristics for supporting PSTs to achieve a better understanding of the NOE.

Stand-Alone Paper

Epistemological Beliefs about the Nature of Science of University Professors in Physics Teacher Education

Gabriela Ferreira*, University of Santa Catarina, Brazil
Dana Zeidler, University of South Florida, USA

ABSTRACT

Discussing aspects of thenatureof science(NOS)is fundamental in teachers' education. Teachers' epistemological beliefs about NOS can influence their conceptualizations in terms of how they frame classroom pedagogical practices, especially when it connects to how their students come to learn and knowabout theactivity of science. In Physics, epistemological beliefs are quite traditional and stable and can be used to help characterize the conceptions of university professorsabout theNOS. This study aimed to investigate and characterize the epistemological beliefs of university professors' conceptualizationsabout theNOS and its influence of pedagogical practice in the context of teaching Physics undergraduate courses. We interviewed 20 university professors from Brazil. We analyzed their beliefs about NOS, NOS learning by undergraduates' students, NOS teaching and its influence onpedagogicalpractice. Wehighlithedthe importanceandchallenges in teaching and learning NOSin Physics teachers' education.

Exploring How Embedding Indigenous Knowledge and Practices into STEM Education Promotes Health and Well-Being

Strand 14: Environmental Education and Sustainability
25-Mar-25, 2:30 PM-4:00 PM
Location: Woodrow Wilson Ballroom

Symposium

Exploring How Embedding Indigenous Knowledge and Practices into STEM Education Promotes Health and Well-Being

Julie Robinson*, University of North Dakota, USA

David Owens*, Georgia Southern University, USA
Lama Jaber*, Florida State University, USA
Sarah Voss*, Western Washington University, USA
Pauline Chinn*, University of Hawaii at Manoa, USA
Nichole Chlebek*, Florida International University, USA
Jadda Miller, UC Davis, USA
Franklin Aucapina*, New York Hall of Science, USA
Rebekah Hammack, Purdue University, USA
Bhaskar Upadhyay, University of Minnesota, USA

ABSTRACT
Tuning policy, innovations, and education to locally-funded and Indigenous knowledge systems has the potential to not only benefit culturally-sustaining practices within discourse and learning environments for the benefit of Indigenous communities, but can serve to both monitor and mitigate threats to human and environmental health to better support a more sustainable future. Such initiatives center the importance of coordinating with local Knowledge Keepers to better define solutions within the local context that generate collective understanding and responsibility built on cultural knowledge and activities. Fostering a sense of stewardship and responsibility for community health begins with education at all levels – throughout K – 12, in higher education, within teacher education, and through community engagement. The focus of this proposed symposium will be to share the many ways that researchers, educators, and community members are reframing and reforming STEM education to embed Indigenous knowledge not just for improved educational outcomes for all learners but for enhanced community, physical, mental, and environmental health as well. Presentations in this symposium will highlight projects from diverse cultures, regions of the world, and science education contexts that embed collaboration with local communities and build from Indigenous Knowledge in ways that impact education and well-being on various levels.

Integrating Strategies

Strand 14: Environmental Education and Sustainability
25-Mar-25, 2:30 PM-4:00 PM
Location: Baltimore 2

Stand-Alone Paper

Integrating Ethics and Values into Middle School Science: Adaptation and Implementation in a Rural School

Zhen Xu, University of North Carolina at Chapel Hill, USA
Rebecca Lesnefsky*, University of North Carolina at Chapel Hill, USA
Troy Sadler, University of North Carolina at Chapel Hill, USA
David Fortus, The Weizmann Institute of Science, Israel
Heewoo Lee,University of North Carolina at Chapel Hill, USA
Nannan Fan, University of North Carolina at Chapel Hill, USA

Keren Dalyot, The Weizmann Institute of Science, Israel
Shira Passentin, The Weizmann Institute of Science, Israel
Natasha Segal, The Weizmann Institute of Science, Israel

ABSTRACT
This proposal introduces the integration of values and ethics education within the Grand Challenges (GC) middle school science curriculum. The GC approach, centered on complex socioenvironmental issues, serves as the foundation for introducing ethics and values education into science learning, with the aim to cultivate a profound comprehension of the interplay between human actions and environmental impacts. We explain how design of the curriculum integrates values and ethics education. Special attention is given to the curriculum adaptation to rural settings, acknowledging the insights, strategies, and frameworks that are potentially unique to science education in rural environments. We provide insights to guide similar initiatives, demonstrating how a theoretically grounded, design-led approach informs successful curriculum adaptations in diverse educational landscapes.

Stand-Alone Paper

Garden-based STEAM Learning and Childrens Self-efficacy for Environmental Action and Attitudes and Knowledge About Pollinators

Kathy Trundle*, Utah State University, USA
Rita Hagevik, University of North Carolina Pembroke, USA
Katherine Vela, Utah State University, USA
Lawrence Krissek, The Ohio State University, USA
Kaitlin Campbell,University of North Carolina Pembroke, USA
William Boone, Miami University, USA
Aurora Villa, Utah State University, USA

ABSTRACT
This study explored the impact of agarden-based learning curriculum on elementary children's (n = 96) knowledge of bees, attitudes about nature and bees, and their self-efficacy toward environmental action and pollinator conservation.The summer camp intervention included an integrated STEAM curriculum that focused on pollinators, pollen, plants, soils, composting, conservation, biodiversity, and sustainability. We conducted pairwise correlation analyses to determine the relationship between the variables. Paired samples t-tests were performed to examine the changes in students' knowledge of bees, self-efficacy toward environmental action and pollinator conservation, and attitudes toward nature after engaging in the camp. We performed a series of repeated measures ANOVA with the duration of participation as a between factor (first-time vs second-time participants) and time (pre- and post-test) as a within factor. We used SPSS version 28.Results indicated that knowledge of bees, self-efficacy toward environmental action, attitudes toward nature, and attitudes toward bees significantly improved pre/post camp.These results showed that engaging students in an integrated STEAM, garden-based curriculum, even for one week, increased confidence in protecting our environment. Increasing knowledge about pollinators

and confidence in protecting our environment should be a priority in order to prepare our children for a more sustainable future.

Stand-Alone Paper

Usable STEM: Student Outcomes Associated with The Iterative Science and Engineering Instructional Model

Nancy Songer*, University of Utah, USA
Julia Calabrese, University of Utah, USA
Holly Cordner, University of Utah, USA

ABSTRACT

While our world consistently presents complicated, interdisciplinary problems with STEM foundations, most K-12 curricula do not encourage fluid and iterative STEM problem solving. We developed the Iterative Science and Engineering (ISE) instructional model that cycles through scientific investigation and engineering design, solving a local environmental challenge. Next, we created a six-week ISE curriculum culminating in 6-9th grade students building traps to mitigate local invasive insect populations. We evaluated student outcomes over three design-based research (DBR) cycles. We analyzed identical pre and post-test data from 554 adolescents to address the research question:what three-dimensional (3D) science and engineering knowledge do adolescents demonstrate over three DBR cycles associated with a curricular program following the Iterative Science and Engineering instructional approach?Results document students' significant statistical improvements, with differential outcomes in different cycles. For example, students demonstrated significant learning of 3D science and engineering argument construction in all cycles—still, students only significantly improved engineering design when they created a second solution. Results support the view that the systematic iteration of scientific investigation and engineering design, which build productively on each other, fosters three-dimensional science and engineering knowledge and supports students' creation of solutions to address interdisciplinary science and engineering challenges.

Stand-Alone Paper

Nature's Mirror: Exploring Youths' Sense of Belonging in Social-Ecological Systems

Elizabeth Diaz-Clark, Colorado State University, USA
Anna Lavoie, Colorado State University, USA
Sara Bombaci, Colorado State University, USA
Meena Balgopal*, Colorado State University, USA

ABSTRACT

Outdoor and environmental education programs can foster a sense of belonging for people of color (POC) in wildlife conservation and other environmental fields. We describe a 3-day immersive program for POC youth the emphasized identity as the youth learned about biodiversity studies. Drawing on multiple sources of data (surveys, field observations, daily reflections, focus group, and interviews) in our grounded theory study, we describe how youth's sense of belonging shaped their conservation identity. Initially they described being small and overlooked, but their perceptions transformed into small and essential, and

eventually into small and mighty – making connections with small organisms that they studied during the program. They decided they could pursue conservation science if they want to. We posit that having program leaders who were POC women in environmental sciences and who shared personal stories of feeling marginalized is one explanation the youth felt empowered after the program.

A showcase of research In Praise of Science Teachers funded by the US National Science Foundation: Roundtable discussions

25-Mar-25, 4:15 PM-5:45 PM
Location: Woodrow Wilson Ballroom

Administrative Session

Melissa Luna, National Science Foundation, USA
Ravit Duncan, The Ritgers University, USA

ABSTRACT

This session will engage the NARST community in small group discussions with research team members of 35 projects funded by the US National Science Foundation that involve teachers and educators as essential partners in the work. Each discussion showcases 2-3 NSF-funded projects aligned to one of the NARST strands or special Research Interest Groups. Discussions will highlight teachers' (writ large) contributions towards researching, reframing, and reforming science teaching and learning across contexts and across the lifespan.

Table 1: Christine Lotter, DeNae Kizys, Ryan Summers, Debra Bernstein
Table 2: Pamela Lottero-Perdue, Lama Jaber, Allison Metcalf, Josie Melton, Sarah Voss
Table 3: Winter Allen, Sanjay Rebello
Table 4: Jamie Mikeska, Alan Berkowitz, Miray Tekkumru Kisa
Table 5: Arif Rachmatullah, Sherry Southerland, Patrick Enderle, Sierra Morandi, Nancy Holincheck
Table 6: Kelli Paul, Savannah Graham Hayes
Table 7: Pauline Chinn, Aditi Wagh, Michael Cassidy
Table 8: Kimberly Jones, Alison Miller, Troy Sadler
Table 9: Kevin Haudek, Leonora Kaldaras, Jill Wertheim, Rachel Henderson, Anita Schuchardt
Table 10: Carla McAuliffe, Donna Governor, Lorraine Ramirez Villarin, Chantelle Renaud-Grant, Carla McAuliffe, Gregor Benz
Table 11: Tamar Fuhrman, Troy Sadler, Ravit Duncan, Jinzhi Zhou

---

Education for Sustainable Development in the context of Indigenous Knowledge Systems and contextual environments: Cases across Southern Africa and the United States of America

25-Mar-25, 4:15 PM-5:45 PM
Location: Azalea 3

Administrative Session

Million Chauraya, Midland State University, Zimbabwe
Angela James, University of KwaZulu-Natal, South Africa
Frackson Mumba, University of Virginia, Charlottesville, USA
Leonard Molefe, University of KwaZulu-Natal, South Africa
Nobuhle Mbanjwa,University of KwaZulu-Natal, South Africa
Martha Bishai, Umkhumbane Schools Project, Durban, South Africa
Julie Luft, University of Georgia, Athens, USA

ABSTRACT

Education for Sustainable Development (ESD) involves integrating Indigenous Knowledge Systems (IKS) and practices with modern educational frameworks, to promote sustainability. In considering contextual environments, it is the diverse cultures and communities each with their unique traditions and knowledge systems used for sustainable development to manage natural resources, agriculture and community well-being. Curriculum development that incorporates IKS into schooling and Higher Education Institutions engage learners and students in learning, appreciating and applying sustainable practices rooted in their cultural heritage. Furthermore, in promoting biodiversity, enhancing cultural pride, a sense of responsibility towards the environment, is fostered. In unpacking development, which has an esoteric, transient, western perspective, current use is inclusive of social justice, cultural diversity, and sustainability. So, how are current paradigms of development and sustainability challenged to be inclusive, equitable, and respectful of IKS and contextual environments? Research presented in the SAARMSTE conferences that address these aspects and related research studies are presented and discussed in this symposium, in a conversational manner, raising questions about the opportunities and possibilities for curriculum transformation.

National Academies of Sciences, Engineering, and Medicine Report on K-12 STEM Education and Workforce Development in Rural Areas

25-Mar-25, 4:15 PM-5:45 PM
Location: Baltimore 4

Administrative Session

Rebekah Hammack, Purdue University, USA
Beth Cady, National Academies of Science Engineering and Medicine, USA
Rebekah Hammack, Purdue University, USA
Guan Saw, Claremont Graduate University, USA
John McNamara, Washington State University, USA

ABSTRACT
In December, 2024, the National Academies of Sciences, Engineering, and Medicine released a report on K-12 STEM Education and Workforce Development in Rural Areas. Mandated through the CHIPS+Science Act and funded by the National Science Foundation, the authoring committee took stock of existing federal programs that support rural K-12 STEM education and workforce development, assessed the relevant research base, and developed recommendations for federal, state, and local action to improve access to quality STEM education and careers for all students in rural areas. This session will present the report's major conclusions and recommendations and will provide time for audience discussion.

Uncertainty in Science Education: Shaping a Research Agenda for an Emerging Field

Strand 2: Science Learning: Contexts, Characteristics and Interactions
25-Mar-25, 4:15 PM-5:45 PM
Location: Annapolis 2

Symposium

Uncertainty in Science Education: Shaping a Research Agenda for an Emerging Field

Marcus Kubsch*, Freie Universität Berlin, Germany
Hannah Kolbe, Freie Universität Berlin, Germany
Simon Tautz, IPN, Germany
Eugene Cox, University of Illinois Urbana-Champaign, USA
Engin Kardas, Karlsruhe University of Education, Germany
Ying-Chih Chen, Arizona State University, USA
Eve Manz, Boston University, USA
Isa Korfmacher, University of Münster, Germany
Simon Blauza, University of Münster, Germany
Amanda Garner, University of Tennessee, USA

ABSTRACT
Uncertainty is an integral part of scientific inquiry, encompassing various forms such as epistemic uncertainty, measurement uncertainty, and the unpredictability inherent in certain phenomena like evolution. These different types of uncertainty pose significant challenges in science education, particularly in an era marked by misinformation and science denial. Enabling students to engage with and effectively navigate these uncertainties is crucial for fostering scientific literacy. However, this engagement is complex, as it requires students to grasp difficult concepts such as probability, while also challenging their beliefs about the nature of knowledge.Recent literature emphasizes the importance of addressing these challenges in science education. Scholars argue that when students participate in scientific practices—such as evaluating evidence and debating models—they develop the ability to manage uncertainty productively. However, achieving this requires careful

instructional support, as both the conceptual demands and students' epistemic beliefs must be addressed. In response to these educational needs, there has been a growing interest in research focused on uncertainty in science education. This symposium aims to consolidate the emerging knowledge in this field, fostering dialogue among researchers across countries and from diverse disciplinary backgrounds to advance both understanding and practice in navigating uncertainty within science education.

Collaborative and Interdisciplinary Approaches to Facilitating Elementary Science Teacher Professional Development

Strand 3: Science Teaching — Primary School (Grades preK-6): Characteristics and Strategies
25-Mar-25, 4:15 PM-5:45 PM
Location: Camellia 2

Stand-Alone Paper

Citizen Science supports for elementary school teachers: Connecting science across disciplines

Sarah Carrier*, North Carolina State University, USA
Danielle Scharen*, Horizon Research, Inc., USA
Patrick Smith*, Horizon Research, Inc., USA
Christine Goforth, North Carolina Museum of Natural Sciences, USA
Meredith Hayes, Horizon Research, Inc., USA

ABSTRACT

Elementary school teachers face many challenges preparing students in science, and examinations of truly integrated STEM preparation reveal the complexities of connecting areas of science with other disciplines. The marginalization of science in elementary classrooms includes limited instructional time for science and instructional materials, including curriculum. Some teachers have attempted to enrich their science instruction by introducing students to citizen science (CS) projects. CS can build student (and teacher) knowledge of science content and practices, while also expanding project data to include data collected by non-professional scientists While supplementing science instruction with CS offers potential to introduce students to the work of scientists, teachers still face the challenge of limited instructional time for science. One strategy teachers use is infusing science with other disciplines, but many teachers struggle with true integration and interdisciplinary instruction. In this presentation, we share research that examines our development of instructional support materials (and share materials) for two CS projects. This convergent mixed methods study documents teacher's views and enactment making interdisciplinary connections of science across disciplines.

Stand-Alone Paper

The Influence of Place-Based Education on Elementary Teachers' Sense of Agency for Science Instruction

Alison Mercier, University of Wyoming, USA
Anica Miller-Rushing*, Associated Universities Inc., USA

ABSTRACT

This study explores the influence of place-based education (PBE) on elementary teachers' sense of agency for science instruction. Teacher agency in science education encompasses the ability to make informed decisions and adapt teaching practices to better meet students' needs, often challenging existing educational structures. The study is designed as a case study involving three rural elementary teachers who integrated PBE into their classrooms, which resulted in enhanced teacher agency for science instruction. Through thematic analysis of interview data, the study found that PBE not only nurtured teachers' science teacher identity but also inspired transformative changes in their instructional practices. These findings suggest that PBE can significantly empower teachers, enabling them to create more meaningful and contextually relevant science learning experiences. This research contributes to understanding how PBE can support teacher development and highlights its potential to promote equity and student-centered learning in science education.

Stand-Alone Paper

An Environmental Center and Elementary School Partnership: A Cross-Case Analysis of Two Fifth Grade Teachers

Rachel Stronach*, University of Massachusetts Dartmouth, USA
Hamza Malik, Lloyd Center for the Environment, USA
Stephen Witzig, University of Massachusetts Dartmouth, USA

ABSTRACT

Partnerships with informal science learning organizations are a promising mode for enriching, expanding, and improving science education (Hartman Hines-Bergmeier, 2021; McCann et al., 2016; NRC, 2009; Weiland Akerson, 2013). This qualitative case study utilizes Lave Wenger's (1991) Community of Practice approach to understand the experiences of two fifth grade teachers in a long-standing (over 20 years) elementary science partnership program between a non-profit environmental research and education organization and a local public school district. The partnership centers on a multi-encounter "Coastal Watershed Watch" (CWW, pseudonym) program. The longevity of the partnership program offered a unique opportunity to examine how teachers describe their experiences over time. Teachers described the CWW partnership program as useful in their science teaching, in their students' science learning, in making a connection to place (both community and the natural environment), and in providing access to environmental experiences. This study sheds light on the possible connections to a sense of place and access to environmental experiences when local resources are engaged, committed, and a substantial partnership forms. This study adds to the literature on educational partnerships that happen in an interformal context (Authors, 2023) by highlighting the possible benefits to teachers, students, and communities.

Stand-Alone Paper

Making Space in Elementary Science Instruction: Fostering Math and Science Achievement Through Curriculum Professional Learning

Kristin Gagnier, AnLar, USA
Kelly Fisher, AnLar, USA
Steven Holochwost, CUNY, USA
Manda Harvey, Prince George's County Public Schools, USA

ABSTRACT

Improving achievement in Science, Technology, Engineering, and Mathematics (STEM) is essential for elevating individual success and solving societal challenges. An untapped avenue lies in developingspatial skillsas research has shown that having good spatial skills leads to success in STEM courses and careers, and improving skills leads to improved STEM performance. Our team partnered with a large, urban school district to evaluate a never-before-tested approach to developing spatial thinking skills in elementary-agedstudentsand theirteachers. The district serves predominantly students who are historically underrepresented in STEM. Together with the district's curriculum development team, we created a "spatially enhanced (SE)" science curriculum for 3rd-grade. This SE curriculum incorporated five spatial tools (spatial language, gesture, spatial comparison, sketching, and visualizations) into teachers' pedagogy and materials, and student activities throughout the academic year. Outcomes in the SE curriculum were compared to two control curricula. We will present data illustrating that spatially enhancing the science curriculum is a viable method for building students' and teachers' spatial thinking skills and improving their academic achievement in science and math. Discussion will focus on the generalizability of spatially enhancing curricula for improving academic achievement in STEM and as a potential lever for reducing achievement gaps.

Articulating Different Conceptualizations and Methodological Approaches for Studying Justice-centered Science Teaching in Various Contexts

Strand 4: Science Teaching — Middle and High School (Grades 5-12): Characteristics and Strategies
25-Mar-25, 4:15 PM-5:45 PM
Location: Magnolia 1

Symposium

Articulating Different Conceptualizations and Methodological Approaches for Studying Justice-centered Science Teaching in Various Contexts

Natalie Davis, University of Michigan, USA
Maria Varelas, University of Ilinois Chicago, USA
Angela Calabrese Barton, University of Michigan, USA
Wisam Sedawi, University of Michigan, USA
Edna Tan*, University of North Carolina at Greensboro, USA
Christopher Wright, Drexel University, USA

Hosun Kang, University of California Irvine, USA
Daniel Morales Doyle, Univeristy of Ilinois Chicago, USA
Monet Harbison, Drexel University, USA

ABSTRACT
This session seeks to articulate the different conceptualizations and methodological approaches for studying justice-centered science teaching in various contexts. Over the past few years, there have been increasing efforts to bring justice at the center of science education by researchers, practitioners, and policy-makers. Scholars recognize substantial variations in the conceptions of equity, justice and justice-centered teaching. To further advance the knowledge base, in this symposium, we center contexts to explore the variations. We bring together seven researchers who have been working in solidarity with teachers, students, parents, and/or community members in various contexts–from elementary to high school, from historically disenfranchised urban communities to middle-class privileged communities, from addressing science ideas (e.g., energy) to climate change and environmental justice. This symposium directly responds to this year's theme, 'In Praise of Science Teachers: Essential Partners in Researching, Reframing and Reforming Science Learning' by highlighting deep partnering activities with science teachers for dreaming and co-designing new possibilities of learning towards social transformation.

Fostering Equity and Engagement in Undergraduate STEM Education

Strand 5: College Science Teaching and Learning (Grades 13-20)
25-Mar-25, 4:15 PM-5:45 PM
Location: Magnolia 3

Stand-Alone Paper

STEM Engagement Program as Resource for First-Generation College Students Authoring Pathways and Practices in Science

Stacy Olitsky*, Saint Joseph's University, USA

ABSTRACT
Studies have shown obstacles to recruitment and retention in science majors for first-generation (FG) college students. One area for inquiry is exploring aspects of support and engagement programs that extend beyond acclimation towards the creation of spaces in which first-generation college students can author their own pathways and shape university science climates. This four-year qualitative study of the experiences of two FG college students in a STEM support program explores how the students drew on program resources in order to develop science identities. Findings indicate benefits of a cohort model focused on diverse identities in science, distributed mentoring, and faculty members making visible the "backstage" of becoming a scientist. The students drew on opportunities in order to center personal and community-oriented goals, including working on food production and environmental conservation. Further, the students perceived, then perpetuated, a climate of networking and support, leading to hybridity that encompassed views of science as

challenging along with views of science communities as collaborative and supportive. This study suggests that through programming that includes effective counterspaces, students can expand their roles, develop a sense of membership in science communities of practice, and have an influence on the culture of science in their university settings.

Stand-Alone Paper

Examining undergraduate experiences with "servingness" in service-learning outreach to pre-college computer science and engineering classrooms

Azizi Penn, Purdue, USA
Tamara Moore*, Purdue, USA
Kerrie Douglas, Purdue, USA

ABSTRACT

The goal of extending computer science instruction to all pre-college students is falling short, especially for urban and small schools. Minority-serving universities can aid pre-college classrooms by having undergraduate students support teachers in delivering computer science instruction through service learning. However, we must investigate whether this type of service-learning program can "truly serve" the undergraduate students who participate. This study focuses on an evolving pilot of a semester-long service-learning program. The undergraduate students serve in pre-college classrooms and guide middle-school student teams through utilizing physical computing and engineering design with arts integration to create and build an artifact. We investigate if this service-learning program meets the call for "truly serving" minoritized undergraduate students at MSIs, HSIs, and postsecondary institutions that wish to serve minoritized groups. We performed a phenomenological study of undergraduate students who participated in the mentorship service-learning pilot at an HSI university during two semesters. We investigate how students' experiences meet the outcomes of The Multidimensional Conceptual Framework for Understanding "Servingness" at HSIs and the Prism Effect of Service Learning (PESL). We align the desired student outcomes of both models in student experiences to show how universities can serve both undergraduate and pre-college students through mentorship-style service learning.

Stand-Alone Paper

Finding Evolution in Our Everyday Lives: Impact of an Expectancy Value Theory Intervention

Lisa Borgerding*, Kent State University, USA
Hannah Petrosky, Kent State University, USA
Mark Kershner, Kent State University, USA

ABSTRACT

Many evolution learners do not find evolutionary content relevant and meaningful to their own lives. This lack of relevance can reduce engagement in evolution learning. In this study, and intervention aligned with the Expectancy Value Theory was developed to help learners identify examples of evolution in their daily lives. Using a mixed methods research approach, pre-post quantitative evolution relevance survey data were compared before and after an Expectancy Value Theory intervention in eight college biology classes. Qualitative open-

ended written post-reflections about the experience of completing or not completing the intervention were used to explain the quantitative findings. Results indicate that participating in the intervention increased participants' perceptions of the relevance of evolution, increased their evolutionary attitudes and literacy, and did not change their evolution acceptance. Qualitative findings indicate that students found the intervention to be mostly easy, enjoyable, and interesting. Intervention completers indicated that the task helped them to see the relevance of evolution in their everyday lives as well as learning more about various aspects of evolution in particular. Implications for future implementations and research about motivation to learn science content are provided.

Stand-Alone Paper

Questing for Relevance: Exploring Student Outcomes from Creative Assessment "Quests" in General Education Biology

Emily Walter*, California State University, Fresno, USA
Neha Mann*, California State University, Fresno, USA
Berenice Mendoza-Alcaraz*, California State University, Fresno, USA

ABSTRACT

This study examines the outcomes of implementing creative, experiential mini-projects, called "Quests," in a General Education (GE) biology course at a large public university. The quests, designed to enhance student engagement and learning, allowed students to choose from a variety of activities, such as outdoor observations, creative arts, and community-based projects, to explore scientific issues. We analyzed1422 student reflections using AI-assisted qualitative coding grounded in Experiential Learning Theory (ELT) and Reflective Practice from four semesters of data from fall 2020, spring 2021, fall 2021, and fall 2023. The findings reveal that the Quests significantly boosted emotional engagement, with a majority of students reporting positive feelings such as enjoyment, excitement, and curiosity. Additionally, the Quests promoted reflective practices and deepened scientific knowledge, with distinct cognitive and emotional responses observed across different types of activities. This study demonstrates that experiential learning can be effectively scaled in large GE courses, offering a viable approach to addressing the common challenges of disengagement and superficial learning in such settings. The results underscore the potential of creative assessments to not only improve scientific literacy but also to bridge the gap between science education and public engagement, thereby contributing to broader societal goals.

Supporting Informal Science Educators and Learners

Strand 6: Science Learning in Informal Contexts
25-Mar-25, 4:15 PM-5:45 PM
Location: Magnolia 2

Stand-Alone Paper

How Educators Foster Learners' Interests, Self-Efficacy, and Outcome Expectations in an AI and Paleontology Camp

Christine Wusylko*, University of Florida, USA
Tonika Jones, University of Florida, USA
Ray Opoku, University of Florida, USA
Gabriella Haire, University of Florida, USA
Chih Hsuan Lin, University of Florida, USA
Nazanin Adhami, University of Florida, USA
Bruce McFadden, University of Florida, USA
Victor Perez, St. Mary's College of Maryland, USA
Brian Abramowitz, University of Florida, USA
Pavlo Antonenko, University of Florida, USA

ABSTRACT

As informal learning opportunities in AI continue to be rapidly developed and implemented, it is essential that we keep pace with practice and explore empirically how to best support learners in these programs. This is especially important for programs which support young learners with backgrounds currently underrepresented in STEM. Educators have long been cited as one of the most important roles in informal education, and in this qualitative study we utilize Social Cognitive Career Theory as a lens to explore how educators in an AI and paleontology summer camp foster Black adolescent learner's interests, self-efficacy, and outcome expectations regarding AI and science. Through interviews and observations, we found that learners' interest in AI appeared to be high and increased during the camp, that social interactions and vicarious experiences fostered through educator feedback and modeling were the most impactful for learners, and that high outcome expectations were also supported by educators. Contrary to other work which champion the role of mastery experiences, we found that perceived social interaction and vicarious learning experiences were most impactful for learners in our context. Further, our paper supports the importance of the role of the educator to learner's perceptions of self-efficacy and outcome expectations.

