



NARST

A global organization for improving
science education through research

99th NARST Annual International Conference

April 19 - 22, 2026 | Seattle, WA



DIGITAL PROGRAM

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99th NARST Annual International Conference



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99th NARST Annual 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

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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

COMPUTATIONAL SCIENCE PRACTICES (CSP-RIG)

The purpose of the Computational Science Practices Research Interest Group (CSP-RIG) is to promote research and innovation to expand computational science practices in science education. The synergy between computational practices and science makes it critical to include computational science practices (CSPs) early, often, and equitably in K-12 science classrooms. Yet, these synergies remain largely untapped in science education. The CSP-RIG will serve as a collaborative space for researchers promoting CSP integration into science education. This RIG will promote the uptake of CSPs, addressing inequities in science education by providing access to innovative practices for more teacher educators, teachers, and students. Given the lack of opportunities for scholars to discuss CSPs and their integration with science, this RIG will provide a space to build a community of CSP researchers. This RIG will promote the advancement of knowledge about CSPs in science education and will disseminate and share members' research-based practices with the NARST and broader science education communities.

Dr. Mandy Peel, apeel@nmsu.edu

Dr. Janice Mak, Janice.Mak@asu.edu

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

Steering Committee Chair: **Jonathan Hall**, jhall@csusb.edu

Steering Secretary: **Heather Lavender**, hflavend@syr.edu

Steering Treasurer: **Stanton Belford**
sbelfor2@utsouthern.edu

EXPLORING PROFESSIONAL AVENUES IN SCIENCE EDUCATION IN NONTRADITIONAL DOMAINS (EXPAND RIG)

The EXPAND RIG supports researchers who pursue and advance science education work outside traditional academic institutions. This group provides a collaborative space for graduate students, early-career scholars, and established researchers working in non-traditional academic settings, including nonprofits, industry, government, research firms, and community organizations. The RIG promotes networking, mentorship, and professional development focused on diverse research trajectories, and highlights scholarship that engages directly with practitioners, policymakers, and communities. By broadening the field's understanding of research impact and elevating voices across sectors, EXPAND aligns with NARST's mission to advance quality science learning for all and strengthens support for researchers navigating careers beyond the tenure-track.

Dr. Ti'Era Worsley, tworsley@nvcc.edu

Dr. Sierra Morandi, smorandi@fsu.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: **Uma Ganesan**, uma.ganesan@utrgv.edu

Chair-Elect: **Miriam Ortiz**, miriam.ortiz01@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: **Brock Couch**, brockcouch44@gmail.com

Communications Officer: **Stephanie Stanley**
sstanley5@una.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

Co-Chair: **Christopher Wright**

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: **Julie Robinson**, julie.robinson@und.edu

Co-Chair: **Bhaskar Upadhyay**, bhaskar@umn.edu

Secretary: **Rouhollah Aghasaleh**, ra292@humboldt.edu

Treasurer: **Pauline Chinn**, chinn@hawaii.edu

Research in Artificial Intelligence-Involvement 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 APISER 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+ RIG)

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 identify 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

2025-2026 NARST Leadership Team

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President-Elect

Maria Varelas (2028)

University of Illinois Chicago

Immediate Past President

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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

2025-2027 Strand Coordinators

Strand 1: Science Learning— Development of Student Understanding

Stefanie L. Marshall (2026)

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Uma Ganesan (2027)

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Strand 2: Science Learning— Contexts, Characteristics and Interactions

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Kathryn Lanouette (2027)

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Christine Bernhardt (2027)

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Meena Kharatmal (2027)

Tata Institute of Fundamental Research

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Strand 8: In-service Science Teacher Education

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Strand 12: Technology for Teaching, Learning, and Research

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

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University of Southampton

Strand 14: Environmental Education and Sustainability

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Hong H. Tran (2027)

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Strand 15: Policy, Reform, and Program Evaluation