Stand-Alone Paper

Supporting STEM identity development in Hispanic community college students via an informal science education internship

James Kisiel*, California State University Long Beach, USA

ABSTRACT

This study examines the impacts of a community college and informal science institution collaboration featuring paid internships for underrepresented students interested in pursuing a STEM major and career. Students were trained as informal educators and over the

course of 26 weeks, engaged with school and family audiences a local space center, facilitating hands-on activities, and assisting with other related activities.Post-internship interviews with 18 students following the completion of the internship were examined to better understand potential program benefits.Using a science (STEM) identity framework (Carlone and Johnson, 2007), qualitative analysis revealed how the experience supported identity development or 'identity work' (Rounds, 2010) related to being a 'science person.'Data revealed that internship activities supported identity development along two dimensions—performance andrecognition. By taking on the role of informal science educators, the college students were able to strengthen their STEM identity through their engagement with visitors and interactions with peers and other staff members. In addition, interns identified several aspects of their teaching experience that were deemed valuable to these future STEM professionals. This unique collaboration shows promise for recruiting and supporting minoritized students with interests in STEM and STEM careers through identity work as informal science educators.

Stand-Alone Paper

Motivation And Barriers of Pre-Service Science Teachers About Outdoor Education

Soykan Sandıkçıoğlu*, Middle East Technical University, Turkey
Özgül Yılmaz Tüzün, Middle East Technical University, Turkey

ABSTRACT

The purpose of the present study was to investigate pre-service science teachers' (PST) motivation and barriers about outdoor education (OE). 181 pre-service science teachers participated in Turkey in the study. The survey research design was used, and the survey included closed-ended and open-ended questions. Data were collected by using the "Outdoor Setting Questionnaire," which was developed by Ernst and Tornabene (2012). Data were analyzed by using quantitative and qualitative analysis methods. The responses to open-ended questions were analyzed qualitatively first, and then the data were transformed into quantitative data. Descriptive statistics analysis showed tendencies of PST' motivation and barriers about OE. While major barriers were lack of parental support and problems caused by parents, difficulties in providing transportation, and arising safety concerns, the most frequent motivations were found as attaining hands-on learning, gaining physical/health benefits, and reaching variety of materials found in the nature.

Stand-Alone Paper

Unseen/Unsupported: Investigating Work Experiences of Informal Science Educators in Part-Time, Seasonal, and Temporary Roles

K. "Ren" Mendoza*, University of Nebraska at Omaha, USA
Emma Refvem, Durham Public Schools, United Kingdom
Mahima Saxena, University of Nebraska at Omaha, USA
Thomas Beatman, Omaha's Henry Doorly Zoo and Aquarium, USA
Maddie Lichti, University of Nebraska at Omaha, USA

ABSTRACT
This research examines the work experiences of a largely overlooked group of informal science educators (ISEs)—those who take on part-time, seasonal, or temporary employment. Through qualitative interviews, we explored how these educators perceive their science and educator identities, professional roles, and work within the context of the gig economy. Our findings reveal that this subset of educators faces unique challenges, including limited training, professional support, and opportunities for meaningful public engagement, despite having significant face time with visitors.The study highlights the potential for early-career education roles in science-rich cultural institutions to serve as pathways to STEM careers. However, it also underscores the need for greater investment in the professional development of gig workers in informal science education. Many of these educators expressed concerns about low pay, limited opportunities for advancement, and the lack of meaningful engagement in their roles, which affects job satisfaction and sustainability. We argue that the underrepresentation of these educators in research results in an incomplete understanding of the field. This study calls for more inclusive research that considers the distinct experiences of part-time, seasonal, and temporary workers, addressing these gaps to enhance the professionalization and well-being of all informal science educators.

Advancing Competencies and Reasoning in Preservice Science Teachers

Strand 7: Pre-service Science Teacher Education
25-Mar-25, 4:15 PM-5:45 PM
Location: Baltimore 1

Stand-Alone Paper

Decision-making competence of pre-service teachers regarding health-related dilemmas: an interview study on a competence model

Helena Aptyka*, University of Cologne, Cologne, Germany, Germany
Marleen Proksch, University of Cologne, Cologne, Germany, Germany
Jörg Großschedl, University of Cologne, Cologne, Germany, Germany
Kirsten Schlüter, University of Cologne, Cologne, Germany, Germany

ABSTRACT
Decision-making competence is essential in teacher education, particularly in health education, where scientific perspectives intersect with norms and values. However, pre-service biology teachers often feel unprepared to engage in or effectively teach decision-making, especially in health contexts. This unpreparedness is attributed to training programs that focus on theoretical models with limited structured support and practical training. This study conducted semi-structured interviews with nine pre-service biology teachers to assess their understanding of decision-making and their readiness to teach this competence. The research also evaluated their decision-making competence with and without the WAAGE model, a structured framework for ethical decision-making. Findings reveal significant misunderstandings of decision-making, with most participants confusing it with performance assessments. Also, they feel unprepared to teach decision-making due to

lacking practical experience. The WAAGE model improved the structuring and differentiation of decision-making processes, with participants formulating alternative actions and constructing arguments. Nearly 89% of respondents found the WAAGE model effective and applicable, but challenges in practical implementation persist. The study highlights the need for reform in teacher education to strengthen decision-making competencies and calls for further interdisciplinary research on the WAAGE model to promote informed, value-based decision-making in education, thereby advancing science literacy.

Stand-Alone Paper

How can students distribute epistemic agency? Looking at regulative agency to better understand students' positions.

Carolina Barros*, Interunit Graduate Program in Sciences Teaching – University of São Paulo, Brazil
Maíra Batistoni e Silva, Physiology Department, Bioscience Institute of University of São Paulo, Brazil

ABSTRACT

This work aims to understand which aspects of regulative agency contribute to the distribution of epistemic agency when students are working on an open-ended problem, as it is known as a context when agency opportunities are available to students. We situate our research in ethnography in education, applying ethnographic principles and participant observation to construct our data in a higher education discipline on Nature of Science. We could observe that regulative agency opens space for the distribution of epistemic agency, through actions such as creating a joint plan of action and monitoring object advancement, favoring a more complex object of knowledge after collective interactions. We believe that regulative agency is an important concept for understanding the distribution of epistemic agency in the classroom and should be investigated further in other contexts.Keywords: regulative agency, epistemic agency, distribution of agency

Stand-Alone Paper

Uncovering Aspects Helping Pre-service Science Teachers to Use Modeling Practices

Paul Engelschalt*, Humboldt-Universität zu Berlin, Germany
Erik Maslyak, Humboldt-Universität zu Berlin, Germany
David Fortus, Weizmann Institute of Science, Israel
Dirk Krüger, Freie Universtiät Berlin, Germany
Annette Upmeier zu Belzen, Humboldt-Universität zu Berlin, Germany

ABSTRACT

Modeling is a scientific practice that pre-service science teachers struggle with. Modeling practices include 'constructing models', 'predicting with models', 'testing models', and 'revising models'. Domain-general metamodeling and domain-specific content knowledge are assumed to support the practices along with other aspects, such as problem-solving strategies. However, how metamodeling knowledge, content knowledge, and other aspects support pre-service teachers' modeling practices has yet to be examined.We conducted

retrospective interviews with 17 pre-service science teachers. They were systematically selected from a larger quantitative study that examined the participant's modeling practice abilities in different tasks. During the interviews, participants were prompted with their responses to the tasks and asked to recall their thoughts when answering them. Their thoughts on when they applied metamodeling and content knowledge or further aspects, e.g., problem-solving strategies, were analyzed.Findings indicate that metamodeling and content knowledge support pre-service science teachers in modeling practices, although their roles vary. Content knowledge was crucial for 'constructing models'- Metamodeling knowledge was significant for 'testing models'. Participants frequently used problem-solving strategies. The strategy of 'structuring the problem' was more fruitful for modeling than 'pragmatic thinking'. For teacher education, we suggest reflecting on these strategies in modeling to foster awareness of when they are fruitful.

Exploring STEM in Teacher Preparation programs

Strand 7: Pre-service Science Teacher Education
25-Mar-25, 4:15 PM-5:45 PM
Location: Baltimore 2

Stand-Alone Paper

Position: Revising STEM Teacher Preparation Courses to Ground in Pedagogies of Care and Reflection

Christina Baze*, Northern Arizona University, USA

ABSTRACT

This proposal presents the position that STEM teacher preparation programs should integrate pedagogical practices relating to a caring classroom environment and frequent, sustained, critical reflection to support critically conscious STEM teachers and improve educational outcomes in the US. In STEM teacher preparation, we should model caring, responsive, and affirming pedagogies in our classrooms for two reasons. First, the field of teaching is dominated by groups with limited perspectives, often different from the student population; and second, most teacher preparation programs do not sufficiently train teacher candidates to implement responsive or affirming pedagogies. Teacher educators should be intentional about providing such pedagogical knowledge, skills, and practical tools to teacher candidates, who can then be better prepared to support K-12 students. The current work is a part of an initiative to revise a STEM teacher preparation program to center transformative practices and focuses on changes made to a practicum course titled Classroom Interactions. In this position paper, I discuss the conceptual framework guiding this work, the design of the course, revisions made, and contributions and impact of this work. I will share student artifacts and reflections (with permission) from the Fall 2024 and Spring 2025 semesters.

Stand-Alone Paper

Exploring the Relationship Between Science Content Knowledge and Engineering Practices in Preservice Teacher Education

Stacey Sneed*, Texas Tech University, USA
Jianlan Wang, Texas Tech University, USA

ABSTRACT

This study investigates the role of science content knowledge in pre-service teachers' (PSTs') ability to integrate engineering practices during a physics teaching methods course. With the upcoming mandatory implementation of revised Science Texas Essential Knowledge and Skills Standards (Science TEKS, 2021) that incorporate engineering practices, understanding the preparedness of PSTs is crucial. This research explores the relationship between PSTs' content knowledge and their performance on tasks involving engineering practices. Through a mixed-methods case study, data was collected from 24 PSTs via pre- and post-tests, evaluating their knowledge across categories like identifying criteria, developing solutions, and planning. Despite hands-on exposure to engineering procedures, results showed no significant improvement in PSTs' performance, highlighting the necessity of emphasizing science content knowledge alongside engineering practices. The study found positive correlations between science content knowledge and engineering practice categories, particularly in planning. These findings suggest that enhancing PSTs' science content knowledge could improve their ability to effectively implement engineering practices in the classroom. The study provides valuable insights for policymakers, stakeholders, and teacher educators on supporting PSTs' professional development, though the small sample size limits generalization. Further research is needed to fully understand the interplay between content knowledge and engineering practices in teacher education.

Stand-Alone Paper

Science/mathematics teaching identity constructs as predictors of persistence in a teacher preparation program.

Ingelise Giles*, Florida International University, USA
Zahra Hazari*, Florida International University, USA

ABSTRACT

Declining interest in teaching as a profession, particularly within the fields of science and mathematics, has led to significant shortages in STEM educators. Despite this, there remains a potential to recruit STEM undergraduates into teaching programs, particularly through the development of a strong science/mathematics teaching identity. This study investigates the impact of science/mathematics teaching identity constructs on students persistence in a teacher preparation program. Utilizing a science identity framework and a Structural Equation Model (SEM), the study examines how pre-course constructs of interest, recognition, performance/competence, and belonging predict post-course identity constructs and subsequent persistence in the program. The study, conducted at a large minority-serving university, involved 562 STEM majors enrolled in clinical teaching courses designed to recruit students into the teacher preparation program. The findings reveal a significant relationship between pre-course and post-course identity constructs, with recognition emerging as a critical factor in identity development. However, a notable inverse relationship was found between pre-course performance/competence and post-course interest, indicating potential misalignments between students initial perceptions of teaching

and the realities encountered in the recruitment course. Interest in teaching was identified as the sole predictor of persistence in the program, underscoring its importance in targeted recruitment efforts.

Stand-Alone Paper

Engineering Design and the Development of Teacher Efficacy

Laura Wheeler*, Brigham Young University, USA
Ryan Nixon, Brigham Young University, USA

ABSTRACT

Owing to changes in K-12 science standards, many science teachers are expected to teach engineering design. Many secondary teachers express a lack of engineering design teacher self-efficacy resulting from limited experience. Eleven preservice secondary science teachers enrolled in a science method and practicum course participated in an engineering design unit with the intent of increasing preservice teacher engineering design teacher self-efficacy (TSE). A general inductive approach was utilized to describe the elements of an engineering design unit that facilitated TSE development across university and practicum contexts. Based on a conceptual framework of the sources of science teacher efficacy, it was determines that engineering design TSE development is dependent upon content and contextual sources. This research provides insights into the content and context specific sources of TSE that are necessary due to existing constraints. These finding are particularly relevant to teacher educators, as they highlight the necessity of including multiple sources of TSE in engineering units in methods courses due to the probable lack of these sources in many practicum experiences.

Adapting to Empower: Examining Teachers' Practical Ideologies for Promoting Epistemic Agency and Critical Science Agency

Strand 8: In-service Science Teacher Education
25-Mar-25, 4:15 PM-5:45 PM
Location: Annapolis 3

Related Paper Set

Beyond the Right Answer: Teachers' Ideological Stances and Pedagogical Decision-Making in Supporting Students' Epistemic Agency

Kevin Hall*, University of Illinois at Urbana-Champaign, USA
Nicholas Leonardi*, University of Illinois at Urbana-Champaign, USA
Logan Lauren, University of Illinois at Urbana-Champaign, USA
Christina Krist, Stanford University, USA
Barbara Hug, University of Illinois at Urbana-Champaign, USA

ABSTRACT

This study explores the influence of teachers' ideological stances on their pedagogical decision-making regarding students' epistemic agency within middle school science

classrooms. Utilizing thematic analysis on data from a four-day professional development (PD) institute aimed at curriculum adaptation for enhancing student agency, we identified four themes of pedagogical spaces for fostering epistemic agency: classroom discourse, choice in science practices, projects and assessments, and classroom routines. This paper focuses on the theme of classroom discourse, highlighting reflections from three teachers that describe a spectrum of approaches to integrating student voice in day-to-day classroom practices. These reflections reveal differing ideological stances on the roles of teachers, students, and the curriculum, from viewing student questions as distractions to recognizing them as opportunities for co-constructing knowledge. Our findings emphasize the need for professional development to support teachers in shifting towards more inclusive pedagogical practices that enhance student epistemic agency by rethinking authority and agency dynamics in the classroom. The study underscores how teachers' beliefs and the structuring of classroom interactions can either limit or promote meaningful student participation and agency in knowledge construction.

Related Paper Set

Finding the 'Sweet Spot' for Adaptations Leading to Pedagogically Generative Learning

Barbara Hug*, University of Illinois Urbana-Champaign, USA
Christina Krist*, Stanford University, USA
Nicholas Leonardi, University of Illinois Urbana-Champaign, USA
Kevin Hall, University of Illinois Urbana-Champaign, USA
Logan Lauren, University of Illinois Urbana-Champaign, USA

ABSTRACT

Our study is situated within IGNITE, a professional learning (PL) project focused on understanding how to support teachers in figuring out how to "open up space for students' epistemic agency" (Author Author, 2019). As our site is district-based, working with science teachers across grades and subject areas, it is not possible to work with a single curricular unit at a single grade level during PL. Instead, teachers bring a variety of curriculum materials to work with. While we anticipated this, we noticed throughout the year that some groups enacted their adapted lessons or units, while others did not (and not because they ran out of time or had other unexpected logistical constraints). This led us to ask: Why did some groups' adaptation efforts lead to successful implementations, while others did not? We present our analysis of five teams of teachers participating in our PL as a first iteration of a design-based research study aiming to generate PL design principles that both informed our work in Year 2 and can be used more broadly in the design of curriculum-based PL for groups of teachers who are not all using the same sets of materials.

Related Paper Set

Community Asset Mapping as an Inroad to Critically Conscious Adaptation

Nga Hoang*, University of Colorado Boulder, USA
Melissa Campanella*, University of Colorado Boulder, USA
Kerri Wingert, Good Questions Research, USA
Mon-Lin Monica Ko, University of Colorado Boulder, USA

ABSTRACT
This paper addresses the project IGNITE partnership work in one high school district in the Midwestern United States and focuses on the importance of Community Asset mapping as an activity that supports critically conscious pedagogies by centering students' experiences (vs. the teachers) during curriculum adaptation. Through video analysis of the whole group discussions as 5 teachers and 4 researchers engaged in asset mapping, we found that the activity offered an important "way in" to how curricular selection and adaptation reflects the sociopolitical positions of teaching. Asset mapping showed itself to be a way to allow for teachers to make visible those histories in order to integrate culture and power into their curriculum adaptation work.

Related Paper Set

Leveraging Composite Methodologies for Characterizing Science Teacher Educators' Critical Consciousness

Enrique Suárez*, University of Massachusetts Amherst, USA
Danielle Crabtree, University of Massachusetts Amherst, USA

ABSTRACT
Our study is situated within IGNITE, a Research-Practice Partnership focused on designing professional learning (PL) for science teachers to make their curricula more justice-oriented. Specifically, we study how researchers within IGNITE conceptualize Critical Consciousness (CC) – a construct science educators use to articulate their visions of justice-oriented education – and how CC shapes the design of PL for science teachers. We employ a composite narratives methodological approach that amalgamates multiple participants' statements into fictional personas, increasing participants' anonymity and forthrightness. To study IGNITE participants' CC, we conducted interviews at important milestones of the project to understand both their conceptualization of CC and how it guided their PL design efforts. Our multidimensional analytical framework combines Freire's (2005) definition of praxis and Burgess Patterson Williams (2022) three layers of equity. Here, we present two personas we constructed based on our analyses from the interviews (Indigo the Introspective; Mindful Morgan) to showcase two distinctive conceptualizations and uses of CC for science education. Through our findings, we argue that leveraging a composite methodology can help researchers to parsimoniously characterize heterogeneity in conceptualizations of CC, as well as increase the efficacy and ethics of studying CC among science education professionals.

Learning from Women and Girls of Color in STEM Education

Strand 11: Cultural, Social, and Gender Issues
25-Mar-25, 4:15 PM-5:45 PM
Location: Azalea 1

Stand-Alone Paper

"Goodbye to what has been..." A Re-evaluation of The Black Women Experience in STEM

Jasmyne Yeldell*, UNC Chapel Hill, USA
Simone Wilson*, UNC Chapel Hill, USA
Anina Mahmud, UNC Chapel Hill, USA
Dionne Cross Francis, UNC Chapel Hill, USA
Kerrie Wilkins-Yel,UMass Boston, USA

ABSTRACT

Women of Color are underrepresented within STEM broadly. Traditionally, the explanations for this underrepresentation have been lack of interest or lack of achievement within the field, with less acknowledgment of the structural barriers Women of Color (WoC) – specifically Black Women - face. They face emotional and physical challenges in White-male dominated spaces, leading to isolation, discrimination, and internalized sexism and racism, which contribute to imposter syndrome. Despite this, Black women persevere in STEM by drawing on their resourcefulness, perseverance, and cultural assets. This study explores the experiences of eight Black women in STEM, highlighting how they overcame systemic barriers and created spaces for joy through culturally embedded resources, such as kinship, mentorship, and centering Black people in their work.

Stand-Alone Paper

'Through the fire...: Re-Examining mental health and persistence in STEM for Women of Color

Simone Wilson*, University of North Carolina at Chapel Hill, USA
Seonmi Jin, Indiana University, USA
Pavneet Kaur Bharaj, California State University, USA
Jasmyne Yeldell, University of North Carolina at Chapel Hill, USA
Anina Mahmud, University of North Carolina at Chapel Hill, USA
Kerrie Wilkins-Yel, University of Massachusetts, USA
Dionne Cross-Francis, University of North Carolina at Chapel Hill, USA

ABSTRACT

Women of Color remain significantly underrepresented across all levels of education in the sciences, technology, engineering, and mathematics (STEM). Research indicates that the continued underrepresentation of Women of Color in STEM is largely due to marginalizing experiences rife in STEM and that such experiences have significant consequences for their mental health. The current study utilized photovoice to center the experiences of 32 Black and Brown undergraduate women in STEM to understand the structures and strategies that support their mental health and wellness as well as their persistence in STEM. Preliminary

findings indicate that experiencing marginalization within STEM often left them feeling confused and overwhelmed about their academics, feeling a lack of belonging in STEM, and feeling as though they are having to conform to inefficient practices by their male counterparts. Importantly, they endorsed several strategies to cope with this toll on their mental health including supportive social groups, finding mentors/advisors with shared identities, and finding moments of joy and mindfulness. Results of this undertaking contribute to understanding the key moments where support efforts from advisors and key STEM stakeholders could be uniquely positioned to mitigate Women of Color's experiences of elevated and sustained distress.

Stand-Alone Paper

What motivates career decisions of Women of Color in STEM? Exploration using Situated Expectancy-Value Theory

Anina Mahmud*, University of North Carolina at Chapel Hill, USA
Pavneet Bharaj, California State University, Long Beach, USA
Jasmyne Yeldell*, University of North Carolina at Chapel Hill, USA
Dionne Cross Francis, University of North Carolina at Chapel Hill, USA
Aishwarya Shridhar, University of Massachusetts Boston, USA
Kerrie Wilkins-Yel, University of Massachusetts Boston, USA

ABSTRACT

This study explores the motivational factors influencing STEM career decisions among Women of Color (WoC) in U.S. higher education. Using the conceptualization of motivational belief under Situated Expectancy-value Theory (SEVT) as theoretical framework, we explore the the motivational factors such as intrinsic value (interest and enjoyment in STEM), utility value (job prospects and financial security), attainment value (alignment with personal identity and altruistic goals), and cost (perceived negative consequences) that shape WoC's academic and career choices. Data was collected from 38 WoC involved in a STEM equity initiative, and findings were generated from qualitative reflections analyzed thematically. The findings reveal that WoC's decisions are primarily guided by their intrinsic interest in STEM, the utility value of their career choices, and the attainment value that aligns with their identities and altruistic goals. However, the perceived costs, such as mental health challenges, also significantly impact their decision-making. The study highlights the importance of providing diverse academic experiences that allow WoC to discover their STEM interests and reduce emotional stress.Keywords: Expectancy value theory, women of color, STEM career

Stand-Alone Paper

Dear Science Teacher: A Message from Black and Latina Girls

Laura Peña-Telfer*, Georgia State University, USA
Natalie King, Georgia State University, USA

ABSTRACT

This study employed care and community cultural wealth as a framework and utilized community-based participatory action research (CBPAR) to examine and reimagine STEM

education in partnership with Black and Latina coresearchers. The research explored the experiences of Black and Latina coresearchers within their formal STEM learning environments and assessed the impact of the curriculum on their STEM identity development. Findings indicated that instructional practices in formal STEM settings undermine the humanizing elements of teaching and learning, resulting in the silencing and invisibility of Black and Latina girls in STEM classrooms. The STEM curriculum often neglects the contributions of people of color, causing Black and Latina girls to feel excluded and discouraged. Nevertheless, Black and Latina girls and their families draw upon their community cultural wealth to foster STEM engagement, recognizing that care and community are vital for enhancing their well-being as they navigate education. This study amplifies the voices of Black and Latina girls and community members, highlighting the importance of prioritizing care and community, and providing actionable insights to promote inclusivity and humanize STEM education. The findings emphasize the transformative potential of community-informed education and offer valuable insights for science educators.

Reframing Science, Technology, and Society through Indigenous STEM Education

Strand 11: Cultural, Social, and Gender Issues
25-Mar-25, 4:15 PM-5:45 PM
Location: Annapolis 4

Symposium

Reframing Science, Technology, and Society through Indigenous STEM Education

Yu-Chieh Wu, University of Hawai'i at Mānoa, USA
Peresang Sukinarhimi, National Sun Yat-sen University, Taiwan
Paichi Pat Shein*, National Sun Yat-sen University, Taiwan
Keiphe Setlhatlhanyo, University of Botswana, Botswana
Richie Moalosi,University of Botswana, Botswana
Yaone Rapitsenyane, University of Botswana, Botswana
Ritesh Khunyakari, Tata Institute of Social Sciences, India
Sefiso Khumalo, Da Vinci Institute of Technology, South Africa
Indu Viswanathan, Hindu University of America, USA
Piata Allen, School of Māori and Indigenous Education, New Zealand

ABSTRACT

This symposium reframes Science, Technology, and Society (STS) education through the lens of Indigenous Science-Technology-Engineering-Mathematics (STEM) by integrating Indigenous Knowledge Systems (IKS), particularly Indigenous Technology Knowledge Systems (ITKS). While STS education promotes scientific literacy, ethical reasoning, and responsible citizenship, barriers like limited research on Indigenous knowledge integration, inadequate resources, and rigid curricula hinder its implementation in diverse settings. Drawing on studies from Botswana, India, New Zealand, South Africa, Taiwan, and USA, this symposium illustrates how Indigenous knowledge can preserve cultural heritage while

broadening STS beyond Western paradigms. It offers strategies for adapting STS education in diverse contexts, fostering inclusive and culturally responsive learning. Ultimately, this symposium underscores the global potential of STS education by emphasizing cultural relevance and inclusivity in educational strategies.

STEM Education in Social-Cultural Context

Strand 12: Technology for Teaching, Learning, and Research
25-Mar-25, 4:15 PM-5:45 PM
Location: Baltimore 5

Stand-Alone Paper

Where Culture, Technology, and Context Meet: Enhancing Artificial Intelligence Education through CTCA

Sia Koroma, Africa Centre of Excellence for Innovative and Transformative STEM Education, Lagos State University, Nigeria
Esther Peter, Africa Centre of Excellence for Innovative and Transformative STEM Education, Lagos State University, Nigeria
David Peter, Lagos State University, Nigeria
Peter Okebukola, Africa Centre of Excellence for Innovative and Transformative STEM Education, Lagos State University, Nigeria
Juma Shabani, University of Burundi, Burundi
Deborah Agbanimu, National Open University, Nigeria
Franklin Onowugbeda, Africa Centre of Excellence for Innovative and Transformative STEM Education, Lagos State University, Nigeria
Adekunle Oladejo, Africa Centre of Excellence for Innovative and Transformative STEM Education, Lagos State University, Nigeria
Olasunkanmi Gbeleyi, Africa Centre of Excellence for Innovative and Transformative STEM Education, Lagos State University, Nigeria

ABSTRACT

The urgency to develop culturally and contextually responsive pedagogies in science education has become increasingly evident in recent times. In response, various teaching methods have been explored, showing success in acquiring scientific knowledge. However, a more transformative approach is needed to fulfill the vision of the "Africa we want" as outlined in the African Union Commission's agenda 2063. This advocacy has led to the development of the Culturo-Techno-Contextual CTCA).The study examined the effectiveness of the CTCA in improving students' attitudes in Artificial intelligence.The study employed a quasi-experimental research design. The experimental group had15 students (5 males, 10 females) and the control group also had 15 students (7 males, 8 females). Artificial intelligence achievement test (AIAT) with a split-half reliability coefficient of 0.71 was used to collect data for the study.ANCOVA result showed that students taught artificial intelligence using CTCA and lecture method had a statistically significant difference in terms of achievementF(1, 27)=1.52; p0.05].The result also revealed that there is a statistically significant difference in

terms of attitude[F (1, 27) =19.2; p0.05].The findings showedCTCA as a potent method for promoting meaningful learningof difficult concepts in ICT.

Stand-Alone Paper

Black Middle Schoolers' Artificial Intelligence Self-Efficacy and Outcome Expectations in a Summer STEM Camp

Ray Opoku*, University of Florida, USA
Tonika Jones, University of Florida, USA
Gabriella Haire, University of Florida, USA
Christine Wusylko, University of Florida, USA
Chih Hsuan Lin, University of Florida, USA
Nazanin Adhami, University of Florida, USA
Natalie King, Georgia State University, USA
Pavlo Antonenko, University of Florida, USA

ABSTRACT

Artificial Intelligence (AI) is transforming our society, yet racial and gender disparities persist in AI access and use. While early exposure to AI could address these disparities, few curricula target middle schoolers from underrepresented groups. This study examines gender differences in self-efficacy and outcome expectations among Black middle schoolers who participated in a summer camp on AI and paleontology. Interviews with 19 boys and 20 girls revealed that both genders experienced elevated AI self-efficacy but expressed this growth differently. Boys articulated confidence directly and competitively, while girls framed their progress in terms of improvement and collaborative learning. Gender differences also emerged in outcome expectations, with boys focusing on broader future applications and girls connecting their learning to immediate educational opportunities.

Stand-Alone Paper

Supporting Blended Math-Science Sensemaking Among College Students from Backgrounds Historically Marginalized in STEM Using Simulations

Leonora Kaldaras*, TexasTech University, USA
Carl Wieman, Stanford University, USA

ABSTRACT

The ability to express scientific concepts in mathematical terms is a foundational cognitive process involved in scientific thinking. This process called "blended math-science sensemaking" (MSS) is a desired skill for all STEM students, but few students are learning it, and there is little research on how to teach it. We introduce activities for undergraduate STEM courses that support self-guided learning of transferable MSS skills. This study builds on our past work on developing and validating a framework for characterizing the cognitive levels involved in MSS among students from dominant and underrepresented backgrounds. This work leverages interactive simulations for developing MSS. We designed an activity that helps develop MSS skills for the topic of heat capacity and then checked the transferability of those skills to the topic of Coulomb's law. The activity was completed autonomously by freshmen community college students (science and non-science majors) from various

underrepresented backgrounds. The results indicated that most students came in with no knowledge of the relevant equations, and the activity supported the development of scientific and mathematical understanding of the equations. Most students demonstrated transfer by providing a reasonable equation for Coulomb's law. Therefore, the activity helps students from diverse backgrounds build transferable MSS skills.

Stand-Alone Paper

Adoption of Virtual Laboratories by Science Teachers in the Global South: Insights from South Africa

BRIAN SHAMBARE*, University of the Free State, South Africa
Thuthukile Jita, University of the Free State, South Africa

ABSTRACT

We present findings from a mixed methods study that involved 186 secondary school science teachers randomly selected from schools in the Eastern Cape province, South Africa. The study is premised on the notion that leveraging novel technologies in classroom practices is contingent upon the existence of conducive enabling conditions for their utilization. Guided by the Unified Theory of Acceptance and Use of Technology (UTAUT) (Venkatesh et al., 2003), we explored teachers' experiences with VL adoption in rural schools, focusing on Social Influence (SI), Facilitating Conditions (FC) and Use Behaviour (UB). The study uncovered unexpected patterns in VL adoption, with peers, colleagues, and school management teams exerting less influence on VL adoption than family and friends. More so, our findings challenge traditional notions of primary sources of teacher motivation, emphasizing learners' enthusiasm as a key factor. Despite teachers expressing uncertainty about facilitating conditions, the research indicates improved technology access, challenging prior perceptions of limited availability in schools in developing countries. However, persistent issues, such as inadequate guidance and support, necessitate comprehensive technical and administrative assistance for successful VL integration. Notwithstanding the current low VL usage, the teachers expressed a willingness to adopt it under conducive conditions, suggesting potential for increased adoption.

Scientific Literacy, Inquiry, and Representation

Strand 13: History, Philosophy, Sociology, and Nature of Science
25-Mar-25, 4:15 PM-5:45 PM
Location: Camellia 1

Stand-Alone Paper

What is Scientific Literacy: a 24 year meta-analysis

Judith Lederman*, Illinois Institute of Technology, USA
Renee Schwartz*, Georgia State University, USA
Selina Bartles, Valparaiso University, USA
Valarie Akerson, Indiana University, USA

ABSTRACT
Scientific literacy has been defined and redefined throughout decades. Where does it stand today and what are the salient features science educators should be targeting? We conducted a meta-analysis to examine common components of scientific literacy. Search parameters included peer-reviewed articles published between 2000-2024 that reported to focus on "scientific literacy" and targeted scientific literacy as an outcome of the research. The was to identify features of scientific literacy and determine any shifts in focus. Results showed that science content knowledge has been a consistent focus. Increased attention has been on the ability to use and assess sources as well as methods of the development of scientific knowledge, ability to apply scientific knowledge to everyday lives, and conceptualize the nature of scientific knowledge and its development. Most recently, attention has shifted toward scientific literacy for reasoning toward social situations such that trust in science and recommendations for the utility of scientific advances are accepted for ensuring the well-being of individuals and the environment. This meta-analysis will serve to guide us as we further examine the broad themes of content, reasoning, and epistemic features to distill out and identify their essential components that are fundamental for functional scientific literacy.

Stand-Alone Paper

Scientific Literacy for Elementary Students- Kindergarten a Baseline Study

Selina Bartels*, Valparaiso University, USA
Judith Lederman*, Illinois Institute of Technology, USA

ABSTRACT
Formal education in the United States begins in kindergarten. The seminal goal of science education in K-12 schools both in the United States and around the world is scientific literacy. Although there is no universally agreed-upon definition of scientific literacy, it is generally understood that scientific literacy is what students need to know about science to be informed, functioning members of society when they finish their formal education. (Roberts, 2008). This calls for the foundations of scientific literacy to be intentionally in all grades beginning with kindergarten. However, due to a lack of science instruction during early grades this seldom occurs and students continue to graduate high school with a lack of scientific literacy skills (Roberts Bybee, 2014). The current study aimed to reveal the understandings of kindergarten childrens scientific literacy by assessing their knowledge of science, scientists, nature of science (NOS) and scientific inquiry (SI). Our goal was to ascertain a global overview of young children students understandings of science, scientists, SI and NOS. The research question that guided this study was: what are kindergarteners understandings of science, scientists, SI and NOS internationally?

School Education Role
Strand 14: Environmental Education and Sustainability
25-Mar-25, 4:15 PM-5:45 PM
Location: Baltimore 3

Stand-Alone Paper
How Do High School Students See Climate Change? Examining Climate Change Visualizations in Lesson Plans
Kathleen Bordewieck*, North Carolina State University, USA
M. Gail Jones, North Carolina State University, USA
Rebecca Ward, North Carolina State University, USA
Sarah Carrier, North Carolina State University, USA
Meghan Manfra, North Carolina State University, USA
Madeline Stallard, North Carolina State University, USA
Tanzimul Ferdous, North Carolina State University, USA
Amber Meeks, North Carolina State University, USA
Stephanie Fiocca, North Carolina State University, USA
Beth Shaver, North Carolina State University, USA

ABSTRACT
This study examined the visual representations and selection rationales used by science teachers to teach climate change. Twenty-five high school science teachers in the Southeast United States provided climate change lesson plans, presentations, and visual representations they have used in their classrooms to teach climate change during the last five years. Participants were surveyed about their selection process for these visual representations and their feelings about teaching climate change. Five hundred fifty-five visual representations were coded for characteristics such as emotion eliciting and temporal psychological distance. The visual representations included 188 photos, 135 graphs, 97 graphics, 77 diagrams, 51 maps, five cartoons, and two tables. Results indicated that teachers prioritized visual representations that show climate change occurring over time (n=150) and the seriousness of impact (n=136 Emotion/Impact), but teachers often did not know the sources of the visual representations they used (n=386 Source Unknown) and dates (n= 428 Year Unknown).This study offers valuable insight into teachers' criteria when selecting visual representations for climate change instruction. It also reveals specific areas where instructors may want support in navigating the politically charged nature of this scientific topic.

Stand-Alone Paper
Latinx Students as Agents of Change in Community Environmental Issues: Teachers' Perspectives
Clare Baek*, University of California, Irvine, USA
Victoria Nguyen, University of California, Irvine, USA
Symone Gyles, University of California, Irvine, USA
Mark Warschauer, University of California, Irvine, USA

ABSTRACT
As environmental issues become increasingly prominent every year, it is crucial to educate children on ways to protect the environment at an early age. One way to achieve this is by empowering students as active agents of change for the environment within their communities through place-based environmental instruction. This study explores how teachers leverage multilingual Latinx students' existing community and cultural knowledge to position them as leaders in addressing environmental challenges. Grounded in critical pedagogy and place-based education, this study integrates students' cultural, civic, and community knowledge into the learning process to foster social-justice-oriented environmental literacy and student agency. Interviews with eight teachers across three different local school agencies reveal strategies that educators employ to harness students' local knowledge and guide them in addressing community environmental issues.

Stand-Alone Paper

Preschoolers' Experiential Learning in Educational Farm—Cognitive and Emotional Effects

Ornit Spektor-Levy*, Bar Ilan University, Israel
Moshe Castoriano, Bar Ilan University, Israel

ABSTRACT
Learning in educational farms has all the advantages of outdoor learning. The weekly/monthly trip to a natural place enhances familiarity and reduces stress. However, the contribution of educational farms to student's cognitive and emotional aspects has yet to be examined empirically. The current study encompassed 93 preschoolers (5-6 years of age, 4 preschools).Forty-seven children experienced 4 visits to the farm with specially developed program (intervention group), 46 didn't visit the farm (comparison group).The study examinedhow do farm visits affect young children's environmental and agricultural literacy and their emotional perspectives toward the natural environment. This mixed-methods study involved knowledge questionnaire (Pre-Post), observations during farm visits, and the preschoolers' drawings (Pre-Post). Data revealed significant increase in the four measures of knowledge evidenced among the intervention group compared to no change among the comparison group. Qualitative and quantitative analyses of the pre-post participants' drawings showed an increase in the number of agricultural and environmental phenomenaand moreexpressions of positive emotionsamong the intervention group.Data from observations supported these findings. This study highlights the value of experiential learning in educational agricultural farms to the cognitive and emotional development of preschoolers as well as their environmental and agricultural literacy.

Stand-Alone Paper

Island STYLE: Impacting Students Through Place-based Environmental Education Programs

Carol Waters*, University of Houston-Clear Lake, USA
Michelle Peters, University of Houston-Clear Lake, USA

ABSTRACT
This research aimed to examine the influence of a nonformal environmental education program on students' stewardship practices and experiences regarding environmental impacts and climate change. Data were collected from students in a high-minority, economically disadvantaged school district in southeast Texas who participated in the program throughout the 2023-2024 school year. Students participated in an Eco-Art Workshop, Eco-Art Kayak Adventure, and Blue Carbon Workshop and created an Environmental Action Project. Findings indicated that through these experiences, students' knowledge of environmental stewardship practices and understanding of their coastal community increased. Results indicated that students had a better understanding of climate change, environmental literacy, and stewardship. Results also indicated that half of the students felt confident in developing an environmental action project, but the other half allowed their fear of failure to impact their confidence, which needs further investigation.

Advancing AI in Science Education (AASE): Responsible and Ethical Uses of AI in Science Education

25-Mar-25, 6:00 PM-7:30 PM
Location: Azalea 3

Social Event

Xiaoming Zhai, University of Georgia, Athens, USA
Kent Crippen, University of Florida, USA
Kevin Haudek, Michigan State University, USA
Juan-Carlos Aguilar, Department of Education, Georgia, USA
Lei Liu, ETS, USA
Xiufeng Liu, University of Macau, China
Kecia Ray, , USA
Marcia Linn, UC Berkeley, USA
Knut Nuemann, IPN, Germany
Ross Nehm, University of Stony Brook, USA
Okhee Lee, University of New York, USA
Natalie King, Georgia State University, USA
Yizhu Gao, University of Georgia, USA
Gyeong-Geon Lee, National Institute of Education, Singapore
Jamie Mikeska, ETS,

ABSTRACT
This social event focuses on the integration of artificial intelligence (AI) into science education with the goal of advancing responsible, ethical and high-quality learning for all students. Funded by NSF (2332964), the RAISE co-chairs commissioned an international committee of experts in AI and science education to advance AI for high-quality K-12 science education through the collaborative production of new scholarly products. This session will present the committee's initial findings, delving into how AI tools such as generative AI (e.g., ChatGPT)

can transform various facets of science education while addressing challenges such as bias, academic integrity, and accessibility.

Fireside Chat: Networking, Socializing, and Connecting Among the ISK-RIG Membership

25-Mar-25, 6:00 PM-7:00 PM
Location: Annapolis 1

Social Event

Julie Robinson, University of North Dakota, Grand Forks, USA
Bhaskar Upadhyay, University of Minnesota, USA
Pauline Chinn, University of Hawaii at Manoa, USA
Sharon Nelson-Barber, WestEd, USA

ABSTRACT
The purpose of the ISK RIG Fireside Chat social event is to provide a comfortable, informal, and casual social setting for ISK members to connect, meet each other, and exchange ideas. The ISK RIG Fireside Chat will provide a physical space at the 2025 NARST Annual International Conference for current, new, and potential ISK RIG members learn more about the RIG and continue to build a community of learners who are invested in Indigenous approaches to STEM education and research. The session will include introductions, ice-breakers, sharing of on-going work and resources, and brainstorming of new ideas and strategies for sustaining the current work of the ISK RIG.

Writing a Winning Grant Proposal: Tips and Advice from API scholars

25-Mar-25, 6:00 PM-7:00 PM
Location: Azalea 1

Social Event

Hosun Kang, University of California Irvine, USA
Edna Tan, University of North Carolina Greensboro, USA
Jennifer Tripp, University at Buffalo, USA
Peng He, Washington State University, Pullman, USA
Xiufeng Liu, University of Macau, China
Okhee Lee, University of New York, USA
Li Ke, University of Nevada Reno, USA

ABSTRACT
The purpose of the API-RIG-sponsored social event is to facilitate networking and mentorship for junior API scholars seeking opportunities to further develop their grant-writing skills. The API leadership will invite two API scholars with existing grants, who are also members of the

API-RIG, to share their experiences, from conception through execution to reflection. The panelists will include Drs. Okhee Lee (recipient of multiple NSF grants) and Li Ke (recent NSF CAREER grantee). These panelists were intentionally selected: Dr. Okhee Lee is a distinguished senior scholar with extensive grant experience, and Dr. Li Ke is a recent NSF CAREER awardee. The breadth of their experiences will be highly beneficial to our discussion. We also acknowledge that API membership is global and that grant-writing is an international scholarly expectation.
The panelists will address the following questions: 1) How did you develop your research topic or idea? 2) What challenges did you encounter in the proposal preparation process, and how did you overcome them? 3) What advice would you give junior scholars preparing to write proposals for the NSF and other funding bodies, such as the Spencer Foundation and the William T. Grant Foundation? This event will provide a targeted opportunity for junior API scholars to ask questions and engage with more senior API scholars with grantsmanship experience, including the two panelists and other attendees.

Equity and Ethics DInner
25-Mar-25, 6:00 PM-9:00 PM
Location: Offsite

Social Event
Iliana De La Cruz, Texas A&M University, College Station, USA
Dominick Fantacone, SUNY Cortland, USA

ABSTRACT
Come one, come all! NARST's Equity & Ethics Committee is hosting their annual dinner event at the Silver Diner at National Harbor. Located 3 blocks (0.2 mi) from the conference venue, our social dinner will offer three courses including a starter salad, dinner entree, and desert; vegetarian and gluten free options will be made available! Please purchase your tickets now or select an option to donate for others! Tickets are $55. Graduate students, look to add your interest in joining this social event on your registration for tickets at a grad student rate (up to 30 tickets offered)!

The Silver Diner is located at 108 Waterfront St., Oxon Hill, MD, 20745.

NARST Fellows Breakfast
26-Mar-25, 7:00 AM-8:00 AM
Location: Magnolia 2

Membership and Business Meeting
26-Mar-25, 8:00 AM-8:45 AM
Location: Cherry Blossom Ballroom

Expanding Horizons: Innovations in Science Outreach
26-Mar-25, 9:00 AM-10:30 AM
Location: Azalea 2

Cristina Guarrella, Australasian Science Education Research Association (ASERA), Australia
Linda Hobbs, Australasian Science Education Research Association (ASERA), Australia
Cristina Guarrella, Australasian Science Education Research Association (ASERA), Australia
Linda Hobbs, Australasian Science Education Research Association (ASERA), Australia
Victoria Millar, The University of Melbourne, Australia
Kyla Adams, University of Western Australia, Perth, Australia

ABSTRACT
Science outreach programs are prolific in Australia and internationally, with an estimated 50% of active scientists participating in some kind of science outreach. In an effort to understand the benefits of science outreach on student outcomes, this symposium showcases research conducted by members of the Australasian Science Education Research Association (ASERA). By synthesizing international literature, the authors of the first presentation identified conceptual fragmentation within the corpus of literature and propose a unified definition of 'science outreach' to facilitate future, high-quality research. Next, three Australian outreach programs embedded within research studies are presented. Using ecological systems theory, one study mapped the interconnected educational ecosystem created by the outreach program to understand beliefs and cultural shifts that occurred. Another explored the influence of outreach in rural Australian schools, investigating the value of the community relationships fostered. Finally, an initiative introducing cutting-edge physics concepts like curved spacetime and photons to students aged 8-16 is presented. Novel teaching approaches, teacher training processes, and outcomes from researcher-led and teacher-led implementations are discussed. Together, these diverse presentations highlight innovative work that expands the horizons of science outreach. They offer insights into defining outreach, engaging underrepresented groups, understanding impacts in unique contexts, and innovating science teaching and learning through outreach. This symposium advances the field by sharing Australian innovations with the international community.

Learning to live with the world: The role of science education

26-Mar-25, 9:00 AM-10:30 AM
Location: Baltimore 3

Lucy Avraamidou, University of Groningen, Netherlands
Giulia Tasquier, University of Bologna, Italy
Katarina Gunter, Umea University, Sweden
Wonyong Park, University of Southampton, UK
Duru Bayram, Eindhoven University of Technology, Netherlands
Nayif Awad, Sakhnin Academic College For Teacher Education, Israel
Sara Wilmes, University of Luxembourgh, Luxembourg
Marta Romero Ariza, University of Jaén, Spain
Lama Jaber, Florida State University, USA
Felicia Moore Mensah, Teachers College, Columbia University, USA

ABSTRACT

More than ever, it is time to re-imagine the future(s). Science education has a responsibility to support not only the re-imagining of the future but also the shaping of the future by responding to urgent challenges, such as climate crises, disinformation, and polarization, responsible use of AI, public (mental) health issues, discrimination and injustices of all sorts across the world.

In this session, the panelists will grapple with the question of how can we promote learning to live with the world instead of attempting to dominate it, as a way of responding to current global challenges. In doing so, they will share their visions of how could science education help us form new relationships with the human, more-than-human, and non-human world. They will share examples of work done in their unique sociocultural contexts, framed within culturally sustainable pedagogies, pedagogies of care and resistance, and which pay attention to different ways of being and becoming in science in more sustainable, hopeful, and just futures.

Collectively, the panelists will engage the audience in thinking of science education otherwise, for the purpose of re-imagining the future(s), through an ecological approach that has interconnectedness and justice at its core.

From Data to Discourse: Enhancing Scientific Communication and Argumentation Skills

Strand 1: Science Learning: Development of student understanding
26-Mar-25, 9:00 AM-10:30 AM
Location: Azalea 3

Stand-Alone Paper

Does size matter? Dealing with diagrams presenting different data amounts when justifying scientific claims

Gregor Benz*, Technical University Munich, Germany
Tobias Ludwig, Karlsruhe University of Education, Germany
Andreas Vorholzer, Technical University Munich, Germany

ABSTRACT

Due to the increasing use of digital tools in science lessons, learners have even more frequent and easier access to large amounts of data. Their use is described as more demanding. To continue to ensure learning success and implement adequateepistemologyin science classrooms, it is necessary to know how learners deal with large amounts of data and how they can be supported in its handling. However, how learners deal with large amounts of data is still unclear, especially when arguing from data, as different assumptions can be derived from epistemic, sociocultural, and cognitive science points of view. To investigate these assumptions, a randomized study was conducted in which 664 high school students were presented with diagrams containing three different amounts of data. The students were asked to write an argument for a self-selected scientific claim based on the given data. The results showed no meaningful effects of the diagrams on the arguments. It seems that for students, the data amounts presented in a diagram do not matter and do not affect their arguments. The study contributes to understanding how students deal with data in learning science, especially when arguing from large amounts of data.

Stand-Alone Paper

What makes you argue? Prompting students' arguments during an ecology class

Rena Orofino*, University of São Paulo, Brazil
Jenifer Xavier, EE. Profa Dinorah Silva dos Santos, Brazil
Melina Leite, University of São Paulo, Brazil
Daniela Scarpa, University of São Paulo, Brazil

ABSTRACT

This paper adds to the discussion on how to teach argumentation. We discuss the role of certain activities, its exercises and how students team up to solve argumentation exercises about ecology. We developed an instrument to identify the argumentation skills in an instructional resource and to identify students' success in portraying elicited skills. We adjusted a model to the success in portraying argumentation skills, considering that the variation in the data can be partitioned into three sources of variability: students, activities, and exercises and performed a Variance Partitioning Analysis using a multilevel model to

quantify the relative contribution of each of these three sources of variability in student's success in portraying argumentation skills. Students' success in portraying argumentation skills was better explained by exercises' statements, which indicate that we should pay attention to how we phrase our exercises. Still, once there was not an evident correlation on the phrasing or the complexity of an exercise and students' success in portraying argumentation skills we hypothesize that teachers' praxis is an important variable to be investigated in similar studies and might help us build knowledge on teachers' agency when teaching argumentation.

Stand-Alone Paper

Reconnecting students' views of NOS to argumentation from an epistemological perspective

Jing Lin*, Beijing Normal University, China
Hongyan Zhao, Beijing Normal University, China
Letong Zhang, Renmin University of China, China
Xiaowei Tang, University of Macau, China

ABSTRACT

Students' practices in argumentation reflect their understanding of science. The associations between students' views of the Nature of Science (NOS) and their argumentation are inconclusive in the existing literature. The present study investigated whether students' understanding of NOS contributes to their argumentation performance and whether the associations vary by gender and grade.Data were collected from 495 Chinese students in grades 5-7, focusing on 1) how they view science in the tentative, empirical, and subjective aspects; and 2) how they perform argumentation in terms of identifying a claim, identifying evidence, constructing an argument, and providing a counter-critique. The results showed significant cross-grade variations in students' views of NOS and their argumentation performance, with the seventh graders scoring the best in both, followed by sixth and fifth graders. Girls were more likely to view science as subjective, and their argumentation performances surpassed that of the boys. The tentative aspect of NOS showed dominant connections with the students' argumentation performance, followed by the dimensions of empirical nature and subjectiveness. The connections were further complicated across genders and grades. The findings suggested the need for more explicit NOS instruction and more vigorous argumentation practices to prepare students for uncertainties in the future.

Building Science Understanding and Memory through Cultural Context and Interactions

Strand 2: Science Learning: Contexts, Characteristics and Interactions
26-Mar-25, 9:00 AM-10:30 AM
Location: Camellia 1

Stand-Alone Paper

Contextualizing Teaching of Genetic: Leveraging Culture and Technology for Enhanced Learning Outcomes

Franklin Onowugbeda, Lagos State University - Africa Centre of Excellence for Innovative and Transformative STEM Education, Nigeria
Peter Okebukola*, Lagos State University - Africa Centre of Excellence for Innovative and Transformative STEM Education, Nigeria
Juma Shabani, University of Burundi, Burundi
Umar Adam, Lagos State University - Africa Centre of Excellence for Innovative and Transformative STEM Education, Nigeria

ABSTRACT

Addressing the poor academic performance of secondary school students in genetics requires a novel pedagogical approach that explores new possibilities in teaching genetics. The integration of elements of culture, technology, and contextualization is recommended to enhance student academic performance in the subject matter. The study was mixed method and a total of 114 senior secondary school II students (SS2) from two schools in Lagos Education District v participated in the study. Students in the intact classes of these schools were assigned to as experimental group (n = 53) and control group (n = 61). The Genetics Achievement Test was used to collect quantitative data with a respectable reliability value of 0.86. Students in the experimental group received genetic instruction using the culturo-techno-contextual approach while the control group students had their instruction on the same subject matter using the conventional lecture method. Since random assignment of subjects to experimental and control groups was not achieved, the data were subjected to an analysis of covariance approach with pre-test scores added as a covariate. The study reveals that the pedagogical approach provided a thorough grasp of genetics that resonated with the cultural and technological landscape of today's world.

Stand-Alone Paper

Impact of Childhood Spatial and Nonspatial Activity on Learner's Verbal and Visuospatial Working Memory Capacity

Seth Davis, University of Florida, USA
Muhammad Rehman*, University of Florida, USA
Do Hyong Koh*, University of Florida, USA
Christine Wusylko, University of Florida, USA
Xiaoman Wang, University of Florida, USA
Priya Prasad, University of Florida, USA
Pavlo Antonenko, University of Florida, USA
Kara Dawson, University of Florida, USA

Jonathan Martin, University of Florida, USA
Ellen Martin, University of Florida, USA

ABSTRACT

The study investigated how childhood spatial and non-spatial activity can affect a learners' working memory capacity (WMC). Specifically, we examined how undergraduate students' verbal and visuospatial WMC was impacted by their interaction with spatial and non-spatial activities in their childhood. Statistical analysis revealed that spatial activity has a positive correlation with both, verbal and visuospatial scores. In contrast, nonspatial activity negatively correlated with the verbal score, but has no significant correlation with the visuospatial score. This study is a part of a National Science Foundation funded design-based research aimed at developing an adaptive gaze-driven learning system for multimedia-based learning content to assist neurodivergent learners.

Stand-Alone Paper

Peer Interaction and Conceptual Development: A Multimodal Interaction Analysis

John Galisky*, UC Santa Barbara, USA

ABSTRACT

Multimodality in science instruction has been often discussed, but mostly from a theoretical perspective. Communication generally, and science communication specifically, is multilayered with simultaneous application of a variety of modalities. In any interaction participants both employ and attend to gesture, gaze, posture, and facial expression. Expecting that peer interaction affects conceptual development, we examined interaction in order to understand the mechanism of that development. This study looked at a pair of students engaged in a science activity with a balance scale protocol. Using the tools of interaction analysis, we analyzed children's peer talk to investigate how their interaction influenced conceptual development. Looking closely at interactions we observed language use associated with patterns, cause and effect, and proportionality. We were able to observe when concepts emerged and how those concepts were co-constructed. Specifically, we found strong evidence of the students mutually co-constructing both the concept and language for cause-effect relationships. For science teachers to support their students in multimodal communication and sensemaking, it is necessary to identify and characterize the modes of communication and the objects of inquiry. Teachers can then plan lessons that engage multiple modes and recognize when and how their students are doing the work of sensemaking.

Strengthening Collaboration in Science Education

Strand 2: Science Learning: Contexts, Characteristics and Interactions
26-Mar-25, 9:00 AM-10:30 AM
Location: Camellia 2

Stand-Alone Paper

Exploring Students' Collaborative Regulation of Learning and Chemical Thinking During a Dynamic-Authentic Learning Experience

Noah Amir*, Technion – Israel Institute of Technology, Israel
Shirly Avargil, Technion – Israel Institute of Technology, Israel

ABSTRACT

This study investigates the collaborative regulation of learning and chemical thinking during an authentic chemistry-based educational escape room experience designed for high-school students. Collaborative learning, known for enhancing knowledge construction, was examined through three types of regulation: self-regulated learning (SRL), Co-regulated learning (Co-RL), and socially shared regulated learning (SSRL). Using video observations and group discussions after the activity, we qualitatively analyzed how high school students applied regulatory strategies: orienting, planning, monitoring, and evaluating, while solving 19 chemistry problems aligned with the national chemistry curriculum. Our findings highlight that monitoring was the most prominent regulatory phase, with SSRL predominantly manifesting during orienting and monitoring phases. Chemical thinking was analyzed through eight categories, with material identification and experimental skills being the most frequent. The results underscore the importance of central chemistry concepts in fostering chemical thinking and demonstrate how students working in groups regulate their learning and knowledge sharing in a collaborative learning environment. This study contributes to theoretical knowledge by providing novel insights into regulation phases and types within a dynamic learning environment and suggests practical implications for assessing students' collaboration and chemical thinking.

Stand-Alone Paper

A Case Study of Fostering Positive Interdependence in Secondary Science Classrooms through Multimodal Collaborative Learning

Jiaxin Chen*, The University of Hong Kong, China
Jiaojiao Hui*, The University of Hong Kong, China
Guojun Xu, Hangzhou Yinhu Experimental Middle School, China
CHEN CHEN, The University of Hong Kong, China

ABSTRACT

This research conducts a case study implementing five multimodal collaborative STEM lessons with 7th-grade students, focusing on the plane table survey technique, a geometry and geography method that requires collaboration among groups. The course enrolled 48 students (71% male, 29% female), aged 12 to 15. After the course, we randomly selected 17 students (6 female and 11 male) from 9 groups to participate in semi-structured interviews. Combining thematic analysis and video analysis, we observed a model of positive

collaboration: students actively shared responsibilities and helped each other achieve a common team goal. Throughout the process, students established effective communication and developed mutual trust. Additionally, we found that these positive collaborative actions may be closely related to the absence of inter- and intra-group competition and the nature of the plane table survey task, which fostered positive interdependence among students.

Roundtables Session 3

26-Mar-25, 9:00 AM-10:30 AM
Location: Cherry Blossom Ballroom

Strand 3: Science Teaching — Primary School (Grades preK-6): Characteristics and Strategies
Roundtable

Developing a Framework to Characterize Talk Moves to Encourage Cross-Team Argument Critique in Engineering Discussions

Pamela Lottero-Perdue*, Towson University, USA
Jamie Mikeska, ETS, USA

ABSTRACT

There is a paucity of literature about talk moves that teachers can use to encourage cross-team (i.e., team-to-team) argument critique during whole-class engineering discussions. To develop an exploratory framework for describing these talk moves, we analyzed videos and transcripts from 14 in-service elementary teachers who each facilitated 25-minute simulated argumentation discussions related to a science-integrated engineering design challenge. The students, five fifth-grade avatars in three teams (two pairs, one individual student), are played by a trained actor. In the simulation scenario, before the discussion, each team created a design, tested it, and documented improvement ideas. Prior to facilitating the discussion, teachers received team artifacts and were reminded about key components of argumentation, including that it involves students critiquing others' ideas. We present a framework derived from our iterative, collaborative, qualitative analysis. The framework has three major categories identifying the nature of the talk moves that the teachers used to encourage cross-team argument critique during the engineering discussions: (1) framing for critique (two subcategories); (2) prompting for critique (four subcategories); and (3) praising critique (three subcategories). We compare moves in our framework with critique-focused moves in the scientific argumentation literature, offering them as a starting point for future research and practice.

Strand 3: Science Teaching — Primary School (Grades preK-6): Characteristics and Strategies
Roundtable

How Primary STEM Teaching Learning Support Student Readiness for Blended Learning: Six Teaching Profiles

Karlis Greitans*, University of Latvia, Latvia
Dace Namsone, University of Latvia, Latvia
Ildze Čakāne, University of Latvia, Latvia

ABSTRACT

This study investigates the changing landscape of primary STEM teaching and learning in the authors' country, focusing on STEMteaching learning that prepares students for blended learning. The research examined the literature on preconditions and student readiness for effective blended primary STEM learning. Through analysis of 186 science and math lessons across grades 1-6, the study identifies differences instudent learning experience in self-regulated learning and student experience in deep learning. The use of ICT in the majority of lessons remains at the surface level.Resultshighlight varying opportunities for students to prepare for blended primary STEM learning. Six teaching profiles were identified that support studentreadiness for blended STEM learning (each with specific needs for professional development) differently.The findings underscore the importance of targeted professional developmentfor the implementation of teaching the skills necessary for student self-regulated and deep learning.

Strand 3: Science Teaching — Primary School (Grades preK-6): Characteristics and Strategies
Roundtable

How Do French Kindergarten Teachers regulate the verbal interactions during explicit Scientific Inquiry-Based Sequences?

Estelle Blanquet*, INSPE of Bordeaux, France
Eric Picholle, INPHYNI, CNRS, France

ABSTRACT

In the context of a French research project on the appropriation of elements of scientificity by Kindergarten teachers and their pupils aged 3 to 6 years, we analyse the share of speaking by pupils and their teachers. Video recordings using 360 cameras were collected over four years from schools in urban, rural and priority education zones. The teachers used scientific explicit inquiry-based sequences specifically designed by the researchers. The collected data concern the same activities carried out with different groups by the same teacher and by different teachers. The video data were transcribed and analysed using multimodal interaction analysis. This communication presents a first level analysis based on the number of interventions of the participants during the different sequences. The transcripts reveal several invariants: interactions are mostly mediated by the teacher and spontaneous exchanges between pupils remain limited; most classes include pupils of all ages, it is mostly the oldest pupils who speak the most, and a limited number of children do most of the

talking. The transcriptions also reveal an appropriation and a verbalization of all the elements of scientificity by the teachers in all the sequences, although in different proportions.

Strand 3: Science Teaching — Primary School (Grades preK-6): Characteristics and Strategies
Roundtable

Linking Teacher Agency to Learning Orientation in Generative Environments: Insights from a Multiple Case Study

Jee Kyung Suh*, University of Alabama, USA
Jale Dursun, University of Alabama, USA
Brian Hand, University of Iowa, USA

ABSTRACT

This study examines the impact of teacher agency on the transition to generative learning environments, as promoted by recent science education reforms like the Next Generation Science Standards (NGSS). Through a multiple-case study of teachers who participated in a professional development program, we explore the relationship between teachers' sense of agency and their orientations toward knowledge generation. Our findings highlight the importance of both organizational support and personal commitment in fostering meaningful educational change. By addressing the interplay between agency and learning orientations, this research offers valuable insights for professional development programs and policy decisions aimed at enhancing teacher and student agency.

Strand 3: Science Teaching — Primary School (Grades preK-6): Characteristics and Strategies
Roundtable

'They really matter!": Relationships' impact on elementary teachers' sense of agency for teaching science

Anica Miller-Rushing*, Associated Universities Inc., USA
Alison Mercier, University of Wyoming, USA

ABSTRACT

This study examines the critical role of relationships in shaping elementary teachers' sense of agency for teaching science. Teacher agency, defined as the autonomy to make informed, intentional decisions in science instruction, is essential for implementing reform-based, equitable, and justice-oriented teaching practices. Through a case study of three rural elementary teachers, this study explores how relationships with colleagues, administrators, and outside partners influence teachers' confidence, motivation, and capability to innovate in their science instruction. Thematic analysis of survey and interview data reveals that supportive relationships foster collaboration, trust, autonomy, and a sense of purpose, all of which enhance teachers' agency. By highlighting the foundational importance of these relationships, the study contributes to the understanding of how professional learning and teacher development programs can be designed to support sustained agency, ultimately leading to improved student outcomes in science education.

Strand 3: Science Teaching — Primary School (Grades preK-6): Characteristics and Strategies
Roundtable

Investigation of Disadvantaged Students' STEM Identity Development During Extracurricular STEM Activities

Guler Akkor, Aydin Adnan Menderes University, Turkey
Arzu Tanis Ozcelik*, Aydin Adnan Menderes University, Turkey

ABSTRACT

STEM education has emerged as a new approach to meet the evolving needs of today's society. To ensure equal educational opportunities, it is crucial that STEM based education is accessible to all societal segments. This study examines the development of STEM identities among disadvantaged students through extracurricular STEM activities. The research involved 10 disadvantaged 4th-grade students from a primary school in western Turkey. Using a case study design, both qualitative and quantitative data collection methods were employed. Data were gathered through semi-structured interviews with students and their teachers, field notes, the 'Scale of Interest in STEM Professions' to assess STEM identity development. SPSS software was used for the analysis of scale, and we used thematic analysis for the analysis of interviews and field notes. The STEM activities, based on the Engineering Design Process, were implemented over a 6-week period. Results indicate a significant increase in students' interest in STEM fields. STEM identities were categorized as developed, moderately developed, and limited based on interviews with teachers, students, and researcher field notes.

Strand 5: College Science Teaching and Learning (Grades 13-20)
WIP Roundtable

Competitors or Community: Attending to Social Networks to Disrupt the Status Quo in STEM

Sombo Koo, UC Davis, USA
Téa Pusey*, UC Davis, USA
José Oyola Cortes, UC Davis, USA
Becca VanArnam, UC Davis, USA
Andrew Hood,UC Davis, USA
Sanjana Dhamankar, UC Davis, USA
Theron Sowers, UC Davis, USA
Rebecca Ambrose, UC Davis, USA

ABSTRACT

In response to the elitist hierarchies perpetrated by the traditional practices in STEM, and the common struggle of inhabiting the identity of an educational researcher, this group of scholars coalesced to build a community of practice (CoP). To address these two concerns, we intentionally built a community of doctoral students and faculty where we could bond emotionally and share intellectual resources to write a collective literature review. As a CoP, we engaged in conducting a review of STEM education articles that employed Social Network Analysis (SNA) to understand equity in STEM settings. As we analyzed studies for

their use of SNA, our own social network developed, providing emotional and intellectual resources that ameliorated the otherwise isolating work of doctoral study. Through narrative inquiry, we highlight the ways in which our CoP intentionally created stronger connections as we engaged in this review as well as continued our doctoral journeys together. Overall, this work brings forth the possibilities of doctoral programs, particularly those focused on STEM, to be a space of collaboration and community rather than competition.

Strand 5: College Science Teaching and Learning (Grades 13-20)
WIP Roundtable

Assessing the Impact of a Culturally Inclusive Teaching Institute for STEM Community College Faculty

Bernadette Sibuma*, Massachusetts Bay Community College, USA
Jayne Ryczkowski, Massachusetts Bay Community College, USA
Meredith Watts, Massachusetts Bay Community College, USA

ABSTRACT

As the higher education sector strives to meet the demand for STEM graduates, community colleges play a pivotal role in supporting underrepresented groups. Despite this, significant disparities in graduation rates and STEM degree completion persist among minority students. This study explores the effectiveness of a comprehensive professional development program designed to enhance culturally responsive and inclusive teaching among STEM faculty at a northeast community college and local high schools. The program included a 3-week virtual institute followed by a year of implementation and mentoring. Using pre- and post-surveys, the study evaluated changes in faculty self-efficacy regarding culturally responsive teaching and its subsequent impact on student achievement, self-efficacy, and outcome expectancy in STEM. Findings revealed that faculty confidence in inclusive teaching practices improved, and initial evidence suggested increased academic success for Black and Latinx students in STEM courses taught by program participants. Nonetheless, challenges remain as disparities in student self-efficacy and outcome expectancy were observed. These results underscore the importance of continued professional development and institutional support to foster equity in STEM education.

Strand 5: College Science Teaching and Learning (Grades 13-20)
WIP Roundtable

Exploring Collective Activity in Mentoring Underrepresented Students within Undergraduate Research Programs in STEM

Hyoung Joon Park*, Oregon State University, USA
Jana Bouwma-Gearhart, Oregon State University, USA
Barbara Ettenauer, Oregon State University, USA

ABSTRACT

With the growing interest in implementing undergraduate research programs that include robust support through mentorship, there has been an expanding body of literature on mentorship within these programs. Despite the increasing focus on studies of undergraduate research with an emphasis on mentoring, there is a lack of empirical research

on the challenges faced by underrepresented students in STEM during their participation in undergraduate research programs from the perspective of both mentors and mentees. Furthermore, little attention has been given to exploring how mentorship is implemented in practice to address the challenges these underrepresented students face during their undergraduate research programs. To bridge this research gap, our study explores the following questions: (1) What challenges do underrepresented students in STEM experience in their undergraduate research programs? (2) In what ways does mentorship support these students in addressing these challenges? To answer the research questions established in this study, a qualitative research design was adopted. We employed a case study approach, which is appropriate for exploring the mentoring process in depth and for understanding the social dynamics between mentors and mentees in undergraduate research programs. A multi-institutional research center in the United States was chosen as the research site for this study.

Strand 13: History, Philosophy, Sociology, and Nature of Science
Roundtable

Feminist Materialist Teaching Practices and the Conceptualization of Trust in Science Education

Anna Skorupa*, New York University, USA
Shaghig Chaparian*, New York University, USA
Leah Master*, New York University, USA
Catherine Milne*, New York University, USA

ABSTRACT

Recent global events, including environmental crises and the COVID-19 pandemic, underscore the need for both appropriate public trust in science and critical engagement with science to address underlying inequities. Traditional conceptions of trust in science built on dominant onto-epistemologies provide an inadequate framework for (re-)connecting students with science and building trust and criticality concurrently. As an alternative, we draw upon Barad's agential realism to redefine trust as intra-active and emergent. To demonstrate how this re-conceptualization of trust might inform efforts to re-imagine science education, we analyze teaching practices within an undergraduate science curriculum inspired by feminist materialism and identify how these practices support the emergence of more flexible and resilient trust among students, teachers, experts, and the material world.

Strand 6: Science Learning in Informal Contexts
Roundtable

Exploring Childrens Environmental Identity in Third Spaces

Srijana Katuwal*, Ohio University, USA
Rejoice Vorsah, Ohio University, USA
Sara Salloum, Ohio University, USA
Danielle Dani, Ohio University, USA

ABSTRACT
This study explored how children aged 6-12 years old develop their environmental identity at acamp of an Environmental Education Club, acting as athirdspace formaking personal connections with nature,issues around climatechange and their community. Given that climate change poses significant risks to children's health, education, and future, it is crucial to involve them in environmental issues. Backed up by the Environmental Identity Development Model (EIDM) and a variety of data sources, we investigated how the camp experience fostered meaningful connections to nature, encouraged investigation, introspection, and exploration through hand-on experiences and outdoor activities, and strengthened their responsibilitytowardsthe environment. The camp offered a valuableopportunityfor children to reflect on their personal identities and their roles in their communities. Our findings highlight the significance of creating informal learning environments like this camp to enhance children's environmental awareness, knowledge, positive outlook on the environment, empathy towards animals, and sense of responsibility towardsthe planet.

Strand 6: Science Learning in Informal Contexts
Roundtable

Refiguring Identities: Cultivating Epistemic Agency in African American Students Through Engineering Practices in STEM

Lezly Taylor*, Virginia Tech, USA
George Glasson, Virginia Tech, USA
Brenda Brand, Virginia Tech, USA

ABSTRACT
This study examines the development of epistemic agency and identity transformation among African American students participating in an informal high school pre-engineering STEM program. Drawing on Holland's Figured Worlds framework and Cunningham and Kelly's (2017) epistemic practices of engineering, the research explores how students navigate sociocultural barriers, such as race and gender, while engaging in STEM activities. Through case study methodology, multiple data sources, including interviews, observations, and student work, were analyzed to understand how participation in engineering practices, such as constructing water filters and programming EV3 robots, facilitates identity refiguring. Two key themes emerged: Negotiation of Identity in STEM through Sociocultural Barriers and Identity Transformation through Epistemic Practices of Engineering. The findings reveal that engaging in epistemic practices allows students to challenge dominant cultural narratives that traditionally exclude them from STEM fields, fostering their self-perception as capable contributors. These insights highlight the importance of creating inclusive STEM learning environments that address sociocultural barriers and support identity formation, empowering underrepresented students to see themselves as future STEM professionals.

Strand 6: Science Learning in Informal Contexts
WIP Roundtable

'Nature leads, and throws up questions for science to answer": Science and Natural Hair

Grace Tukurah*, Michigan State University, USA

ABSTRACT

This study invesitgates the process of online content creation by Black girls and women in the natural hair community to understand how they conceptualize their role in sharing science content within the community.Black girls and women in digital communities gain empowerment through collective action in the natural hair community. Hair plays an important role in a Black girl or woman's identity development and taking care of it often occupies a significant portion of their time. Natural hair content creators play a central role in helping Black girls and women in personal hair care practices and use scientific knowledge to develop these practices. Scientific knowledge within the natural hair community is diverse and recognizes science knowledge generation outside of mainstream modern science communities that are rooted in Eurocentric ideals. The findings of this study support the imporatance of digital literacy and the affordances of digital spaces for science learning for historically marginalized groups.

Strand 7: Pre-service Science Teacher Education

WIP Roundtable

Improving Science Teaching: A Comparative Study of Online and Traditional Science Methods Course Modalities

Burak Sahin*, University of Nevada, Las Vegas, USA
Maizie Dyess, University of Nevada, Las Vegas, USA
Katherine Wade-Jaimes, University of Nevada, Las Vegas, USA

ABSTRACT

This study investigates the impact of different science methods course modalities on teachers' self-efficacy and attitudes toward teaching science within the UNLV College of Education’s Paraprofessional Pathways Project (PPP). In the Summer of 2024, a science methods course was delivered asynchronously to paraprofessionals and school support professionals in Las Vegas, Nevada, with a comparison to follow using data from an in-person version of the course that will be offered in Fall 2024. Data collection included pre- and post-course surveys, written assignments, and online discussion responses, and analyzed both quantitatively and qualitatively. Preliminary findings revealed three emergent themes: teacher factors in teaching science, self-efficacy in teaching science, and teaching strategies. Results indicate a low self-efficacy among teachers regarding their ability to teach science effectively, despite participating in the course. Teachers also expressed a belief that student success in science is less influenced by their efforts and more by inherent student abilities or external factors, such as parental influence. The findings highlight the challenges teachers face in adopting effective science teaching strategies and suggest a need for further support to enhance their confidence and instructional methods in teaching science.

Strand 7: Pre-service Science Teacher Education
WIP Roundtable

Preservice teachers' understanding of NGSS-aligned science instruction measured by a modified SIPS survey

Youngjin Song*, California State University Long Beach, USA
Sara Dozier, California State University Long Beach, USA
Lisa Martin-Hansen*, California State University Long Beach, USA
Thao Tran, California State University East Bay, USA
Michele Korb, California State University East Bay, USA

ABSTRACT

In this study, we validated a modified survey to measure elementary and secondary preservice teachers' (PSTs) understanding of science instruction aligned with the Next Generation Science Standards (NGSS) in the context of a NSF-funded project. In this effort, we utilized a modified version of the Science Instructional Practices (SIPS) survey, which was originally validated and developed to track changes of in-service teachers' practices. Our study involved data collection from 1,116 PSTs enrolled in science methods courses across eight universities in the United States. The results of Exploratory Factor Analysis (EFA) indicated that the modified SIPS survey shows evidence of validity and reliability in measuring PSTs' understanding of science instruction in the context of NGSS. Analysis of the post-survey scores indicated that there is variance among PSTs' understandings of NGSS-aligned science instruction. This research provides an introduction to the modified SIPS survey measuring how PSTs currently understand NGSS-aligned instruction, offering a basis for science educators to measure possible impact on their strategies to enhance their students' understanding of NGSS. The modified SIPS survey is expected to be a valuable asset for science teacher educators, especially within the NARST community.

Strand 7: Pre-service Science Teacher Education
WIP Roundtable

Encouraging Pre-Service Teachers to Embrace STEM Education through Multidisciplinary Collaborations

UrLeaka Newsome*, Tennessee State University, USA
Catherine Armwood-Gordon, Tennessee State University, USA
Reniece Mashburn, Tennessee State University, USA

ABSTRACT

There is a need to improve self-efficacy in teaching STEM subjects among pre-service teachers and increase retention of underrepresented students in engineering programs. This study assesses an initiative involving collaborative work between education and engineering students. The study aims to determine if the program 1) positively impacts pre-service teacher self-efficacy and content knowledge for teaching STEM subjects and 2) enhances engineering student persistence through their first two academic years. A year-long program pairs education and engineering students from the same university. Students partner to develop STEM curriculum and conduct workshops for K-12 students. Program effectiveness is

evaluated through quantitative metrics including GPA, retention rates, and qualitative measures such as surveys and interviews. Participants engaged in regular training to plan STEM lessons, then developed and presented workshops for elementary students. Education students provided instructional expertise while engineering students offered technical knowledge. Strengthening skills and content mastery for teaching STEM was expected to increase pre-service teacher confidence and competence. Early exposure to instruction was hypothesized to benefit engineering students' subject understanding and retention. Findings offered insights for collaborative models that simultaneously develop the STEM teaching workforce and support students from underrepresented groups pursuing STEM degrees.

Strand 5: College Science Teaching and Learning (Grades 13-20)
WIP Roundtable

Investigating undergraduate biology students understanding of plant physiology using concept inventory

Meena Kharatmal*, Homi Bhabha Centre for Science Education (Tata Insittute of Fundamental Research), India
Mayur Gaikwad, Sophia College, India
Aashutosh Mule, Somaiya College, India

ABSTRACT

Plant physiology and respiration topics are interconnected in undergraduate biology education. Applying core concepts of matter and energy is challenging for undergraduate biology students. Misconceptions in one topic gets carried over to other topic, resulting in increasing number of difficulties. Studies indicate misconceptions about photosynthesis persist through school, college levels, from direct experiences, textbooks, teaching. The conventional assessment does not cater towards identifying misconceptions, while concept inventories (CI) are designed to diagnose students' conceptions and difficulties. The objective of this study is to diagnose students' conceptions about matter and energy in plant physiology course. A quasi-experimental study was conducted wherein students' responses were evaluated using a validated CI following plant physiology course. Findings suggest that most students (75%) provided correct responses on structural aspects of photosynthesis. However, the application of core concepts of matter and energy was a challenge, highlighting their difficulties and misconceptions. For tracing matter, only 46% provided correct response and for tracing energy only 31% provided correct responses. Most responses depicted confusion between photosynthesis and cellular respiration. These preliminary findings serve as baseline work for further research studies. The study has implications for designing pedagogical intervention for instructional change at undergraduate biology education in our country.

Strand 8: In-service Science Teacher Education
Roundtable

Influences and expressions of in-service elementary teacher agency for science: Deeply considering the SETSA framework

Anica Miller-Rushing*, Associated Universities Inc., USA

Alison Mercier, University of Wyoming, USA

ABSTRACT

This paper deeply examines the literature-based conceptual framework presented in the previously validated and published instrument, Survey of Elementary Teachers' Sense of Agency (SETSA). The SETSA investigates elementary science teachers' sense of agency for teaching science. How elementary teachers' are influenced and how they express their agency is critical to the learning outcomes of youth, particularly because elementary classrooms often serve as foundational sites for science experiences. Yet, elementary science teachers' sense of agency for teaching science is understudied. The SETSA's 10-factor model considered an elementary teacher's influence on their sense of agency for teaching science including: structures, science teacher identity, relationships, emotions, experience, professional vision. Factors included in an elementary teacher's expressions of that agency were: structure negotiation, science teacher identity negotiation, change in teacher practice and teaching with a justice orientation. Although the SETSA was validated, more work needs to be done to carefully consider and articulate the literature-based theoretical framework on which it is undergirded. This work carefully examines those factors and encourages future literature to deeply consider and critique the SETSA's conceptual framework within their theorizing of teacher agency.

Strand 8: In-service Science Teacher Education
Roundtable

A Systematic Review of Equity-Centered Mentoring for PreK-12 Science Educators

Raju Ahmmed*, University of Houston, USA
Sissy Wong, University of Houston, USA

ABSTRACT

Mentoring is an important part of teacher development as it supports novice teachers in acclimating to the teaching profession and provides an additional avenue of professional development. Beyond general topics, it is critical that mentoring is intentional and focused in developing the knowledge and skills essential to highly effective science instruction. For science teaching, mentoring should be content-specific and prepares teachers to work with the diverse student populations. To understand what equity-focused mentoring programs have been put in place, we conducted a systematic review of the literature by searching web-based sources for articles from 2000 to 2023 using key terms. We identified 21 articles after applying the inclusion and exclusion criteria. The articles were then coded using an inductive coding method to generate major categories using a thematic analysis approach.. Two coders independently coded the articles and finalized the themes through constant comparison. The results were five major themes of equity-centered mentoring; culturally responsive mentoring, differentiated mentoring, collaborative mentoring, reflective practice-based mentoring, and model-based mentoring.

Strand 8: In-service Science Teacher Education
Roundtable

Strengthening Elementary STEM Teacher Identity through Quantum Content and Curriculum

Nancy Holincheck*, George Mason University, USA
Jennifer Simons*, George Mason University, USA
Stephanie Dodman, George Mason University, USA
Xiaolu Zhang, George Mason University, USA
Jessica Rosenberg*,George Mason University, USA
Benjamin Dreyfus, George Mason University, USA
Julia Lipman, George Mason University, USA

ABSTRACT

This study examines the development of STEM teacher identity for ten elementary teachers engaged in professional learning and curriculum development for quantum science integration. We applied a model of STEM teacher identity in our analysis of pre- and post-interviews, reflective journals, and professional development artifacts. We found that participation in the project increased dimensions of teachers' STEM learner identity, as they engaged as STEM learners to understand the STEM content. Teachers also had an increase in task-perception and self-efficacy. Implications for teacher educators and science education researchers are discussed.

Strand 8: In-service Science Teacher Education
WIP Roundtable

Using an intersectional approach to uncover inequities in access to research experience for teachers programs

Amanda Morrison*, Oregon State University, USA

ABSTRACT

Research experience for teachers (RET) professional development (PD) programs have long been regarded as an effective means for science teachers to learn and develop skills necessary to effectively teach science. RET programs immerse learners in conducting research alongside professional researchers, engaging them in the practices of science which they bring back to their classroom teaching. However, those who are able to participate tend to be privileged due to social capital determined by many factors outside of the individuals control. The goals of this work-in-progress research project are to reveal who does and who does not have access to RET programs and to explore barriers to accessing these learning opportunities. Quantitative methods are used to analyze applicant data from multiple RET programs and to conduct an intersectional investigation of individual and structural level variables related to access and equity issues facing in-service teachers decision to apply. Findings will inform the science education research community about how representative participation in RET programs actually is and enable PD program developers to reimagine the research experience so that it is more inclusive and accessible to all K-12 science teachers.

Strand 8: In-service Science Teacher Education
WIP Roundtable

Examining Critical Reflexivity in STEM Career Change Teachers

Jennifer Simons*, George Mason University, USA

ABSTRACT

As education faces an increase in unfilled positions, career changers are increasingly filling STEM education jobs. STEM career changers are highly sought after as STEM educator positions are historically difficult to fill, especially in schools serving low-income students and students of color. While career changers may excel at content knowledge, already being experts, the classrooms they will most likely work in will be increasingly diverse. Understanding career changers' capacity for critical reflection and which factors amplify or obstruct their critical reflexivity is increasingly important to provide equitable education. This qualitative proposal seeks to understand how STEM career changers critically reflect, and which factors affect educators' ability to critically reflect in their practice.

Strand 11: Cultural, Social, and Gender Issues
Roundtable

Engineering as Culturally Responsive Science Education Amidst CRT and DEI Prohibitions

Christopher Irwin*, Florida International University, USA
Berry Lamy, Florida International University, USA
Joshua Ellis, Louisiana State University`, USA
Andrew Green, Engineering For Us All, USA
Nicholas Oehm, Florida International University, USA
Darryl Dickerson, Florida International University, USA

ABSTRACT

Recent policy changes have necessitated a rethinking of what it means to teach STEM for diversity, equity, inclusion, and social justice in areas where state and local legislation has been passed to prohibit discourses related to CRT and DEI. Consequently, there is a large geographic and heavily-populated area within which educators may find that their typical ways of ensuring equitable and inclusive classroom environments are no longer sanctioned. In this roundtable session, we share how secondary science educators and their students have experienced an encouraging overlap of engaging engineering lessons and practices that acknowledge and value students assets, values, and experiences. We see an urgent need for the proliferation of teaching practices that acknowledge and respond to students' identities, lived experiences, and cultures, while keeping teachers and their students safe from whatever punitive action may be associated with "teaching CRT," "teaching DEI," "being woke," etc. Although the activities in our project were originally conceived as engineering activities, most of the lessons do not require expert engineering knowledge on the part of the teacher. Thus, we believe that these strategies are worth exploring in other teaching contexts: other places in the United States, as well as within K-8 education.

Strand 11: Cultural, Social, and Gender Issues
Roundtable

Towards a Science Education Chimera and Possibilities for Professional Learning

Linsey Brennan*, Michigan State University, USA
Terrance Burgess, Michigan State University, USA

ABSTRACT

Science teachers' sensemaking of racialized and gendered phenomena is consequential for equity in science education; however, teachers are often dysconcious of the ways their sensemaking discourse is based on taken-for-granted assumptions, influenced by and reifying dominant systems of power. Existing scholarship identifies and explains individual concepts comprising the dominant culture of science education; however, there exists a need to conceptualize the ways these concepts interact with one another and the dominant culture of broader society. Drawing on work from Critical Race Theory, we offer the Science Education Chimera as a conceptual framework for understanding systems of power and oppression within science education. The chimera's three heads (Western Modern Science, Science as White Property, and the Achievement-Motivation Master Narrative) each operate independently, and yet, mutually reinforce one another and whiteness, patriarchy, and capitalism. The Science Education Chimera, particularly when paired with Critical Discourse Analysis, offers future possibilities for professional learning that supports science teachers in understanding and shifting their own sensemaking discourses towards equity.

Strand 11: Cultural, Social, and Gender Issues
WIP Roundtable

Implications for Black Individuals in STEM within the Mid-Atlantic Region: A Systematic Literature Review

Jess Edwards*, American University, USA
Martinique Sealy, American University, USA
Shari Watkins, American University, USA
Brian McGowan, American University, USA
Ihsan Hawkins, American University, USA
Zaki Hawkins, American University, USA

ABSTRACT

This research contributes to literature for a mixed methods study focusing on the examination of Black people across STEM disciplines within the Washington Metropolitan area. This systematic literature review provides socio-historical contextual background that informs future STEM research in this region and adds to the literature focused on the history of Black people in STEM generally. The primary objective of this systematic literature review was to identify empirically supported items (e.g. books, articles, thesis, news, law briefings) relevant to Black/African American's studying or working in STEM fields at universities in the MidAtlantic region (i.e. Washington, D.C., Maryland, Virginia, West Virginia, New York, New Jersey, Pennsylvania, and Delaware).

Strand 11: Cultural, Social, and Gender Issues
WIP Roundtable

Catalytic catharsis: breaking the self-perpetuating cycle of unchanging white anti-racism in science education

Michael Nocella*, University of Illinois Chicago, USA

ABSTRACT

Science education plays a profound role in the reproduction of whiteness and white supremacy (Le Matias, 2019). This is further exacerbated by white emotions in education spaces, which often drive the choices that teachers make (Matias, 2016). As white, cisgendered, male science teachers have privileged voices, and thereby emotions, within science education, they often dictate the norms and values associated with communities of practice (Yerrick Johnson, 2011). With this in mind, white teachers are often "emotionally blocked" (Matias et al., 2016, p. 3) to anti-racism. Most efforts towards anti-racism will, therefore, likely be met with significant resistance. Usingcritical positional praxis(Rodriguez et al., 2024) as a lens, this critical autoethnographic study focuses on the roles that white emotions can play in catalyzing the (re)production of whiteness within science education. Despite the power of white emotions within communities of practice, the catalytic cycle of whiteness (re)production proposed in this paper can be broken by those to which it most directly applies, in-service white, cisgendered male, science educators. This paper, therefore, acknowledges the tenacious efforts of science teachers confronting white supremacy in science education amidst the hostility posed by white emotionalities, as they work towards a more just future.

Strand 11: Cultural, Social, and Gender Issues
WIP Roundtable

We Are Empowered! The Positionality of Black Women Science Teachers to Engage Black Girls

Teresa Massey*, Georgia State University, USA

ABSTRACT

Black women science teachers' experiences and perceptions; their pedagogical knowledge, orientations, enactments; and the impacts of their pedagogy can be impactful in contributing to Black girls developing a science identity.Dialogical relationships between Black women science teachers and the girls that they teach can lead to their shared empowerment to change the Black women STEM deficit narrative. The purpose of this study is to examine the ways that dialogical relationships between Black women science teachers and the Black girls that they engage can provide a foundation for a STEM career.

Strand 11: Cultural, Social, and Gender Issues
WIP Roundtable

Translanguaging in Science Classrooms: Student Perspectives on and Identity Outcomes of Using Multilingualism in Science

Alexis Rutt*, University of Mary Washington, USA
Erich Sneller, Harrisonburg City Public Schools, USA

Elizabeth Hunter, Harrisonburg City Public Schools, USA

ABSTRACT

As science classrooms become increasingly linguistically diverse, translanguaging pedagogies have been highlighted as a way to support multilingual learners' (MLs') science learning and engagement while challenging monoglossic norms that dominate K-12 education and disadvantage linguistically minoritized students. Significant research in recent years has investigated the educational outcomes of a translanguaging stance in science classrooms, yet little research has considered how opportunities to engage translingually in science classrooms relates to MLs' perspectives on the role of language in science and the relevance of science in their communities, and how translingual learning might relate to MLs' science identity formation. The purpose of this work-in-progress is to determine how opportunities to engage in science translingually in Spanish-dominant and English-dominant environmental science and biology classrooms are taken up by MLs, and how these opportunities relate to MLs' perceptions of the role of multilingualism in science, their science identities, and the perceived relevance of science in their lives and communities. After a presentation of initial findings, the authors will engage attendees in conversation about how teacher education and research are working to dismantle the monoglossic norms dominant in science education, and what contextual considerations, particularly those related to student perspective, need to be considered.

Strand 11: Cultural, Social, and Gender Issues
Roundtable

Exploring how language is framed to describe impostor phenomenon in STEM fields

Devasmita Chakraverty*, Indian Institute of Management Ahmedabad, India

ABSTRACT

Impostor phenomenon occurs when successful peopledisbelieve their success and feel like a fraud. It is prevalent inscience, technology, engineering, and mathematics. Using conceptual metaphor theory, this is a secondary analysis of textual data collected from an online national survey in 2017-2018. In an open-ended question without word limit, 959 participants (students and professionals) described an instance when they experienced impostor phenomenon. This yielded 41,205 words of free-text responses. Of them, 484 responses used metaphors to describe their impostor phenomenon; these responses were analyzed using hybrid (inductive and deductive) coding. Findings showed the use of 198 metaphors further grouped into eight metaphor families. Most frequently used were metaphors of1) health; 2) war or violence; 3) sports and game; 4) force or struggle; and 5) animal/plant. The least used were metaphors of quality, fit, and probability/statistics. This cross-sectional study showed how people frame impostor experiences when not prompted a priori (through scale items). Findings reveal how STEM persons use language to frame impostor experiences; they can help design interventions where people learn to frame their experiences in constructive ways to manage it better; and to develop new, more contextually relevant measurement scales.

Strand 11: Cultural, Social, and Gender Issues
WIP Roundtable

Is it culturally responsive teaching if the teacher does not call it that?

Elaine Howes*, American Museum of Natural History, USA
Jamie Wallace*, American Museum of Natural History, USA

ABSTRACT

In this study, we explore teachers' perspectives and practices concerning culturally responsive education in their science classrooms, bringing teachers' voices and actions into the ongoing discussion. As part of a larger study, we are developing nine case studies based in teachers' practices in high-need schools in urban, suburban, and rural settings. This case study focuses on what one teacher does and considers regarding culturally responsive education (CRE) in their science classroom. To frame the study, we use tenets of CRE that describe teaching that holds high expectations for all students' learning, values students' assets and uses these assets as resources in instruction, draws upon students' cultures to strengthen their connections to them, and adopts and supports students in developing a critical stance toward sociopolitical structures and processes. Interestingly, in this teacher case study, the teacher stated that they did not plan explicitly for CRE nor did they think about it intentionally. However, we found evidence of culturally responsive teaching as described in the literature and supported by the CRE tenets. Thus, we aim to discuss in this Roundtable presentation:Is it culturally responsive teaching if the teacher does not call it that?

Strand 11: Cultural, Social, and Gender Issues
WIP Roundtable

Science and language: how can we support student integration?

Maiza de Albuquerque Trigo*, University of Luxembourg, Luxembourg
Pit Lepage, Ministry of Education, Luxembourg
Thierry Frentz, Ministry of Education, Luxembourg

ABSTRACT

[blinded country] is a multilingual country with a complex stratified school system. The student diversity scenario reflects the country's population diversity, whereas there is almost an equal balance between foreign and native residents. Children who arrive in [blinded country] are directed to a support system to develop skills in the school languages, named [reception]. This contribution aims to present a pilot project [blinded – Science and Language], which intends to facilitate language acquisition and science literacy simultaneously amongst migrant children through an integrated curriculum approach. This project will take place between November 2024 and April 2025 and we (the researcher and the teachers involved in the project) will discuss about how the project is being implemented, with the goal of exchanging ideas with other presentations that use the dialogue between science and language as a support system to integrate newcomer students in a primary school system.

Strand 11: Cultural, Social, and Gender Issues
WIP Roundtable

Examining Culturally Relevant Dispositions in District Science Coordinators and Science Teachers

Meredith Schwendemann*, Clemson University, USA
Brooke Whitworth, Clemson University, USA
Julie Luft, University of Georgia, USA

ABSTRACT

This explanatory sequential mixed methods study investigates district science coordinators' (DSC) and teachers' attitudes and beliefs about culturally relevant education (CRE). DSCs are science education leaders in a position to influence the instructional practices of teachers, including their incorporation of CRE. CRE is an inclusive term drawing from asset-based pedagogies including culturally relevant pedagogy, culturally responsive teaching, and culturally sustaining pedagogies. CRE has been shown to improve student outcomes when incorporated into classroom practice. Utilizing a CRE framework from Aronson and Laughter (2016) and Bronfenbrenner and Morris' (1998) Process-Person-Context-Time framework, we seek to identify common characteristics and contexts that support the development of attitudes and beliefs aligned with CRE. Initial quantitative results from theDispositions of Culturally Responsive Pedagogies Scale(Whitaker Valtierra, 2018) indicate DSCs and teachers are receptive to CRE, however, there is no correlation between DSC and teacher scores within the same school district. Interviews provide additional qualitative data to further identify common characteristics of individuals and contexts that may promote dispositions toward CRE. The findings of this study may inform professional development and pre-service teacher education experiences that can support the development of culturally responsive dispositions among science teachers.

Strand 15: Policy, Reform, and Program Evaluation
Roundtable

A Case for Elevating Community STEM Brilliance Beyond the Pipeline in Global Policy Discourses

Meredith Bittel*, University of Kansas, USA
Alexander Bittel*, University of Kansas, USA

ABSTRACT

The pipeline model of STEM education, which focuses on developing human capital through technical knowledge and skills, is viewed as a development panacea for the Global South. Through a critical examination of two key global policy discourses - STEM for sustainable development and gender equity in STEM - we reveal how this model of STEM education legitimizes a narrow definition of STEM skills and knowledge, which functions to marginalize local STEM knowledge, create and perpetuate deficit-based narratives of the Global South, and reinforce global power hierarchies. By advocating for a community assets-based approach that values local STEM brilliance, this study calls for a shift away from the pipeline model towards more just and equitable STEM education frameworks that are adaptable to local context, value local STEM knowledge, and envision broader outcomes of STEM

education. The study highlights the need for counter-narratives that center community-based knowledge and promote a more globally inclusive vision of STEM education.

Strand 15: Policy, Reform, and Program Evaluation
WIP Roundtable

Fidelity of Implementation to Three-Dimensional Critical Components: A Systematic Review

Lauren Browning*, George Washington University, USA

ABSTRACT

April 2023 marked the tenth anniversary release of the Next Generation Science Standards (NGSS). In an effort to review the standardization of research on NGSS, it is imperative to understand how studies that claim NGSS-alignment are portraying their adherence to NGSS critical components. This research is a systematic review that aims to characterize researchers fidelity to NGSS-alignment. It is important to understand how researchers characterize reform efforts because it ensures they are conducting research that is both consistent across the literature and faithful to how it was intended to be depicted by the standards. The study consists of four phases culminating in a full text review of appropriate studies. Relevant studies in the final phase are given an overall quality rating of either high, medium, or low and characterize how researchers are addressing NGSS alignment.

Strand 15: Policy, Reform, and Program Evaluation
WIP Roundtable

Leader Identity Construction of Science Teachers who use Social Media to Advocate for Science Education

Rachel Benzoni*, University of Nebraska-Lincoln, USA

ABSTRACT

This study explores how secondary science teachers who advocate for science education on social media platforms construct their identity as leaders. Participants were recruited through personal contacts and professional organizations and given a survey to determine eligibility for the study. Eligible participants are those who self-identify on the survey as having used and/or are currently using social media to advocate for science education. Eligible participants then participate in a semi-structured interview. Transcripts of their interviews were analyzed and thematically coded. Participants were asked to provide the content discussed in that interview. The content on their social media account was examined to collect digital artifacts of their advocacy for content analysis as well as for discussion in follow up interviews. The goal of the study is to add to the research on science teacher leaders who currently engage in advocacy on social and to inform the creation of professional learning experiences for science teachers who wish to learn how to advocate.

Reshaping traditional science teaching methods to deepen student understanding and engagement

Strand 4: Science Teaching — Middle and High School (Grades 5-12): Characteristics and Strategies
26-Mar-25, 9:00 AM-10:30 AM
Location: Baltimore 4

Stand-Alone Paper

The Potential of an "Epistemic Boost" to Support Student Belonging in Science

Corinne Singleton*, University of Colorado Boulder, USA
William Penuel, University of Colorado Boulder, USA
Anna-Ruth Allen, University of Colorado Boulder, USA
Clarissa Deverel-Rico, University of Colorado Boulder, USA
Andrew Krumm,2 School of Information and Michigan Medicine, University of Michigan, USA
Carol Pazera, 3 Charles A. Dana Center, University of Texas, Austin, USA

ABSTRACT

The "practice turn" in science education seeks to meaningfully engage students in science practices in order to increase learning and disciplinary identification and belonging (Passmmore et al., 2014). However, research has shown that engaging in practices may be insufficient for students to fully grasp an expanded understanding of science that creates spaces for them to see themselves within the discipline (Berland et al., 2016; Manz et al., 2020). Here, we examine the extent to which classrooms that cultivate an expansive epistemology of science also support students' sense of belonging in science. By an "expansive epistemology" we refer to an understanding of science as an endeavor driven by our curiosities about the world—an endeavor that involves uncertainty and mistakes, collaboration, multiple ways of knowing, sharing and critiquing ideas, and persistence in gathering evidence to incrementally advance our scientific understanding. We conduct hierarchical linear modeling with survey data from 847 middle-school students across 31 classrooms and nine states to examine relationships between classroom epistemologies of science and students' sense of belonging. We argue that fully realizing the vision of the "practice turn" requires that we also embrace an "epistemic boost" to advance equity and belonging in science education.

Stand-Alone Paper

System Thinking Approach in Fostering Students' Understanding of the Concept of Chemical Equilibrium

Guluzar EYMUR*, Giresun University, Turkey

ABSTRACT

AbstractThe primary objective of this research was to enhance students' comprehension of chemical equilibrium by implementing a systems thinking approach.The study involved students from a public high school that primarily prepared students for university education. 53 students in the 11th grade, divided into two intact classes, participated in this research. The experimental group comprised 28 students (16 females and 12 males), while the comparison

group consisted of 25 (15 females and 10 males), all aged 15 to 16 years. To evaluate the effectiveness of the systems thinking approach, we compared student learning under two different instructional conditions. In the experimental group, students received instruction in a chemistry class where the curriculum was designed with a focus on systems thinking. The comparison group, on the other hand, received identical chemistry lectures but followed a more traditional teaching approach. Both groups received instruction on chemical equilibrium, which spanned two weeks and four hours of teaching by the same instructor. The study results indicated that the systems thinking approach was superior in enhancing students' comprehension of chemical equilibrium compared to the more traditional teaching method.

Stand-Alone Paper

Recognized and Realigned: A Veteran Teacher's Moves to Realign Familiar Forms of Epistemic Agency

Christine Hirst Bernhardt*, University of Maryland, USA
Andrew Elby, University of Maryland, USA

ABSTRACT

Our case study explores a mismatch between students' familiar forms of epistemic agency and the forms of epistemic agency invited by a set of NGSS-aligned curricular materials, showing how a veteran teacher adjusts the lesson to better align with the forms of epistemic agency to which students were accustomed. Initial lessons did not appear to "work" and students pushed back. The teacher's adjustments—such as allowing students to choose their sources of information and encouraging them to present that information in their own words—led to increased student engagement and ownership over their learning. The findings suggest that structured, NGSS-aligned curricula can be more effective when teachers adapt them to align with familiar epistemic cultures, routines and opportunities. This study highlights the importance of understanding the different forms of epistemic agency that students are accustomed to and how these can be leveraged to enhance engagement with science practices. The implications for teacher professional development are significant, suggesting the need for professional learning that empowers teachers to modify curricula in ways that resonate with their students' established ways of learning while maintaining the integrity of the science practices embedded in the materials.

Stand-Alone Paper

Variations in Epistemological Messaging in High School Biology

Cynthia Passmore*, University of California, Davis, USA
Hessam Ghanimi, University of California, Davis, Saint-Barthélemy
Cari Hermann-Abell, BSCS Science Learning, USA
Patricia Olson, BSCS Science Learning, USA
Jeffrey Snowden, BSCS Science Learning, USA
Molly Stuhlsatz, BSCS Science Learning, USA
Chris Wilson, BSCS Science Learning, USA

ABSTRACT
This study investigates the epistemological messages conveyed by high school biology teachers during classroom instruction. Drawing on the concept of "epistemological messaging," which encompasses how teachers communicate the nature of knowledge-building in science, we examine how these messages differ across instructional contexts. Our research questions explore the types of epistemological messages teachers send and how they vary across the study sample. Using a remote observation protocol focused on teacher actions, we analyzed lessons from a larger curriculum intervention study. We present findings from a subset of teachers, highlighting contrasts in how they elicit and respond to student ideas. Our analysis reveals differences in the extent to which teachers encourage students to explain their reasoning, incorporate student ideas into discussions, and position students as active participants in knowledge construction. This work contributes to understanding how curriculum and teacher practices shape the epistemic context for science learning, with implications for supporting reform efforts centered on student agency in scientific practices.

Stand-Alone Paper

Multiple Case Studies of Middle School Students' Epistemic Practices of Engineering During Integrated STEM Unit

Muhammad Purwanto*, University of Minnesota-Twin Cities, USA
Gillian Roehrig, University of Minnesota-Twin Cities, USA
Jeanna Wieselmann, Southern Methodist University, USA

ABSTRACT
K-12 students are expected to work collaboratively in small groups during science learning to develop design solutions, mirroring professional engineers' and scientists' practices. These activities provide opportunities to examine how discourse shapes students' understanding and practices. However, limited research focuses on student discourse and dynamics during small-group engineering work. Therefore, this study explored students' engagement in epistemic practices of engineering during small-group activities. Using multiple-qualitative case studies, we examined how multiple groups of middle-school students engage in these practices during an integrated STEM activity. Participants included one all-boys group, one all-girls group, and one mixed-gender group. Our findings revealed diverse engagement in epistemic practices, largely independent of teacher facilitation, emphasizing the interwoven nature of cognitive processes, sense-making, and knowledge-building.

NARST Connects
26-Mar-25, 10:45 AM-12:15 PM
Location: Baltimore 5

Discussion Session
This is a time for conference attendees to connect and discuss professionally related topics of their choosing. There are no designated presenters or moderators. Participants are expected to adhere to the NARST Program Code of Conduct.

Instructor Supports and Strategies for Implementing Student-Centered Instruction
Strand 5: College Science Teaching and Learning (Grades 13-20)
26-Mar-25, 9:00 AM-10:30 AM
Location: Magnolia 3

Stand-Alone Paper
Findings from the Implementation of a Learning Community for Science Faculty
Peter Cormas*, Pennsylvania Western University, USA
Min Li, Pennsylvania Western University, USA
Louise Nicholson, Pennsylvania Western University, USA
Kyle Fredrick, Pennsylvania Western University, USA
Elizabeth Steiner, RAND Corporation, USA
Sy Doan, RAND Corporation, USA
Rebecca Wolfe, RAND Corporation, USA

ABSTRACT
A ubiquitous type of professional development known as a learning community (LC) has successfully been used to impact instruction and student learning in the higher education science classroom. A LC resembles a focus group, has a facilitator, and allows higher education science faculty (instructors) to have conversations centered on beliefs, attitudes, skills, instruction, and student learning. The authors recently implemented a one-year LC with instructors (n=7) at their institution. Findings from surveys and focus interviews include that instructors believed (a) the LC motivated them to try new instructional strategies, (b) the LC was a good use of their time, and (c) the changes that they made to their instruction improved student engagement and collaboration but did not impact science literacy, grades, or attendance. The instructors enjoyed talking about their instruction and learning about their colleagues' instruction, and stated that being in a LC improved their relationships with their colleagues. While instructors believed that active learning strategies are valuable and were motivated to devote more class time to them, numerous barriers prevented them from doing so, including the amount of content they need to cover in class, lack of planning time, and students' lack of foundational content knowledge.

Stand-Alone Paper

Science Student-Teacher Perceptions of the Project-Based Learning (PjBL) Model: A Phenomenological Study with Graduate-Level Students

Isabel Delgado*, University of Puerto Rico-Rio Piedras, Puerto Rico
Emanuel Santos*, University of Puerto Rico-Rio Piedras, Puerto Rico

ABSTRACT

Project-Based Learning (PjBL) model is highly recommended to frame STEM learning experiences to achieve transformative education at all levels (Boss Larmer, 2018; Carpraro et al., 2013; Jiang et al., 2024). This qualitative phenomenological study (Creswell, 2012) describes the perceptions and experiences of science student-teachers towards the PjBL model implemented in the graduate course they were enrolled during the academic year 2022-2023 at the College of Education of a public university of Puerto Rico. The "Gold Standard PBL" framework was used to design and implement the curriculum unit. The study involved 12 graduate students, 6 master's and 6 doctoral students, who took one of the core courses of their program in Curriculum and Teaching with a subspecialty in Science Education. Data collection techniques include, initial and final individual interviews, document analysis (reflective notebooks and final products) and a focus group for master's students. The findings indicate that the PjBL model was perceived as a constructivist learning model that allowed greater learning of the course content. The experience at the graduate level was qualified as highly valuable by participants for their training as science teachers. Motivation and collaborative learning are two elements that stand out as essential to their learning process.

Stand-Alone Paper

Planning to Fail: Teaching Strategies to Navigate Failure-Related Research Challenges in an Introductory Biology CURE

Joseph Harsh*, James Madison University, USA
Gabrielle Gauldin, James Madison University, USA
Isobel Cobb, James Madison University, USA
Sarah Coleman, James Madison University, USA
Emma Powell, James Madison University, USA
Charlotte Stewart, James Madison University, USA
Julie Cumins, James Madison University, USA
Brett Chappell, James Madison University, USA
Lisa Corwin, University of Colorado - Boulder, USA
Oliver Hyman, James Madison University, USA

ABSTRACT

The ability to successfully navigate research-related challenges and failure is widely recognized as a hallmark of a proficient scientific disposition and has been identified as a predictor of persistence in the sciences. Despite this importance, undergraduates are rarely taught how to productively cope with research-related failures. Course-based research experiences (CURES) can provide ideal environments for students to develop their ability to navigate scientific obstacles when provided the appropriate instructional support and

scaffolding to do so. This work reports on a framework – that relies on "predictable failures", iteration, reflection, collaboration, and failure normalization – for explicitly building instruction into the curriculum to prepare students for research failure and help them develop resilience using a large-enrollment introductory biology CURE as a case study. Mixed methods data from 300 current and former CURE participants in two studies provide evidence to the effectiveness of the framework in contributing to their preparation for and adaptive coping responses to failure. This study adds to our understanding of generalizable and scalable instructional activities in support of the development of introductory CURE participants' scientific resilience that can be used by educators and researchers interested in helping research students "learn how to fail".

Stand-Alone Paper

Exploring Instructor Autonomy Support in Student-Centered College Biology Classrooms

Kimberly Pigford*, North Carolina Agricultural and Technical State University, USA
Miriam Ferzli, North Carolina State University, USA
Margaret Blanchard, North Carolina State University, USA

ABSTRACT

Active learning instructional practices are becoming more commonplace in undergraduate STEM courses thanks to a growing body of research illustrating the positive benefits to students and several national calls for reform that emphasize the development and use of active learning practices. For students to be successful in any learning environment the instructor must support and nurture the students' sense of autonomy and volition regarding their own learning, but this is particularly true in student-centered learning environments where students may be uncomfortable taking control of their own learning. Based within the theoretical framework of Self Determination Theory, this quasi-experimental study utilized hierarchical linear multiple regression modeling to examine the effects of instructor autonomy support (IAS) on student motivation, performance, and behavioral outcomes in both a traditional biology lecture section and sections utilizing active learning. Results from the study found that student perceived IAS was higher in sections utilizing active learning than traditional lecture and that IAS had a positive effect on student motivation and performance. The results provide further support for the use of student-centered instructional practices in undergraduate STEM courses and highlight the importance of the instructor and their role in creating a successful student-centered learning environment.

Empowering agency to support Teaching and Learning
Strand 7: Pre-service Science Teacher Education
26-Mar-25, 9:00 AM-10:30 AM
Location: Baltimore 2

Stand-Alone Paper
Empowering Future Educators: Pre-Service Elementary Teachers' Self-Efficacy related to Equitable Science Instruction
Lillian Bentley*, Georgia State University, USA

ABSTRACT
This mixed-methods study explores how pre-service elementary teachers (PSET) develop self-efficacy related to equitable science instruction, a critical skill as the U.S. student population becomes increasingly diverse. While previous research has focused on general science teaching self-efficacy, this study delves into the specific challenge of equipping predominantly White, female, and monolingual PSET to teach science in ways that are culturally and linguistically responsive. Using a parallel convergent mixed-methods design, the study collected quantitative data from 97 PSET through the Self-Efficacy Beliefs About Equitable Science Teaching (SEBEST) survey (Ritter et al., 2001), and qualitative data from interviews with eight PSET across five institutions. The findings reveal that while most PSET exhibit strong self-efficacy in equitable science teaching, there are notable gaps, particularly in supporting English language learners and female students in science. The study highlights the need for teacher education programs to explicitly address these challenges, fostering an inclusive ethos and empowering future educators to create equitable learning environments. The research contributes to the discourse on equitable science education, advocating for curriculum changes that prioritize diversity, equity, and inclusion, and suggesting further exploration into the intersectionality of race, gender, and language in shaping PSETs' teaching practices.

Stand-Alone Paper
Empowering International Science Teacher Candidates (ISTC) to Become Agentive Contributors
Moyu Zhang*, Indiana University, USA

ABSTRACT
International Science Teachers and Teacher Candidates (ISTCs) often encounter multiple deficit views that hinder their strength and effectiveness in teacher education. The literature largely portrays ISTCs through a lens of linguistic and cultural deficits, overlooking their potential contributions. This study aims to develop a Transformative Empowerment Framework for ISTCs (TEFI) that shifts the narrative from a deficit to a more agentive and active perspective, which employs Transformative Activist Stance (TAS), Standpoint Theory, Indigenous Knowledge Theory, Belongingness and Care theory to develop a bricolage theoretical framework. The framework was integrated into a graduate-level science education pedagogy course. Evidence shows that the framework effectively challenged and

began to transform the entrenched deficit stance both internally among ISTCs and externally among educational stakeholders.

Stand-Alone Paper

Agency and the two-worlds problem: What emerges from an asset-based understanding of preservice teachers' learning.

Ryan Coker*, Florida State University, USA
Lama Jaber, Florida State University, USA
Sherry Southerland, Florida State University, USA

ABSTRACT

Pre-service science teachers develop their teaching practices across the university and school contexts of teacher education programs. The practices and visions of teaching emphasized in each context are often disjointed, a problem scholars of teacher education refer to as the "two-worlds problem." This qualitative case study explores how two pre-service teachers recontextualized and transformed teaching practices across contexts, and how they navigated tensions related to their appropriation across contexts. The findings highlight how they enacted agency to re-envision and reject teaching in ways that aligned with how they were recontextualizing and transforming teaching practices across contexts. Critically, our findings pressed us to reconsider how we, as a field, have privileged our own university contexts and demands in discussions of teacher education and teacher agency. In this study, we located pre-service teachers agency in their navigation of tensions in the school context, and showed how their work to re-envision and reject university teaching practices were choices agentively made within the structure of the two-worlds problem. Our work contributes to the field of science education research by suggesting how reframing this locus of agency also reframes our approach to supporting pre-service teachers' learning across the contexts of the two-worlds problem.

Stand-Alone Paper

A Framework for Supporting Reform-Oriented Storyline Instruction in Preservice Science Methods Courses

Benjamin Lowell*, New York University, USA
Sage Andersen, University of Texas at Austin, USA
María González-Howard, University of Texas at Austin, USA

ABSTRACT

One method that has shown promise around helping teachers develop their ability to implement reform-oriented science teaching is the use of curricular materials designed for these goals paired with learning experiences around these materials. In particular, storyline materials are a relatively new approach centered around students using science practices to figure out phenomena in the context of a series of investigations that are motivated by students' emergent questions across a unit. Though emerging research has indicated promise in these materials supporting inservice teacher learning, there is little theorizing or empirical research on how they might be employed to support learning in the preservice context. We propose a framework for designing preservice science methods class using

storyline materials: 1) develop avisionof reform-oriented science instruction 2) highlightcore practicesof the storyline instructional approach that can help teachers to achieve that vision 3) encouragereflective sensemakingon the tensions, uncertainties, and possibilities tied to using storyline instruction. Based on this framework, we crafted a conjecture map to outline key design choices that might support this work for preservice teachers. We describe the map, how it influenced the design of preservice science methods courses, and future research questions that it raises.

Epistemic Orientations and Scientific Sensemaking

Strand 7: Pre-service Science Teacher Education
26-Mar-25, 9:00 AM-10:30 AM
Location: Baltimore 1

Stand-Alone Paper

Preservice science teacher educators' language orientations for scientific sensemaking

María González-Howard*, The University of Texas at Austin, USA
Sage Andersen, The University of Texas at Austin, USA
Leticia Garza, The University of Texas at Austin, USA
Nazia Tasnim, The University of Texas at Austin, USA

ABSTRACT

Because of the language-intensive nature of science practices there has been a rapid expansion of research exploring approaches for developing preservice teachers' dispositions and pedagogies for working with multilingual students. This line of research has mostly focused on the learning experiences of preservice teachers, and while important, we argue that the field needs to also step back and examine preservice science teacher educators (PSTEs). PSTEs' orientations and practices greatly impact teacher education spaces, and therefore can greatly influence the next generation of science teachers' orientations and practices. Addressing this void, in this study we adopt a translanguaging lens to explore PSTE's language orientations for scientific sensemaking.Twenty-four PSTEs engaged in a survey designed to unearth an individual's language orientations, specifically as they relate to how multilingual students use language to sensemake via science practices. Analyses revealed patterns around PSTEs' language orientations, including that what a PSTE views countsas language can influence their views of how and why language is used for sensemaking, as well as which language resource(s) students should use. Findings suggest the importance of supporting PSTEs in problematizing their own language orientations, and of helping PSTEs develop more expansive views around language for scientific sensemaking.

Stand-Alone Paper

EPISTEMIC ORIENTATIONS OF PRE-SERVICE SCIENCE TEACHERS IN A SCIENCE METHODS COURSE

Yetunde Adaramola*, Washington State University, USA

Omowumi Frieyo*, Washington State University, USA
Patrick Ochieng*, Washington State University, USA
Andy Cavagnetto, Washington State University, USA

ABSTRACT

There is strong evidence to show that the epistemic orientation of science teachers influences the classroom practices of teachers. However, we know very little about how pre-service teachers' epistemological orientations change as they progress through their teacher education programs. This explanatory research examined the shift in the orientation of a group of 12 pre-service teachers enrolled in a secondary science education course. Preservice teachers completed the Epistemological Orientation Survey (Suh, 2022) when they commenced their course (Pre) and many artifacts were collected during the course of the semester such as vignette 1, 2, 3, lesson plan, Lesson plan reflection, Video analysis 1, 2 and final examination and then again at the end of the semester the Preservice teachers completed the Epistemological Orientation Survey (Suh, 2022) (Post). The EOS scores indicated that there were shifts in some of the preservice teachers' orientation between course entry and the end of the semester of their course. The qualitative data show that some students moved further towards an orientation that supports a generative learning environment, other students are interpreting the fundamental ideas of the course differently. Results are discussed in terms of the implications for teaching and teacher education.

Stand-Alone Paper

Secondary Pre-Service Science Teachers' Learning to Use Students' Ideas

Nessrine Machaka*, University of Illinois at Urbana Champaign, USA
Christina Krist*, Stanford University, USA

ABSTRACT

This study addresses the need for responsive teaching in light of current science education reforms. Responsive teaching involves recognizing and building on students' ideas, adapting instruction, and engaging with their intellectual resources (Robertson et al., 2016; Thompson et al., 2016). However, this approach is challenging for novice teachers, particularly during the induction period (Haverly et al., 2020). Consequently, studying PSSTs' instructional vision is crucial because it shapes their approach to teaching, guiding them in making pedagogical decisions that align with high-quality instruction (Munter, 2014). Through longitudinal interviews with four PSSTs, this qualitative study examines how various factors influence the construction of their instructional visions during their preparation year. The analysis identified several factors that influenced their instructional vision construction, including teacher education programs, teaching placements, and unique experiences like summer camps or research projects. These factors influenced different aspects of the PSSTs' instructional visions, such as beliefs about teaching and learning and images of high-quality instruction. The study highlights the importance of context and prior experiences in shaping instructional visions and offers insights into how teacher education programs can better support the development of responsive teaching practices by providing evidence-based recommendations for enhancing teacher education to align with reform-oriented instruction.

Stand-Alone Paper

Examining how teachers support students' equitable science sensemaking: A review of the literature from 2012-2024

Carrie-Anne Sherwood*, Southern Connecticut State University, USA
Amanda Benedict-Chambers*, Missouri State University, USA

ABSTRACT

This paper presents a systematic review of literature published between 2012 and 2024 on how teachers support students' equitable sensemaking in science education. As K-12 science education shifts towards active engagement in scientific practices, the concept of sensemaking emerges as pivotal for students to construct knowledge by resolving gaps in understanding. Central to this approach is the notion of epistemic agency, where students are empowered to shape classroom discourse and knowledge-building processes. The review synthesizes findings across various studies focusing on pedagogical practices that promote equitable sensemaking, highlighting themes such as teacher noticing, responsiveness to student ideas, and the challenge of reconciling traditional pedagogical beliefs with contemporary educational goals. Key implications for teacher education and practice are discussed, emphasizing the need for targeted supports and professional learning to foster environments conducive to equitable science sensemaking. This review contributes to the evolving discourse on effective science teaching by identifying areas of consensus, gaps, and future research directions aimed at enhancing educational equity and student engagement in science classrooms.

Transforming Teacher Perspectives for Innovative Science Education Implementation

Strand 8: In-service Science Teacher Education
26-Mar-25, 9:00 AM-10:30 AM
Location: Annapolis 3

Stand-Alone Paper

Shifting Teachers' Conceptions from Models of to Models for: Curriculum Materials, Professional Development, and Implementation

Katherine Glover*, North Carolina State University, USA
Grace Carroll, North Carolina State University, USA
Jobie White, North Carolina State University, USA
Elizabeth Kluckman, North Carolina State University, USA
Soonhye Park, North Carolina State University, USA
Laura Chalfant, North Carolina State University, USA
Scott Ragan, North Carolina State University, USA
Jason Painter, North Carolina State University, USA

ABSTRACT
The focus of this study was on how curriculum materials relate to teachers' conceptions of modeling.We employed a case study design to investigate modeling conceptions present in model-based curriculum materials called Modeling Instruction Biology as well as teachers' conceptions of models as they learned and enacted the curriculum materials over a one year period. Prior to implementing the materials, teachers got to experience the materials themselves during a professional development (PD) workshop. Curriculum materials and teachers' survey responses at four time points throughout PD and implementation were coded usinga prioricodes derived from Gouvea and Passmore's (2017) '"'Models of' versus 'Models for'" heuristic. Findings revealed most lessons in the curriculum materials promoted modeling conceptions beyond using models as tools for representing phenomena (models of) but did not meet all necessary criteria to promote using models for the purpose of generating knowledge (models for). Results also indicated that teachers' conceptions of models were most similar to modeling conceptions present in the curriculum materials following PD rather than during implementation. Implications include more explicitly connecting science content with science and engineering practices when designing curriculum materials and continuing to provide support for teachers as they implement curriculum materials following training.

Stand-Alone Paper

Investigating the Support for Science Teacher Noticing on Reform-based Practices

Yuxi Huang*, University of California, Irvine, USA
Joseph Deluca, University of Georgia, USA
Ella Yonai, University of Georgia, USA
Xinyu He, University of Georgia, USA
Elizabeth Ayano, University of Georgia, USA
Julie Luft, University of Georgia, USA
Brooke Whitworth, Clemson University, USA

ABSTRACT
This study explores the evolution of science teacher noticing of reform-based practices in the context of the Next Generation Science Standards (NGSS). Three randomly selected teachers' noticing interviews, classroom instruction interviews, and end-of-year interviews were qualitatively analyzed. The study aimed to understand how these teachers notice reform-based practices and what influences their use of such practices. Through video-based instruments and a series of interviews, the research identified changes in the teachers' attention, knowledge-based reasoning, and interpretative frameworks over the two years. The findings suggest that science teachers increasingly noticed and engaged with reform-based practices, with variations in their interpretative frameworks reflecting deeper understanding and complexity. Key influences on these changes include professional development, professional learning communities, personal experience, and collegial support. This study contributes to the broader understanding of science teacher learning and offers insights for designing more effective professional development programs that support the implementation of NGSS-aligned instruction. The research highlights the importance of

multi-faceted support systems in enhancing teacher noticing and promoting high-quality science education.

Stand-Alone Paper

Cultivating Teachers' Asset-Based Orientation for Implementing 3D Assessments

Miray Tekkumru-Kisa*, RAND, USA
Jill Wertheim*, WestEd, USA
Jennifer Richards, Northwestern University, USA

ABSTRACT

Assessments have historically been used to identify deficits in students' ideas. Transforming teachers' use of assessments can be powerful for providing more equitable opportunities for students' learning. Our project sits at the nexus of assessment and instruction by focusing on teacher learning within the context of a professional learning (PL) program centered around the use of three-dimensional performance assessments that are designed to surface students' ideas, interests, and experiences. By diminishing the line between assessment and learning, instructionally-embedded performance assessments engage students in working with authentic and meaningful problems, while providing an opportunity for students to demonstrate their knowledge-in-use. In this study, we seek to understand the opportunities for teacher learning in the PL that afforded space for teachers to work on cultivating asset-oriented approaches, and ideas, tensions, and challenges emerged throughout the PL grounded in the use of performance assessments. Analysis of the PL artifacts revealed opportunities embedded in the design of the assessments, PL materials, and framing of the PL discussions that contributed to developing teachers' asset-based orientation to their students' learning. Teachers described specific ways their views of students' abilities were challenged and transformed as a result of using these complex tasks within their local contexts.

Stand-Alone Paper

Exploring teachers perceptions and beliefs about implementing socio-scientific issues using the Repertory Grid Technique

Yael Shwartz, Weizmann Institute of Science, Israel
Emil Eidin*, University of Wyoming, USA
Asaf Salman, Weizmann Institute of Science, Israel

ABSTRACT

Educators have recognized the importance of implementing socio-scientific issues as an integral part of the science curriculum. However, it has been shown that teachers have a spectrum of dispositions about the implementation of SSI, ranging from utter disapproval to full support. Previous works were limited in their methods of revealing teachers' beliefs about SSI implementation, primarily relying on a qualitative approach. Additionally, those works did not address what orientations make teachers more likely to implement SSI. This paper uses the Repertory Grid Technique (RGT), a semi-quantitative tool, to elicit teachers' perceptions of and beliefs about SSI implementation. We also use teachers' interviews as a complementary method to affirm the RGT results. Twenty-two secondary science teachers from various

disciplines voluntarily participated in the research. Our analysis reveals four meta-categories relating to teachers' perceptions and beliefs about SSI: Self-consideration, Student considerations, sources of tension, Conflict and ethical dispute, and Pedagogical tensions. Furthermore, we show that the elicitation of constructs under the teacher's self-consideration category aligns with the teacher's deliberation and will to implement SSI. Furthermore, our results show a positive relationship between the interconnectedness of SSI PCK aspects and teachers' awareness of the various challenges SSI implementation entails.

Evolving Partnership to Advance Earth Science Across a Large District's Biology, Chemistry, and Physics Courses

Strand 10: Curriculum and Assessment
26-Mar-25, 9:00 AM-10:30 AM
Location: Magnolia 1

Related Paper Set

The Evolution of Teacher Collaboration and Leadership in a Research-Practice Partnership

Alan Berkowitz*, Cary Institute of Ecosystem Studies, USA
Kevin Garner, Baltimore City Public Schools, USA
Edmund Mitzel, Baltimore City Public Schools, USA
Beth Covitt, University of Montana, USA
Angela Hood, Cary Institute of Ecosystem Studies, USA
Carolyn Parker, American University, USA
Lauren Browning, George Washington University, USA
Jonathon Grooms, George Washington University, USA

ABSTRACT

Our Research Practice Partnership (RPP) includes district leaders, teachers, scientists and education researchers; our problem space is the integration of Earth science, 3D and responsive teaching into high school biology, chemistry, and physics courses.Q1. How is our learning helping us pivot to work on new boundary infrastructure?Multiple pathways, including professional learning sessions, observations, surveys, interviews and one-on-one conversations with staff liaisons, help elevate teachers voice and identify compelling new directions. Q2.How is collaboration to develop new boundary infrastructure sensitive to partners assets and contexts?Staying committed to goals and working within the constraints of all partners allows the RPP to tackle new boundary objects. In our case we pivoted away from an assessment focus to develop new curricula interweaving assessments and storylines about Earth science phenomena.Q3. What intermediary outcomes are contributing learning toward future RPP evolution?Work on crafting a vision for curriculum and instruction to guide the RPPs work, data from students engaged in the RPPs curriculum, and outcomes from professional learning co-led by teachers for all District high school science teachers are invaluable sources of information for collective learning. Evidence from meetings, surveys, interviews, and intermediary products will be shared to illuminate RPP evolution.

Related Paper Set

Teachers Views About Integrating Earth Science Into High School Biology, Chemistry and Physics Curriculum

Lauren Browning*, George Washington University, USA
Annie Caires, University of Montana, USA
Beth Covitt, University of Montana, USA
Jonathon Grooms, George Washington University, USA

ABSTRACT

As states and districts adopt the NGSS, supporting all students in meeting Earth science standards at the high school level has posed a challenge for the portion of districts that have historically only offered Earth science as an elective course. This study is part of a larger project that centers on an urban District that has responded to this challenge by integrating Earth science standards into traditional physics, chemistry and biology courses. This study aims to understand how teachers in the District are conceptualizing and receiving the integration of Earth science into the District curriculum. Teachers were interviewed and asked to describe the pros and cons of integration of Earth science with their discipline, as well as what the integration looks like to them. Findings show that the top four perspectives regarding what integration looks like or means to them are related to: 1) focusing on reform-based practice, 2) interdisciplinary interweaving of concepts that drive student understanding, 3) beliefs about students and learning, and 4) focus on real world application. These findings offer insights for how the District can responsively support high school biology, chemistry, and physics teachers in productive integration of Earth science into their course instruction.

Related Paper Set

Partnership Participation and Teachers Changing Views of Reform Science Teaching

Jonathon Grooms*, George Washington University, USA
Lauren Browning*, George Washington University, USA
Annie Caires, University of Montana, USA
Beth Covitt, University of Montana, USA
Alan Berkowitz, Cary Institute of Ecosystem Studies, USA

ABSTRACT

This study is situated within a large-scale research practice partnership project, where our team is engaged in NGSS informed work to develop and refine Earth science integrated curricula and assessments across the partner district's core science courses - biology, chemistry, and physics. Central to this effort is the professional learning opportunities provided to district teachers to support their learning about key facets of the reform goals of the district, e.g., rigorous and ambitious, phenomenon-based, three-dimensional teaching and learning for all students. This specific paper reports on the changes in teachers' thinking with respect to one key aspect of the new curricula - three-dimensional teaching and learning. Analysis of teacher interview data from year one and year two of the project

suggests that teachers are developing more coherent and NGSS-aligned conceptions of three-dimensional teaching and learning. However, persistent challenge expressed by the teachers is the difficulty to fully incorporate crosscutting concepts as a meaningful aspect of their instruction. We also share implications related to teacher professional learning within the context of research practice partnerships.

Related Paper Set

Cultivating Assessment Elements to Support 3D Learning Within a Complex District Landscape

Beth Covitt*, University of Montana, USA
Kevin Garner, Baltimore City Public Schools, USA
Lauren Browning, The George Washington University, USA
Angela Hood, Cary Institute of Ecosystem Studies, USA
Alan Berkowitz, Cary Institute of Ecosystem Studies, USA
Edmund Mitzel, Baltimore City Public Schools, USA

ABSTRACT

This paper reports research examining a large, urban school districts science assessment landscape and implications for how research-practice partnership (RPP) collaborators can refine infrastructure and routines to increase the assessment systems effectiveness. Assessment systems exist as part of a complex landscape in which reform efforts require attention to multiple conditions and aims such as: (1) timely and actionable assessment information that is aligned with the curriculum and that teachers can use with ease to inform responsive instruction; (2) assessment data that can inform refinement of curriculum materials and professional learning design; and (3) district-scale evidence of student knowledge, practice, and learning. Growing shared understandings about the landscape have helped the RPP understand that it is not feasible to develop a new project-initiated assessment system, so the RPP is applying an iterative management approach to collaborative assessment system work to identify and appraise options, implement, monitor, reassess, and iterate. We describe strategies we are exploring including, for example, shifting from an assessment-only focus to integrated work on curriculum and assessment. Through iterative management, we will be better-poised to identify assessment system elements that support reform-based goals with sensitivity to the diverse needs and conditions of the District and the RPP.

Explorations of Positioning Theory Constructs in Science Education Research Centering Equity and Justice

Strand 11: Cultural, Social, and Gender Issues
26-Mar-25, 9:00 AM-10:30 AM
Location: Annapolis 4

Symposium

Explorations of Positioning Theory Constructs in Science Education Research Centering Equity and Justice

Maria Varelas*, University of Illinois Chicago, USA
Felicia Mensah*, Teachers College, Columbia University, USA
Maria Rivera Maulucci*, Barnard College, USA
Jrène Rahm*, Université de Montréal, Canada
Laura Zangori*, University of Missouri, USA
Eli Tucker-Raymond*, Boston University, USA
Tammie Visintainer, San José State University, USA
Jenny Martin*, Australian Catholic University, Australia
Ayça Fackler, University of Missouri, USA
Molly Botkin, University of Missouri, USA
Troy Sadler, University of North Carolina, USA
Katherine Frankel, Boston University, USA
Xi "CiCi" Yu, Boston University, USA
Maria Olivares, Boston University, USA
Ferdous Touioui, University of Montreal,
Stephanie Batres Spezza, University of Illinois Chicago, USA

ABSTRACT

Science education, as a practice and a research domain, has been shaped over the last three decades by various calls foregrounding constructivist, sociocultural, and critical perspectives regarding the goals and means of sciences and science education. As the field has been moving towards denouncing deficit framings and embracing and actualizing asset-based and humanizing perspectives of children, youth, families, and communities with various racial and ethnolinguistic identifications, there has been attention to positioning constructs. Positioning involves norms, expectations, rights, and duties that people perform in discourse acts that are shaped by and shape social forces within evolving storylines associated with peoples' identities. In this interactive symposium, eight science education scholars/research teams who have contributed to bringing positioning theory to the science education field will participate in a session focused on past and current scholarship that attends to positioning theory constructs and how positioning theory can be used in conjunction with other frameworks to pursue research that centers equity and justice. The contributors focus on equity and justice (social, educational, and environmental) as they relate to access to and reconceptualization of science learning and engagement, what counts as science, and how science impacts people and the world.

Understanding Ethical Decision-Making Through Equity Frames Across Science Contexts

Strand 11: Cultural, Social, and Gender Issues
26-Mar-25, 9:00 AM-10:30 AM
Location: Annapolis 1

Related Paper Set

How Design Dilemmas are Helping Teachers Grapple with Racial and Social Equity in Science Curriculum

Katarzyna Pomian Bogdanov*, Northwestern University, USA

ABSTRACT

Science learning environments have been shaped by Eurocentric ideologies that center science as a set of culturally neutral and color-blind systems (McGee, 2020) which science teachers are often reluctant to acknowledge (MoralesDoyle, 2021). However, current reforms in the US are asking science teachers to teach in more justice-oriented ways. This requires shifts in teachers' approaches, which can be challenging for them to accomplish (NRC, 2012). This study investigates how three teachers discuss issues of racial and social justice as they work to co-design science curricula alongside researchers. I employ the curricular values framework which characterizes design dilemmas as moments when a design team encounters multiple ways in which they can proceed with the design process and identifies curricular values that underlie criteria used to make design decisions (Pomian Bogdanov, 2022). I characterize the design dilemmas using the Framework on Equity – a useful tool through which we can diagnose and understand, past, current, and future frames of equity to build more equitable environments in science education (National Academies (NA), 2024). Through unpacking dilemmas in teachers' ideas and approaches, I find ways that teachers shift their understanding and approaches to designing curricula to be more justice-centered.

Related Paper Set

Ethical commitments to equitable and inclusive teaching of pre-service teachers

Ronan Rock*, Univeristy of Illinois Chicago, USA

ABSTRACT

In pre-service teacher (PST) education, issues of equity and justice are commonplace topics in coursework today(Schiera, 2019). Using the equity framework from National Academies (2024), I examine the syllabi and structures of the PST science methods and practices course for undergraduates at a large urban midwestern university I teach. This piece centers the ways of knowing and teaching from a neurodiverse, trans, and queer science educator (the author) in designing and structuring a course to support equity for PSTs and model commitments to equity in pedagogical practices for PSTs. Using DisCrit ecological classroom perspectives(Annamma Morrison, 2018; Kulkarni et al., 2021), this PST nature and practices of science course supports and affirms diverse learners and models commitments to a variety of frames of equity. In structuring a course to model equitable teaching for PSTs, this work

encourages other PST educators and researchers to make sense of their own commitments to equity, as well as how those commitments may be reflected in their own pedagogical practices and thus modeled for PSTs.

Related Paper Set

Ethical and Historical Considerations as Design Dilemmas in Transfer Task Development

Nicole Vick*, Northwestern University, USA
Daniel Voss, Northwestern University, USA

ABSTRACT

'Transfer task''-style assessments in NGSS-aligned units provide students with opportunities to demonstrate science learning in the context of new phenomenon or engineering problems. Penuel et al. (2019) identified four key design features to guide the development of three-dimensional assessments. Additional considerations identified as equity frames by NASEM (2024) must be taken to ensure students see STEM as a way to promote social justice or envision more sustainable futures. Due to the limited time frame students have to engage with a transfer task, design dilemmas arise when thinking about theethicalandhistoricalconsiderations related to the chosen phenomena or engineering problem. We reflect on how we handled these design dilemmas using design stories inspired by Svihla Reeve (2016). Our design stories were framed around two questions intended to garner insight to design decisions and the role of equity in those decisions. Through discussion of the design stories, we evaluated how well the transfer task aligned to key design features and equity frames. In this paper, we will share how analysis of our design stories helped identify two tensions designers face and potential alternatives which could be deployed in future transfer task design work.

Cognitive and Emotional Aspects in STEM Education

Strand 12: Technology for Teaching, Learning, and Research
26-Mar-25, 9:00 AM-10:30 AM
Location: Baltimore 5

Stand-Alone Paper

How Textual Features Interact with Cognitive Factors: Environmental Cognitive Augmentation Using AI

Richard Lamb*, University of Georgia, USA
Christine Brugh, Laboratory of Analytic Sciences, USA
Lori Wachter, Laboratory of Analytic Sciences, USA
Steohen Shauger, Laboratory of Analytic Sciences, USA
Bo Light, Laboratory of Analytic Sciences, USA
Kenneth Thompson, Laboratory of Analytic Sciences, USA

ABSTRACT
This study investigates how cognitive control and cognitive demand interact to enhance student performance through the application of adaptive technologies. By examining the cognitive processes involved in information processing, we aim to develop strategies that can support science educators in creating more effective learning environments. Our methodology includes a mixed block-event design, involving tasks that require varying levels of cognitive control and cognitive demand. The findings suggest that adaptive technologies can significantly improve students' ability to process and retain information, thereby enhancing educational outcomes. This research has important implications for the development of tools and techniques that can assist science educators in addressing cognitive overload and improving student engagement. The significance of this study lies in its potential to inform educational practices and policies, ultimately contributing to more equitable and effective science education.

Stand-Alone Paper

First-year STEM undergraduates at an HBCU: Less Course Tech, More Role Stress

Elizabeth Deimeke*, Clark Atlanta University, USA
Renee Schwartz, Georgia State University, USA

ABSTRACT
Diversity in science, technology, engineering, and math (STEM) is critical to meet equitably the demands of an uncertain future. Historically Black colleges and universities are more successful in producing such graduates compared to predominately White institutions. However, poor STEM retention is a universal problem in higher education. This study expands the retention discussion by exploring differences in STEM and non-STEM students regarding course technology requirements, technostress, role stress, and productivity among first-year undergraduates at a historically Black university in southeastern United States. Although variable among participants, technostress and productivity did not differ between STEM and non-STEM students. Differences existed with the other variables: STEM students use fewer technological tools and experience greater role stress relative to non-STEM students. This study has implications for recommendations to improve student retention and success in STEM. In addition to interactive student-centered instruction, introductory STEM courses may demonstrate greater student success with diverse digital applications.

Stand-Alone Paper

Integrating Harlybot with CTCA: Enhancing Learners' Retention, Motivation, and Attitudes in ICT and STEM Education

Alli Abdurrazaq, Lagos State University, Nigeria
Olugbenga Akindoju Lagos State University, Nigeria
Hakeem Olatoye,, Lagos State University, Nigeria
Peter Okebukola, Lagos State University, Nigeria
Sanni Rasheed, Lagos State University, Nigeria

ABSTRACT
In Sub-Saharan African countries, research has shown low retention, motivation, and positive attitudes among learners towards ICT and STEM subjects due to ineffective traditional teaching methods Despite efforts to improve ICT education outcomes, there is still a significant gap. However, integrating AI in education and innovative teaching approaches show promise in transforming learning experiences and outcomes. The research looked into how Harlybot, an AI educational chatbot, coupled with the Culturo-Techno-Contextual Approach (CTCA), could enhance the understanding of mobile and adaptive systems in secondary schools in Nigeria. The hypothesis proposes that incorporating this will improve academic performance, retention, and motivation more than conventional teaching approaches. Data was gathered from 140 students of mixed cultural backgrounds through pretests, posttests, retention tests, and a questionnaire. Results indicated a notable enhancement in academic achievement, retention of knowledge, and favourable attitudes towards mobile and adaptive systems among students who were instructed using Harlybot and CTCA (posttest mean difference = 26.25, p 0.001), (F (1, 98) = 14.44, p 0.001). This strategy integrates culture, technology, and context to enhance student motivation and engagement.

Advancing Science Pedagogy: Insights from Inquiry, Practices, and Differentiated Approaches

Strand 2: Science Learning: Contexts, Characteristics and Interactions
26-Mar-25, 10:45 AM-12:15 PM
Location: Camellia 1

Stand-Alone Paper

Science Content to Practice: Investigating Middle-Grade Students Views About Inquiry and Science and Engineering Practices

Alex St. Louis*, Augusta University, USA
Savannah Hayes*, University of Houston, USA
Taylor Kate Guerrero*, Augusta University, USA

ABSTRACT
This qualitative study investigates middle-grade students' views about scientific inquiry and their development and use of science and engineering practices using an inquiry-based curriculum that allows students to complete an authentic scientific research project. We report on the relationship between two inquiry aspects (scientific investigations can follow different methods and questions drive the [scientific] process) and two science and engineering practices (asking questions and defining problems and analyzing and interpreting data) to delve deeply into the nuances of middle-grade students' understanding and engagement with scientific inquiry. Our data and analysis indicate evidence supporting an understanding of the inquiry aspects seen in the science and engineering practices within the middle-grade classrooms. Integrating science and engineering practices through "doing science" in authentic inquiry experiences provides a more effective learning environment to prepare students for the challenges faced in a scientific-driven society. We aim to provide

more support for curriculum and teaching practices to integrate scientific inquiry and science and engineering practices so that students better understand the scientific process and community.

Stand-Alone Paper

A Systematic Review of High Impact Review Studies in STEM Education

YURDAGÜL BOĞAR*, Hakkari University, Turkey

ABSTRACT

ABSTRACT: The aim of the study was to conduct a systematic review of high impact review studies in STEM education. Systematic review was employed in order to reach this aim. Some inclusion and exclusion criteria were determined by the researchers to select the studies to be included or excluded in this systematic review. The determination of high impact review articles in STEM education was carried out in stages. As a result, 18 review articles were included in this systematic review. The articles were analyzed in terms of their number of authors, countries where the authors are located, publication year, number of studies reviewed, name of journal, SSCI status and topic. In order to ensure the reliability of the study, each article was analyzed by each researcher. The result of the study indicated that the vast majority of the journals in which high impact review articles related to STEM are published are well-established, respected, and have a long publication history. This study focused on high impact review articles related to STEM. In future studies, a systematic analysis of all review studies related to STEM can be conducted.Keywords: STEM, STEM education, review study, systematic review

Stand-Alone Paper

Model-based Inference as a Source of Agency in Scientific Explanation

Jonathan Shemwell*, University of Alabama, USA
Daniel Capps*, University of Georgia, USA
Daniel Pimentel*, University of Alabama, USA

ABSTRACT

The present study is intended toexpand ideas about the utility of a thinking process called inference projection that is the central generative mechanism in the scientific practice of developing and using models. The study addresses inference projection in the context of using models for scientific explanation, or alternatively, model-based explanation. Inference projection occurs within model-based explanation and other modeling activities when learners implicitly expect causal relations in models to hold in scenarios on which models are instantiated. The power of inference projection to generate crucial insights into phenomena is well established in the literature, but this body of work mostly treats these insights as ends unto themselves, giving minimal consideration to their downstream impacts, especially on learning processes. Consequently, the present study addresses one such impact, shedding light on how projecting inferences can student interacting with subject matter, particularly as students use models to construct scientific explanations.

Stand-Alone Paper

Comics in STEM aren't Superior to Traditional Worksheets

Marc Rodemer*, University of Duisburg-Essen, Germany
Nils Ullenboom, University of Duisburg-Essen, Germany

ABSTRACT

This study investigated comic-based worksheet compared to traditional worksheet formats in enhancing student learning outcomes. Our findings indicate that both instructional methods yield comparable learning gains for students across different levels of prior knowledge. High school students enjoyed comics more than traditional worksheets and found them more comprehensive, however, there were no effects for neither ease, nor effort, possibly indicating student's familiarity with the conventional worksheet format. The results suggest that comic-based worksheets serve as a viable methodological variation, neither significantly enhancing nor impeding student learning gains. Further research is needed to investigate its impact on other affective variables.

New Approaches to Understanding Classroom Culture in Science Classrooms

Strand 2: Science Learning: Contexts, Characteristics and Interactions
26-Mar-25, 10:45 AM-12:15 PM
Location: Camellia 2

Related Paper Set

Simultaneously addressing epistemic and relational aspects of classroom activity: A teacher's opportunities and challenges

Annabel Stoler*, Boston University, USA
Eve Manz, Boston University, USA

ABSTRACT

The social process of sensemaking in science education necessitates that teachers foster collective learning environments. However, effectively enacting this can be challenging, particularly when navigating the relational and epistemic dimensions of classroom culture. This study addresses how these dimensions interact and influence teachers' decision-making. Using the case of a fifth-grade teacher, "Ms. Shaw", we explore how teachers'pedagogical decisions are shaped by the tensions between epistemic and relational goals. We identify moments during class science discussions in which Ms. Shaw faced tensions between supporting students' individual uncertainties and fostering collective problem-solving. This research contributes to our understanding of how teachers' decisions impact the collaborative nature of science learning, emphasizing the need for designing equitable learning environments that integrate caring relationships with science sensemaking.

Related Paper Set

Children's Voices on Classroom Norms: Understanding Second Graders' Experiences in Collaborative Science Learning

Souhaila Nassar*, Boston University, USA
Eve Manz, Boston University, USA

ABSTRACT

Even young children are capable of developing an understanding of what science is and who they are in relation to science (NASEM, 2022).We believe that these understandings develop as childrenparticipatein communities of practice, influenced by norms teachersattemptto introduce (Cobb Yackel, 1996).Yet we know little about children's experiences; how they conceptualize norms, when they experience them, and whether and how their experiences and dispositions change over time. In this paper, we explore how second graders describe their experiences with and dispositions toward three science classroom norms: 1)recognizing uncertainty, 2)learning from each other, and 3)seeing one's ideas and contributions as of value.We interviewed nine children inthe 2022-2023 school year. Thematic analysis of children's responses across the three normsrevealed that(1) childrengenerally indicatedthat the norm was at play,(2)childrenconceptualized and looked for different forms of evidence from each other, in ways we found interesting, and (3) wegenerally didnot see strong patterns of change over time.The findings from this studycontribute to the field's understanding of the ways classroom culture intersects with science learning, particularly regarding how young children experience and conceptualize science classroom norms.

Related Paper Set

Relational messaging as a support for the collective enterprise of purposeful sensemaking in science classrooms

Jason Buell*, Northwestern University, USA
William Penuel, University of Colorado Boulder, USA
Chris Griesemer, University of California, Davis, USA
Yang Zhang, Northwestern University, USA
Jessica Alzen, University of Colorado Boulder, USA
Cynthia Passmore, University of California, Davis, USA
Kelsey Edwards, Northwestern University, USA
Brian Reiser, Northwestern University, USA

ABSTRACT

Sensemaking is both epistemic and relational when it takes place as a collective enterprise. Through epistemological messaging, students learn both what counts as knowledge and how to construct it as well. This proposal argues for attention to relational messaging. We present data from a curriculum-based professional learning project showing what relational messaging was being communicated by teachers, students, and through the organization of the activity. Student interviews are used to show how these messages likely contribute to how students construct what it means to be "good" in science class. Attending to relational messaging, when in service of collective sensemaking, helps students to understand not just how and why they are building knowledge, but how and why they are doing it together.

Related Paper Set

How college students experience a physics course designed to support collective learning

Eric Kuo*, University of Illinois Urbana-Champaign, USA
Christina Krist, Stanford University, USA

ABSTRACT

Approaches to structuring science learning as a collective, rather than individualistic, enterprise in K-12 science are not immediately compatible with the curricular goals and structural constraints of undergraduate science courses. This paper describes how a college instructor redesigned their intermediate physics course to foster a sense of collective learning in a context where, compared to typical K-12 settings, larger course sizes and fewer weekly course meeting times constrain possibilities for relationship building through in-depth collaborative work. Interviews with students who had completed the course were designed to uncover students self-reported perceptions of these instructional design efforts to foster interpersonal relationships and collective science learning. As an example of how students attended to these intentionally-designed course elements, we share student perceptions of (i) how office hours supported a feeling of homework problem solving as a communal rather than individual activity and (ii) the perceived socio-emotional benefits of this communal activity. This paper presents design possibilities for supporting collective learning in undergraduate course contexts, which have different constraints and demands than K-12 settings, in ways that can impact students epistemic and relational views of science learning.

Identity, Belonging, and Cultural Capital in STEM

Strand 5: College Science Teaching and Learning (Grades 13-20)
26-Mar-25, 10:45 AM-12:15 PM
Location: Magnolia 3

Stand-Alone Paper

Assessing Identity, Belonging, and Impostorism for Interdisciplinary Graduate Education

M. Gail Jones*, NC State University, USA
Alicia Fischer, NC State University, USA
Shiyan Jiang, NC State University, USA
Madeline Stallard, NC State University, USA

ABSTRACT

This exploratory study examined sense of belonging, academic self-concept, and perceived impostorism for doctoral students engaged in interdisciplinary research. A survey was developed and given to 85 graduate students conducting interdisciplinary research. An exploratory factor analysis found three factors: interdisciplinary identity, imposterism, and sense of belonging. The survey was found to have good validity and reliability. Perceptions of

belonging and impostorism were similar for students' disciplinary and interdisciplinary research contexts. Students who reported high levels of impostorism reported having lower levels of belonging and lower academic self-concept than students with low perceived levels of impostorism.

Stand-Alone Paper

Graduate STEM Students as Role Models for High School Students

Ana-Maria Topliceanu*, North Carolina State University, USA
Katherine McCance*, University of Texas at San Antonio, USA
Margaret Blanchard*, North Carolina State University, USA
Jennifer Sollinger*, North Carolina State University, USA

ABSTRACT

Graduate STEM students' work on funded research occasionally engages them in K-12 outreach. Yet, graduate students lack professional development experiences to prepare them for these roles. This descriptive case study, guided by the motivational theory of role modeling, chronicles the experiences of six international and two domestic graduate STEM students who visited high school classrooms via Zoom to present research and lead a college/career discussion. The research questions investigated how the graduate students planned, implemented, and reflected on their Zoom visits, and their perceived supports, benefits, and challenges. Zoom recordings of visits and interviews were analyzed using the constant comparative method. The findings demonstrate the graduate students' focus on engaging students, the relevance of science, and job opportunities in STEM. The perceived challenges were associated with making the complex research understandable to high school students. Implications for formalized training of both international and domestic graduate STEM students are discussed.

Stand-Alone Paper

Bridging families: Leveraging first-generation, familial, and filial piety cultural capitals in Physics classrooms

Lucia Hau, San Francisco State University, USA
Khanh Tran*, Purdue University, USA
Elleanor Pangilinan, San Francisco State University, USA
Alegra Eroy-Reveles, University of California, Santa Cruz, Uganda
Kim Coble, San Francisco State University, USA

ABSTRACT

This project seeks to explore how students from historically marginalized communities leverage family support as a form of cultural capital to persist in STEM majors, particularly in physics. Building on Community Cultural Wealth, specifically familial capital, and the concept of "pedagogies of the home," we examine how family members—through emotional, instrumental, and financial support—contribute to students' academic success and aspirations. Our findings highlight how first-generation, familial, and filial piety capital influences the persistence and success of STEM students from diverse backgrounds. In particular, these cultural capitals around families and familial ties emphasize the

multidirectionality of familial support and highlight the critical role family and cultural values may have in shaping the educational experiences and aspirations of students in STEM. Thus, the integration of familial and cultural capital, along with a collective approach in educational settings, can enrich students' experiences and foster a sense of belonging and purpose.

Innovations In Quantitative Assessment Frameworks And Methodologies In Undergraduate Biology Education

Strand 5: College Science Teaching and Learning (Grades 13-20)
26-Mar-25, 10:45 AM-12:15 PM
Location: Magnolia 1

Related Paper Set

Can Large Language Models outperform Machine Learning auto-scoring models? Efficacy tests using text-based scientific explanations

Yunlong Pan*, Stony Brook University, USA
Ross Nehm, Stony Brook University, USA

ABSTRACT

Few studies have quantified the extent to which Large Language Models outperform existing interview-validated automated scoring methods developed using Machine Learning, or explored the privacy, ethics, time, and economic benefits and drawbacks of using LLMs vs. existing scoring approaches. Our study fills this gap and uses a corpus of 1,000 text-based human-scored student scientific explanations in order to compare the scoring efficacies among three LLMs and an existing ML-based scoring engine. We used percentage agreement, kappa, precision, recall, and F1 to compare computer to human scoring. In addition, we estimated setup time and considered issues of privacy, ethics, and cost. We found that larger open-source LLMs did not yield better results than proprietary LLMs with fewer parameters. ChatGPT-4 provided the most accurate results but was still less accurate and much slower than the ML-based scorer. In addition to poorer performance, LLMs introduced considerable ethical and economic drawbacks; student writing products became the property of the LLMs, the proprietary LLM required payment, and 1 month of funding was required to engineer prompts that achieved subpar LLM scores. Overall, it is clear that LLMs cannot automatically be assumed to be the best option for all science assessment goals.

Related Paper Set

Quantitative frameworks for assessing equity in undergraduate classrooms: comparing learning across traditional/reformed instructional contexts

Benjamin Hechtman*, Stony Brook University, USA
Gena Sbeglia, San Diego State University, USA
Ross Nehm, Stony Brook University, USA

ABSTRACT
This study showcases how Ladson-Billings' "educational debt" conceptual framework can be operationalized by using assessment data and statistical approaches to quantify inequity patterns over time in undergraduate classrooms at two institutions: Institution 1 (I-1), Institution 2 (I-2).Longitudinal patterns of learning and debt mitigation/ maintenance/ exacerbation were studied in 859 biology undergraduates across six semesters at Institution 1 using multiple validated instruments to examine: (1) the magnitudes of educational debt among historically excluded student groups (HEC) at course entry, (2) the impacts of instruction on educational debt, (3) differences in learning and debt patterns between traditional and reformed versions of a course, and (4) the consistency of patterns in relation to the same course at I-2. Overall, for I-1, reformed instruction semesters displayed high magnitudes of learning (similar to I-2), whereas traditional instruction produced significantly smaller learning magnitudes. At I-1, most HECs did not display substantial incoming educational debt in either version of the course (unlike I-2). After instruction, no meaningful debt accumulated for HEC student groups (similar to I-2). Thus, across institutions and for both traditional and reformed courses, maintenance of incoming debt patterns prevailed (vs. mitigation or exacerbation). We discuss implications for equity in undergraduate education.

Related Paper Set

Uncovering Educational Inequalities with Feature Manifold Transformers, a New Way to Interpret Complex Feature Interactions

Derrick Cox*, Wright State University, USA
Tanvi Banerjee, Wright State Universit, USA
William Romine, Kairos Research, LLC, USA

ABSTRACT
Accurate methods for gauging a student's fundamental understanding of course material, including that related to evolution, are paramount to ensuring quality education. This starts with quality unbiased measurement; however, the ongoing struggle for accessibility of questions to all audiences is a pervasive problem. We introduce a machine learning technique, Feature Manifold Transformer (FMT) for visualizing DIF-related anomalies in multiple-choice responses from students of diverse backgrounds but similar established aptitude using the Concept Inventory of Natural Selection (CINS) assessment. The method draws upon the intersectionality approach but implements it under a machine learning paradigm in the use of embedding spaces and transformers to interpret abstract relationships between demographic features and differences in student response patterns while controlling academic proficiency. Compared to logistic regression, the FMT method produced similar high-level conclusions but provided a richer context in terms of its ability to account for many demographic intersections in the data simultaneously and provide graphical displays of the complex relationships. The largest gain of FMT over traditional methods is visualization of the data while still retaining the explainability of traditional statistical methods like logistic regression or MIMIC.

Related Paper Set

Quantitative assessment of the relationship between evolutionary conflict perception and high doses of evidence-based instruction

Audrey Johnson*, San Diego State University, USA
Gena Sbeglia, San Diego State University, USA

ABSTRACT

Students perceptions of conflict with evolution have been hypothesized to hinder evolution acceptance, evolution learning, and evolution career pursuits. Using the Scales of Evolutionary Conflict Measure (SECM), we investigated patterns of pre-post evolutionary conflict perception that emerged in the presence of a high dosage of evidence-based instruction. We assessed these patterns across six semesters and two formats traditional and reformed of a large-enrollment gateway biology course at a Hispanic Serving institution in the United States (N = 1516). The reformed course format included active learning and Nature of Science instruction. In alignment with prior validity work with the SECM at a different institution, Rasch analysis indicated robust functioning and demonstrated the instruments ability to generate inferences about the construct in this new population. Linear mixed-effects models revealed significant pretest disparities in conflict perception across racial groups and for college generation status and significant reductions in conflict in only the reformed format. While the study can not isolate the causal contributions for particular course conditions, it provides insights into how evidence-based course reform might interact with students evolutionary conflict perception and may highlight possible causal factors warranting further investigation.

Description of a Place-Based, Informal Science Learning Experience at the Great Dismal Swamp

Strand 6: Science Learning in Informal Contexts
26-Mar-25, 10:45 AM-12:15 PM
Location: Baltimore 4

Related Paper Set

A Literature Review of African American Informal STEM Learning

Jomo Mutegi*, Old Dominion University, USA
Seth Cudjoe, Old Dominion University, USA

ABSTRACT

This paper provides an overview of how informal STEM learning of African Americans has been addressed in extant literature.

Related Paper Set

Using Socially Transformative Curriculum to Design a Placed-Based Informal STEM Learning Experience

Seth Cudjoe*, Old Dominion University, USA
Jomo Mutegi, Old Dominion University, USA
Robert Atkinson, Christopher Newport University, USA

ABSTRACT
This paper provides a detailed description of the informal STEM learning experience, with special attention focused on the curricular structure.

Related Paper Set
Exploring the Impact of an Informal STEM Learning Experience through Narrative Inquiry.
Mujibat Akorede*, Old Dominion University, USA
Seth Cudjoe, Old Dominion University, USA
Umar Adams, Lagos State University, Nigeria
Jomo Mutegi, Old Dominion University, USA

ABSTRACT
This study reports findings from a subset of participants at the Great Dismal Swamp. The study collected data to uncover the participants' stories.

Related Paper Set
Participant Voices: What I Learned as an Intern in the Great Dismal Swamp.
Mujibat Akorede*, Old Dominion University, USA
Liliana Boyd, Lakeland High School, USA
Pearl Kmutia, Kings Fork High School, USA
Kay Adams, Friends of the Great Dismal Swamp National Wildlife Refuge, USA
Jomo Mutegi,Old Dominion University, USA

ABSTRACT
This paper is a first-person report wherein student participants describe what they learned.

Approaches of Developing Self-efficacy for STEM Teaching and Learning

Strand 7: Pre-service Science Teacher Education
26-Mar-25, 10:45 AM-12:15 PM
Location: Baltimore 1

Stand-Alone Paper
What is STEM? Preservice Elementary Teachers' Conceptions of Integrated STEM Instruction
Jeanna Wieselmann*, Southern Methodist University, USA
Deepika Menon, University of Nebraska - Lincoln, USA
Brynn Price, Southern Methodist University, USA
Allison Johnson, University of Nebraska - Lincoln, USA

Sumreen Asim,Indiana University Southeast, USA
Sarah Haines, Towson University, USA

ABSTRACT

Reform efforts in K-12 education emphasize integrated science, technology, engineering, and mathematics (STEM) instruction. However, elementary teachers face particular challenges in implementing integrated STEM, and many teacher preparation programs have been slow to adapt to the demands of STEM integration. Thus, elementary preservice teachers (PSTs) may hold a range of conceptions of integrated STEM instruction, which would likely impact their instructional practices. This mixed methods study included 627 elementary PSTs from 11 different teacher preparation programs across the U.S. We addressed the research questions: (1) What are elementary PSTs' conceptions of integrated STEM education? and (2) How, if at all, do elementary PSTs' conceptions of integrated STEM education shift over a semester as they participate in science or STEM methods coursework? Findings showed that participants most frequently discussed the integration of STEM disciplines and the elements of the STEM acronym in their personal definitions of integrated STEM instruction. Further, there were shifts in conceptions over the course of the semester, highlighting that science or STEM methods coursework may inform PSTs' conceptions of integrated STEM instruction. Implications for practice and future research are discussed.

Stand-Alone Paper

Analyzing Item Endorsement Difficulty of the Engineering Teaching Efficacy Beliefs Instrument Using Wright Maps

Ezgi Yesilyurt*, Weber State University, USA
Erdogan Kaya*, George Mason University, USA
Hasan Deniz, University of Nevada, Las Vegas, USA

ABSTRACT

This study employed the Wright Map analysis derived from the Rasch Model, to conduct a deeper examination of the Engineering Teaching Efficacy Beliefs Instrument (ETEBI) responses from 280 pre-service elementary teachers (PSTs). This study explored the PSTs' self-efficacy in teaching engineering, specifically focusing on Personal Engineering Teaching Efficacy (PETE) and Engineering Teaching Outcome Expectancy (ETOE) beliefs. Findings revealed varied confidence levels across different aspects of engineering teaching. Specifically, the PSTs demonstrated lower efficacy in overall preparedness and understanding of engineering design concepts, but higher confidence in engaging with students and improving teaching methods. The ETOE subscale indicated moderate beliefs in the impact of teaching on student outcomes. The analysis identifies specific areas requiring development in teacher preparation programs, such as building content knowledge and pedagogical skills specific to engineering. Additionally, it highlights the need for a balanced understanding of factors influencing student achievement in engineering. This study provides valuable insights for designing targeted interventions in teacher education programs and demonstrates the utility of Wright Map analysis in comprehensively understanding teaching efficacy beliefs. The findings have implications for improving PSTs'

engineering teaching efficacy and preparing them to meet the challenges of integrating engineering into elementary education.

Stand-Alone Paper

Improving STEM-EL Instruction: Replicating and Evaluating a Specialized Teacher Training Program for Future Educators

Catherine Lussier*, University of California, Riverside, USA
Melissa Klaib, University of California, Riverside, USA
Jack Eichler, University of California, Riverside, USA
Leslie Bushong, University of California, Riverside, USA

ABSTRACT

Teachers' preparedness to support STEM English Learners (ELs) remains an area of concern, especially in light of the achievement gap between them and Non-ELs (NCSES, 2021). To address this, a teacher training program was developed to provideSTEM pre-service teacher training focused onadapted EL instruction including: (a) EL language development, (b) research-based ELteaching fieldwork, and (c) generatinghands-on STEM curriculum for diverse learners. The purpose of the present study is to replicate and evaluate the effectiveness of this program, comparing the replication results (Study 2) with last year's results (Study 1). All preservice teachers demonstrated significant growth in teaching across all six domains. While Scholars in Study 1 outperformed Non-Scholars in five out of six domains, in Study 2 they outperformed Non-Scholars in all domains. In Study 1, the differences between groups were significant only at the beginning and middle timepoints; however, for Study 2 there was a significant difference at the end of the program. In both studies, Scholars experienced greater growth from program start to end. Study 2's findings improve upon Study 1, providing encouraging insight for STEM-EL teacher training and addressing a crucial need in preparing teachers to better support the growing EL population.

Stand-Alone Paper

Investigating Elementary Preservice Teachers' STEM Self-Efficacy

Arzu Tanis Ozcelik*, Aydin Adnan Menderes University, Turkey

ABSTRACT

Effective STEM education requires teachers to have substantial knowledge and experience in engineering, yet elementary preservice teachers (PTs) often lack sufficient training and confidence in this area. This study investigates the impact of engaging elementary PTs in an online engineering design module on their STEM self-efficacy and perceived competency in STEM. The study used mixed methods research with an explanatory sequential design. The context of the study was a 15-week science elective course where PTs learn about simple experiments in science and design experimental tools in a public university in Turkey. The participants of the research consist of 33 elementary PTs (23 Female, 10 Male) studying in the 4th year of the elementary teacher education program. Data were collected using a pre-post STEM Self-Efficacy Scale, participant reflections, and interviews. Quantitative data were analyzed using SPSS. Qualitative data from reflections were analyzed thematically, focusing on PTs' beliefs about their competency in the engineering design process. The quantitative

findings showed that engagement in the designing bridges module experience impacted the PTs' engineering self-efficacy. Findings from this study could provide insights into enhancing STEM education preparation for elementary PTs.

Approaches to Exploring Preservice Teachers' Learning and Teaching

Strand 7: Pre-service Science Teacher Education
26-Mar-25, 10:45 AM-12:15 PM
Location: Baltimore 2

Stand-Alone Paper

The Role of the Lesson Study on the Development of Pre-service Chemistry Teachers' Self-reflection

Esra SARICI*, Middle East Technical University, Turkey
Esen KONDAKCI, Middle East Technical University, Turkey

ABSTRACT

The aim of this study is to examine the role of the lesson study in the development of pre-service chemistry teachers' (PCTs) self-reflection processes. Three PCTs (2 female, 1 male) participated in the study. Data were collected through observations of instructions, semi-structured interviews, and lesson study meeting recordings. The collected data were analyzed using a framework based on the self-reflection phase of the Zimmerman self-regulation model. Analysis of the results revealed that after participating in the lesson study, the PCTs became more critical and conscious in their self-evaluations, attributing failures to controllable, internal, and unstable factors. In addition, their self-satisfaction with their teaching increased, and they incorporated more student-focused adaptations. The collaborative and reflective nature of the lesson study, supported by the facilitator, along with peer observation and feedback, have the potential to facilitate this development.

Stand-Alone Paper

Unpacking Contradictions in Elementary Preservice Teachers' Science Planning and Teaching

Felisha Dake*, Oregon State University, USA
Cory Buxton, Oregon State University, USA

ABSTRACT

Elementary teachers require support to meaningfully engage in science planning and teaching, but face many challenges due to the minimized focus on science at the elementary level, demonstrated through the decline in instructional time spent on science, increased focus and instructional time spent on English language arts and math, and fewer curriculum resources, professional learning, and data on students science learning (Haverly Davis, 2023). This qualitative multiple-case study focuses on three preservice teachers situated in a university-school partnership using third-generation cultural-historical activity theory to examine the collaboration of teacher educators and preservice teachers inan elementary

teacher preparation program. Field observations, interviews, and documents are used to examine the contradictions PSTs experience while learning to plan and teach science and opportunities for expansive learning as they move between a science methods course and their field placement. Initial findings demonstrate that 1) supporting PSTs'agentic choices can help resolvecontradictions stemming from a misalignment oftasks and power between program participantsand 2)supporting PSTs to adapt and use curriculum materials from their elementary school placements in their science methods course can help resolve contradictionsstemming from the misalignment of tools between each system.

Striving to Transform STEM Education through Social Justice and Socioscientific Issues: Insights from Professional Development

Strand 8: In-service Science Teacher Education
26-Mar-25, 10:45 AM-12:15 PM
Location: Annapolis 3

Related Paper Set

Striving forward: Findings from an SSI focused STEM professional development
Joseph Johnson*, Mercyhurst University, USA
Charu Varma, Arcadia University, USA
Eva Henneman, Mercyhurst University, USA
Eli Louis, Mercyhurst University, USA

ABSTRACT

This study reviews emergent research from the first three years of a four-year, NSF funded project aimed to address inequities in STEM education by fostering innovative, culturally responsive STEM pedagogies. This collaboration between four universities and a regional consortium targets 7th through 12th grade STEM classrooms in high need urban communities, implementing a SocioScientific Issues and SocioTransformitive Constructivism framework to facilitate the incorporation of real world, science-based social-justice topics into STEM education. It involves two years of professional development and support for inservice teachers, focusing on instructional design and delivery of SSI lessons to empower students as STEM literate citizens. Research has shown positive impact on teacher confidence, cultural awareness, and ability to incorporate SSI leading to increased student engagement and enhanced problem solving and critical thinking skills. Teachers faced challenges integrating discursive elements into their classrooms and overcoming curricular barriers. Students demonstrated increased student ownership of STEM content, student agency, and interest when engaging with SSI, but tended to struggle to articulate their stances on SSI, to evaluate sources of information, and to comprehend the interconnectedness of systems involved in SSIs. Ongoing research continues to explore impacts on teacher leadership and student development as capable agents of social change.

Related Paper Set

Reimagining and Reframing STEM Instruction: Addressing Diverse Learners Using a Socioscientific and Social Justice Framework

Greer Richardson*, La Salle University, USA
Becky Mathers, Arcadia University, USA
Joseph Johnson, Mercyhurst University, USA
Lisa Marco-Bujosa, Villanova University, USA
Ling Liang, La Salle University, USA

ABSTRACT

While STEM education reform efforts intended to enhance the applicability and authenticity of learning in STEM courses have shown promise, school accountability measures have caused a regression to teaching content and procedural knowledge rather than critical thinking skills related to real-world contexts. Research suggests thatlocal contextual topics are central to effectively teaching science in urban contexts, however these suggestions are overlooked by teacher education programs. In an effort to address the need for relevant and engaging STEM instruction, the socioscientific issues (SSI) and sociotransformative constructivism (sTc)framework was designed and used to enact a two-year professional development (PD) series for secondary education teachers. The paper reports on the extent to which teachers incorporated elements of the SSI/sTc framework to reimagine and reframe their instructional design. Units of study were created and implemented by teachers. Paired t-tests compared unit alignment at the end of years one and two. In addition, teacher interviews noted teachers' changes to their practice.At the end of the project, teachers displayed growth in their ability to incorporate components of the SSI/sTc framework into their STEM instructional design. Implications for future use of SSI/sTc STEM PD and STEM teacher education are discussed.

Related Paper Set

Problematizing SSIs for Justice

Zachary Minken*, Arcadia University, USA

ABSTRACT

Recent reforms in STEM education have placed a greater emphasis on personal, social, and cultural relevance in the classroom (ITEEA, 2020; NCTM, 2000; NRC, 2009, 2010, 2012), and highlighted the value of infusing social justice themes within STEM education through SSI as a means to both engage learned and to develop students' moral and ethical reasoning abilities in hopes that this would lead to a more just world (Dos Santos, 2009; Morales-Doyle, 2017; Zeidler, 2016). This case study (Creswell Poth, 2018; Yin, 2018) explored the ways in which teachers participating in a PD program developed and refined their pedagogical content knowledge of problematization throughout the course of the program. Findings from this study highlight how teachers expressed their PCK of Problematization in the way they illuminated tensions inherent in the SSI central to their SJSP unit of study by asking students to consider how implications of the SSI and potential resolutions thereof would play out on a local vs. a global scale (magnification), and furthermore how the particulars of the SSI shifted depending on the locale the SSI was applied to (comparative localization). Findings suggest

several implications for practice, both for classroom educators and for providers of professional learning opportunities.

Related Paper Set

Supporting Teachers Instructional Practices for Socioscientific Issues

Lisa Marco-Bujosa*, Villanova University, USA
Greer Richardson*, La Salle University, USA
Ling Liang, La Salle University, USA
Sarah Hughes, Villanova University, USA
Nicholas Sinni,La Salle University, USA
Sanaa Jett, Villanova University, USA
Becky Mathers, Arcadia University, USA
Nicholas Kennedy, Villanova University, USA

ABSTRACT

Research indicates teachers struggle to fully integrate SSI into their teaching, often only superficially using SSI as a hook or culminating activity. Moreover, there is a need for more research exploring what teachers actually do in the classroom and the instructional strategies they use to support students. We utilized Park's (2019) revised consensus model of pedagogical content knowledge (PCK) as a lens to examine how teachers utilized instructional strategies in their design SSI units. We employed multiple-case study methodology to explore the ways teachers interpreted, applied, enacted, and learned across two years of a professional development program through a variety of data sources including teacher developed unit plans, classroom observations, and interviews. Analysis included mapping PCK through instructional episodes documenting the use and reflection upon instructional strategies across different data sources. Findings indicated variety in the instructional strategies teachers utilized in enacting SSI. Interestingly teachers who were most effective at integrating SSI across the unit utilized the same instructional strategy throughout the unit to integrate SSI into their teaching. Implications for PD about SSI includes introducing these high leverage practices to support teacher learning to reframe instruction around SSI goals as well as supporting student understanding and action.

Related Paper Set

Developing student agency: Authentic application of SSI in STEM classrooms

Becky Mathers*, Arcadia University, USA
Joseph Johnson, Mercyhurst University, USA
Alan Kaufman, Arcadia University, USA
Nicholas Sinni, Lasalle University, USA
Eli Lois, Mercyhurst University, USA
Eva Henneman, Mercyhurst University, USA

ABSTRACT

Current STEM education reform places an emphasis on hands-on, authentic learning experiences that mirror real-world problems (Parker et al., 2016), yet traditional STEM education often falls short of these goals.Incorporating socioscientific issues (SSI) can provide

a framework for addressing issues of moral reasoning and civic engagement, while addressing student engagement and key STEM content and practice, ultimately engaging students in new and deeper ways (Zeidler et al., 2005; Marco-Bujosa et al., In Review).This study explores the experiences of STEM teachers who participated in professional development (PD) focused on a SSI/socioTransformative constructivism (sTc) framework as an avenue to empower student agency. One research question guided this study: In what ways, if any, do participant teachers foster authentic, active engagement and student agency in their STEM classroom following participation in an SSI focused professional development program?The findings demonstrate that teachers provided students with authentic learning opportunities which developed student agency by moving beyond traditional STEM content, moving beyond the classroom walls, and moving inward within the school. Understanding the ways in which teachers engage students in authentic learning and foster student agency within an SSI unit has implications forscholars and researchers who provide PD to teachers.

Listening as a social and powered practice in science and engineering learning contexts

Strand 11: Cultural, Social, and Gender Issues
26-Mar-25, 10:45 AM-12:15 PM
Location: Annapolis 1

Related Paper Set

Multilingual sensemaking in investigations: Listening to the non-linguistic ways of meaning-making

Samuel Lee*, California State University, Long Beach, USA

ABSTRACT

This paper investigated sensemaking moments within a 7th-grade classroom context when orienting toward non-linguistic communication. There is a gap in the literature examining EMLs' languaging practices and their sensemaking around the practice of planning and conducting investigations (González-Howard et al., 2023). The author analyzed students' interactions and languaging resources during one science lesson as they investigated air resistance to identify three types of sensemaking moments: procedural, investigative, and explanatory as the teacher worked to desettle sensemaking as solely a logocentric endeavor. These findings surfaced rich ways bi/multilinguals were active participantswithEnglish-dominant users. By attuning to the non-linguistic ways of communication, findings showcased languaging as an interactional and creative process of making meaningwithothers and materials. However, as the sensemaking task became more abstract in the explanatory sensemaking moment the students' English language dominated the interaction. This proposal demonstrates that the science education community should rethink investigations as more than skill development or affirming concepts, but positioning and designing investigations as rich sensemaking opportunities for knowledge building. Another implication is to reorient the roles of the listening subject. The roles of the teacher

and the students were essential in supporting equitable sensemaking in the classroom context.

Related Paper Set

Learning Engineering by Listening to Communities: Supporting Middle School Youth's Competencies in Climate Tech Journalism

Clara Mabour*, Tufts University, USA
Greses Perez, Tufts University, USA
Chelsea Andrews, Tufts University, USA
Kristen Wendell, Tufts University, USA
Fatima Rahman,Tufts University, USA

ABSTRACT

Are we listening to youth and their communities? Young people are at the forefront of climate change activism. They are listening to their communities and want to inspire action by understanding how societal choices about climate technologies and solutions in response to climate change affect their local contexts. Yet in K-12 classrooms, students rarely have the opportunity to draw on the language and cultural resources of their communities to critically analyze and communicate about climate technologies nor do they gain practical experiences to design culturally and linguistically meaningful solutions.

Related Paper Set

Listening across Divides: Learners' Use of Resources amid Conflict in a Climate Exhibit

Lynne Zummo*, University of Utah, USA
Benjamin Janney, University of Utah, USA
Jordan Giron, University of Utah, USA
Marc Whiting, University of Utah, USA

ABSTRACT

In the US, a sociopolitical milieu of polarization has rendered climate education fraught. One area of promise relies on framing, or the idea that specific words, phrases, and images activate different schemas, affecting learners' interpretation of messages. Taking place in a US natural history museum, this study investigates learning at a climate exhibit intentionally developed through engagement with research on framing. Hopeful Future (HF), aims to engage visitors in productive patterns of discourse around climate change through "side door" frames. Conceptualizing listening as a powered, social practice, we draw on an adapted version resource theory to explore tensions when listening against powered and different ideological stances. We use qualitative discourse analysis to study social groups of visitors engaging with HF, and we focus on moments of conflict among group members. We study how participants take up, respond to, and/or dismiss the resources used by co-actors within moments of tension. This work offers insight into the design of educational experiences about climate change amid a polarized sociopolitical milieu. Specifically, this study shows how listening practices can be constrained in moments of conflict, as well as how listening can serve to mitigate conflict through ideological brokering.

Related Paper Set

Power, Positionality, and Educational Justice: Teacher Educators Grappling with Tensions Inherent in Listening

Shannon Davidson*, University of Alabama, USA
Lama Jaber, Florida State University, USA
Allison Metcalf, Florida State University, USA
Carla Finkelstein, Towson University, USA

ABSTRACT

Listening to honor student reasoning can be deeply humanizing and consequential for fostering equitable learning environments. However, listening is not a simple or neutral task, particularly for teacher educators whoin effort to support K-12 teachers to listen to their students--must also hone their own listening skills to intently tune into and appreciate teachers sensemaking, making space for uncertainties and vexations that teachers may experience as they listen to and reason about K-12 student sensemaking. Within this work of listening lie inherent tensions related to the powered dynamics and hierarchical relationships between TEs, teachers, and students, whether in K-12 classrooms or in teacher preparation contexts. As educators across these contexts engage in the work of listening, interpreting, and responding to student contributions, they must confront biases, assumptions, and harmful hegemonic narratives that often position studentsparticularly those from non-dominant communitiesin deficit ways. This study explores such tensions related to the powered and political nature of listening experienced by a team of teacher educators. We posit questions aimed at opening conversations that center listening as a critical act of teaching and as a balancing act requiring thoughtful attention with regard to power, positionality, and justice in teacher education.

Related Paper Set

Race Critical Listening: A Precursor to an Afrofuturistic Climate-Environmental Justice Literacy

Terrell Morton*, University of Illinois Chicago, USA
Nkosi Muse*, University of Miami, USA
Monica Miles, University of Buffalo, USA

ABSTRACT

This paper takes a conceptual approach to theorizing race critical listening as a precursor to an Afrofuturistic Climate-Environmental Justice Literacy (ACE). ACE is geared towards scientists, policymakers, and educators, and it seeks to enhance their approach to communicating and teaching about environmental science education. ACEpromotes a narrative justice that challenges prevailing attitudes towards climate change and environmental issues particularly considering the knowledge and experiences of African, African Indigenous, and African Diasporan people. We positionRace Critical Listening (RCL) asprecursor to ACE, helping scientists, policymakers, and educators with adopting an ACE literacy or other culturally-relevant practices. To theorize Race Critical Listening, wedraw from Critical Race Theory, the Sonic Color of Sound, and the Mathematics of Black life.We provide

the framework for RCL in addition to implications for how it can be employed by various stakeholders vested in environmental science education.

Supporting Justice-Centered Science Teaching and Learning Across Varied Contexts

Strand 11: Cultural, Social, and Gender Issues
26-Mar-25, 10:45 AM-12:15 PM
Location: Annapolis 2

Related Paper Set

Exploring Intersectional Climate Change Identity of Women of Color Preservice Elementary Teachers

Amal Ibourk*, Florida State University, USA
Lauren Wagner, University of North Alabama, USA
Sukanya Chakraborty, Florida State University, USA

ABSTRACT

This study examines the environmental identity of Sage, a young Black preservice elementary teacher from the southeastern United States, using a storied-identity approach. The research explores how Sage's personal narratives influence her understanding of and engagement with environmental challenges, particularly as they intersect with her race, gender, and lived experiences. Sage's story highlights the unequal effects of environmental issues on underserved communities, including those of lower socioeconomic status. As a resident of a hurricane-prone state, her experiences reflect the unique vulnerabilities faced by many Black communities during natural disasters. Despite these challenges, Sage's active efforts to support displaced families showcase her resilience and dedication to fostering community care.

Related Paper Set

The Emotional Labor of Justice-Centered Science Teaching in a Violent Sociopolitical Context

Allison Metcalf*, Florida State University, USA
Lama Jaber, Florida State University, USA

ABSTRACT

In the sociopolitically violent context surrounding education in the United States, there are personal and professional risks inherent to justice-centered teaching. Navigating these risks requires emotional labor. Yet, little is known about how preservice science teachers (PSTs) are experiencing these risks and burdens within STEM teacher education programs. Centering PSTs with intersecting marginalized racial, ethnic, and gender identities in the specific context of an "anti-woke" Florida, this poster will explore the racialized and gendered emotional labor they engaged in as they endeavored to balance their commitments to justice-centered teaching with the need to protect their jobs and personal well-being. Our

findings highlight the emotional burden placed on PSTs by macro-level white supremacist discourses and histories that are upheld and perpetuated in micro-level interactions with students. It is critical for our own practice as science teacher educators and researchers to understand such labor so that we can be responsive to PSTs' needs and show up for them in solidarity.

Related Paper Set

Yes, I am an abolitionist science teacher: Exploring the journeys of Black STEM educators

Vanessa Louis*, University of Michigan, USA
Natalie King*, Georgia State University, USA

ABSTRACT

This study investigates the factors influencing the decisions of two Black STEM professionals, Leonard and Elizabeth, to enter science education and examines the impact of abolitionist teaching on their classroom practices. It focuses on how these educators humanized their students within the science classroom and created safe learning environments. Guided by two key research questions, the study explores the motivations behind Black early-career science teachers' entry into STEM education and the role of abolitionist teaching in shaping their instructional decisions. Abolitionist teaching (Love, 2019) served as a theoretical framework, while narrative inquiry (Connelly Clandinin, 2006) was used to portray the educators' experiences. Two primary themes emerged: (1) the participants were inspired to pursue science teaching to increase representation and serve as models or extended family members for Black and Brown children to realize their potential, and (2) the inclusion of abolitionist teaching within the science teacher preparation position early-career educators to resist marring practices within their schools. This study underscores the need for teacher education programs that prepare and support early-career teachers committed to educational equity and the liberation of Black students in science classrooms.

Related Paper Set

Exploring Middle School Black Girls' Self-Defined Learning about Light, Optics, and Digital Photography

Natalie Rae*, Penn State University, USA

ABSTRACT

Black girls in the US often experience forms of educational injustice in science, where racial and gender-based oppression shapes their demographic underrepresentation in STEM and stereotypes positioning Black girls as non-scientific in STEM classrooms limit opportunities to learn science on their terms. This poster explores data collected from a design-based research project aiming to cultivate Black girlsself-definedapproaches to science learning, recognizing and valuing these self-defined approaches asoppositionalto what normatively counts as science and aspolitical, drawing on cultural intellectual genealogies typically unconsidered in science. In particular, I use a conceptual framework rooted in Black feminist epistemologies to highlight and contextualize Black girls activity within a larger genealogy of Black feminist intellectual production, a genegology not considered scientific. Within this

setting, I ask,how do learners self-define their science engagement? Using sociocultural theories of learning, I trace the trajectories of students who self-identified their learning as scientific and use a conceptual framework rooted in Black feminist epistemologies to create narrative episodes to highlight their learning as cultural, relational, and affective experiences. In a time when Black history faces intense censorship in schools, this design explores culturally and historically grounded science learning for Black girls.

Related Paper Set

Engaging High School Students and Science Teachers in Racial Justice through Climate Change Education

Sophia Jeong*, The Ohio State University, USA
Kelsea Frazier, Columbus City Schools, USA
Elena Silverman, Indiana University Indianapolis, USA

ABSTRACT

Leveraging Daniel Morales-Doyle's justice-centered science teaching framework, this study explores how incorporating students' storytelling about their lived experiences can deepen their understanding of environmental science and empower them as advocates for racial justice. The methodology draws on Ellsworth Miller (1996) and Butler's theories on identity construction to facilitate a dialogic reflexivity among students and teachers, enriching the educational experience by linking theoretical analysis with real-world applications. Our findings reveal profound insights from a community mapping activity in a historically marginalized community known as the "Lows," showcasing how students articulate and navigate the racial and economic dynamics that shape their environment. This presentation aims to provide educators with practical strategies to foster a more inclusive and responsive classroom environment, promoting a curriculum that reflects students' realities and supports systemic change in education. Through this work, we highlight the necessity of recognizing students' contextual knowledge as central to effective teaching and learning in science, urging a shift towards more justice-centered educational practices.

Related Paper Set

Justice-Centered STEM Education to Address Pressing Societal Challenges

Okhee Lee*, New York University, USA

ABSTRACT

The increasing urgency of societal challenges(e.g., climate change, air and water pollution), which expose systemic injusticesdisproportionately impacting minoritized groups,compels STEM educators to reframe the role of STEM education in society. Contemporary approaches, based on A Framework for K-12 Science Education (National Research Council, 2012) and the Next Generation Science Standards (NGSS Lead States, 2013), center equity by providing opportunities for all students to make sense of phenomena in science and design solutions to problems in engineering. Going beyond contemporary approaches, research programs on justice-centered STEM education have been emerging. Sharing a commitment to justice, we propose a potential future approach—justice-centered STEM education—that addresses societal challenges by leveraging multiple STEM subjects while centering justice. Specifically,

we articulate the affordances of justice-centered STEM education for one minoritized student group that has been traditionally denied meaningful STEM learning: multilingual learners.We close by calling for the STEM education community to address increasingly complex, prevalent, and intractable societal challenges by centering justice for minoritized groups. In K-12 classrooms, unprecedented societal challenges present an unprecedented opportunity to center justice in STEM education and society broadly.

Related Paper Set

Student sensemaking about trees, climate change, and redlining in an urban community

Rich DelVechio*, Montclair State University, USA
Karen Woodruff*, Kean University, USA
Mario Sanivanez, Hackensack High School, USA
Brooke Zwier, Hackensack High School, USA
Benjamin Keeler, Hackensack High School, USA

ABSTRACT

Trees are an essential component of our communities and influence our well-being in multipleways. This study suggests that students living in an urban community can notice and make senseof trees through the learning opportunities afforded in their high school science classes. One highschool science supervisor and three science educators implemented an eight-lesson ambitiousscience unit (Windschitl et al., 2018) focused on a storyline grounded in a place-basedphenomenon: Why are the trees in our community disappearing? Evidence of sensemakingemerged through students noticing, exemplified through this student statement: "I never realizedthat they weren't there until I saw that they were."Researchers employed the Justice-centered Ambitious Science Teaching (JuST) framework(Luehmann et al., 2024) as the analytical lens to learn from survey data, student artifacts, andinterviews. Four themes emerged: 1) recognition of the important of trees in the ecosystem; 2)the need to educate and engage adult community members; 3) interest in taking action locally;and 4) the relationship between race, economics and gentrification in the community. Overall,this work suggests that students in one urban, minority serving school community made sense oftree distribution and used science as a transformative tool for influencing public opinion.

Related Paper Set

Anti-Racist Ambitious Science Teaching as an Organizational Structure to Support Preservice Teacher Learning

Jennifer Jackson, Oak Ridge Institute for Science and Education, USA
Jonathan McCausland, Iona University, USA
Scott McDonald, Pennsylvania State University, USA

ABSTRACT

Due to limited experience in the field, science interns tend to experience difficulties with navigating the political dilemmas of science education (Windschitl, 2002). It can be particularly challenging in teacher education contexts that are exclusively or almost

exclusively white. Using a design-based methods approach, this study addresses this problem by examining the multiple iterations of a series of science teaching methods courses, specifically focusing on an improv workshop, rooted in principles of Critical Whiteness Improv Pedagogy (Tanner Miller, 2024). For context, the improv workshop is designed to provide the interns with the opportunity to examine the relationship between science, science education, and white supremacy. Findings for this study include descriptions of the improvisational activities referred to ascharacter walksandstill image theatre. By having interns participate in improvisational work, teacher educators can begin to integrate supportive task structures that will impact how interns understand white supremacy and the various political dilemmas that exist in science education.

Climate Justice

Strand 14: Environmental Education and Sustainability
26-Mar-25, 10:45 AM-12:15 PM
Location: Baltimore 3

Stand-Alone Paper

Elementary Climate Education: A Framework for Including Climate Justice in Climate Emergency Lessons

Hong Tran*, Purdue University, USA
Joseph DeLuca, University of Georgia, USA
Shweta Lahiri, University of Georgia, USA
Emily Adah Miller, University of Georgia, USA
Ajay Sharma, University of Georgia, USA
Erin Hamel, University of Georgia, USA
Peng He, Washington State University, Pullman, USA
Yuxi Huang, University of California, Irvine, USA
Tingting Li, Washington State University, Pullman, USA
Julie Luft, University of Georgia, USA

ABSTRACT

Climate emergency (CE) is the single most important socioscientific issue for today's students, yet challenges for elementary teachers interested in teaching about CE and climate justice (CJ) are many, including introducing science content that departs from the science standards - especially, when there are competing minutes for science, and worrying about creating fear and hopelessness in students. We bring together theories of science teaching and learning and CJ theories, to advocate for a model of recognitional CJ, in which CE is forwarded through science education that is anchored in and motivated by students' experiences. We propose a framework for including CE and CJ in elementary science curricula. We illustrate this framework with examples from our work with elementary students and their teachers in a Gulf state, which integrates CE and CJ into a five-lesson unit. Alongside other researchers doing this work, we hope our framework and examples can be

part of building toward more sophisticated and integrated strategies of justice pedagogies and practices in science classrooms.

Stand-Alone Paper

De-Naturalizing Climate Disasters Through Justice-Oriented Science Education

Wonyong Park*, University of Southampton, United Kingdom
Noemi Waight, University at Buffalo, USA
Fatemeh Mozaffari, University at Buffalo, USA
Jennifer Tripp, University at Buffalo, USA
Christopher St. Vil, University at Buffalo, USA

ABSTRACT

As the impacts of the climate crisis intensify and diversify, there is growing discussion about how to address climate disasters and extreme weather events in K-12 science education. We build on scholarship in disaster studies and justice-oriented science education to advocate for education that denaturalizes so-called "natural" disasters and addresses the unequal distribution of the impacts of climate and environmental change. We illustrate this approach through a community-based research project with residents and teachers affected by the deadly Blizzard of 2022 that struck Buffalo, NY, and disproportionately affected historically marginalized groups within the community. Drawing on the knowledge and experiences of the community, we discuss opportunities for justice-oriented science education in the face of climate disasters and extreme weather events.

Stand-Alone Paper

Math as a Tool for Advocacy: Teachers' Quantitative Moral Moves During Climate Justice Activities

Helen Fitzmaurice*, UC Berkeley, USA
Michelle Wilkerson, UC Berkeley, USA
Jacob Barton, UC Berkeley, USA
Alyssa Sayavedra, CSU Monterey Bay, USA

ABSTRACT

A growing number of science teachers are bringing the sociopolitical aspects of climate justice and environmental justice into their instruction. However, such integration is not supported by the current Next Generation Science Standards(Clark, 2024; Morales-Doyle et al., 2019)or widely available curricula and more support is needed for teachers trying to build their students' capacity to use quantitative reasoning in support of climate justice.This represents a missed learning opportunity, because in the spheres of activism, policy making, regulatory enforcement, and public planning, issues of justice are often intertwined with quantitative understandings of climate change and other environmental issues.In this paper, we definequantitative moral sensemaking,quantitative moral teaching, andquantitative moral advocacyas three ways in which people use quantitative moves in the context of climate and environmental justice. We explain why we believe the development of such skills are important and hypothesize that one way to support the development of such skills is to prioritize advocacy skills, rather than specific science content, as a primary learning goal.

Finally, we present an analysis of quantitative moral moves that science teachers make in the context of an advocacy task during a professional development institute focused on air quality.

AUTHOR INDEX

A

B

C

D

E

F

G

H

I

J

K

L

M

N

O

P

Q

R

S

T

U

V

W

X

Y

Z