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Laura Rios	Maria Rivera Maulucci	Monica Sircar	Paulo Mauricio
Laura Wheeler	Marie Johanna Univer	Mon-Lin Monica Ko	Peggy Harte
Laura Zangori	Marina May	Monsour Zakariyah	Peng He
Lauren Browning	Marti Canipe	Mourad El Karkri	Perla Ramos Carranza
Lauren Dudley	Mary Olayanju	Moyu Zhang	Peter Cormas
Lauren Harper	Mary Whitfield	Ms Mutiara Syifa	Peter Idowu
Lauren Madden	Matt Adams	Muhammad Abd Hadi Bunyamin	Peter Rillero
Lauren Wagner	Matt Nyman	Muhammad Purwanto	Petra Bezeljak
Layla Ye Zang	Matt Stewart	Mushfique Ashique	Phillip Dixon
Leah Master	Matthew Blank	Na'ama Av-Shalom	Piata Allen
Lena Lenz	Matthew Weinstein	Narendra Deshmukh	Priya Pugh
Leon Yufeng Wu	Matthias Klassen	Nazia Tasnim	Priyanka Parekh
Leroy Großmann	Meagan Graves	Neta Shaby	Qian Wu
Lezly Taylor	Meena Kharatmal	Niki Koukoulidis	Qianqian Gao
Lia Betancourt	Meg Gardner	Nikola Schild	Qianyu Teng
Like Deng	Megan Ennes	Nils Bergander	Qingna Jin
Linsey Brennan	Megan Silander	Nina Minkley	Quan Wang
Lisa Borgerding	Meghan Macias	Noam Brenner	Quentin Biddy
Lisa Marco-Bujosa	Mehmet Aydeniz	Norris Erhabor	Quentin Sedlacek
Liz Carletta	Melanie Kinskey	Noushin Nouri	Rachel Benzoni
Lu Wang	Melissa Livingston	Nushrat Hoque	Rachel Chaffee
Lucky Nonyelum	Melissa Mendenhall	Olayinka Mohorn	Rachel Stronach
Lutz Kasper	Mengqian Wang	Olayinka Oyewole	Rafael Pelletti
Lynn Huff	Mercy Funke Ogunsola Bandele	Olivia Magnuson	Rahmi Qurota Aini
Lynne Zummo	Michael Cassidy	Olusegun Fashakin	Razan Hamed
M. Gail Jones	Michael Giamellaro	Oluwatosin Akande	Rebecca Hite
Magdalena Pando	Michael Mauricio	Omowumi Frieyo	Rebecca Sansom
Mahnaz Zolfaghari	Michele Weston	Özlem Önal	Rebecca Swanson
Maiza Trigo	Michelle Brown	Öznur Avcı	Rebekah Hammack
Maizie Dyess	Min Jung Lee	Parin Chawalit	Regis Komperda
Manal Almalki	Min Li	Patricia Moreira Seguel	Ren Mendoza
Mandy Peel	Mindy Chappell	Patricia Patrick	Rena Orofino
Manuela Mejia	Minjung Ryu	Patrick Smith	Richard Bex
Mao-Jen Tseng	Miranda Allen	Paul Moran	Richard Lamb
Maram Al Aqra			

Program Proposal Reviewers

Richard Sannert	Shauna Schechtel	Tanya Churaman	Xiao Huang
Rida Munir	Sheikh Ahmad Shah	Tara Barnhart	Xiaomei Yan
Rika Mardiana	Shelley Rap	Taylor Mule	Xiaoyu Tang
Robert Idsardi	Shikhar Kashyap	Tej Dalvi	Xijuan Li
Roe Peretz	Shirly Avargil	Teresa Massey	Xin Xia
Roger Erb	Shiva Javanmardi	Terrance Burgess	XinJia Ma
Ron Blonder	Shondricka Burrell	Terrell Morton	Xinyu He
Rosa Mykita-Chomsky	Shumin Zhao	Thanh Le	Xiuju Li
Roshni Bano	Sibel Erduran	Thomas McKenna	Yael Feldman-Maggor
Rudan Wang	Sierra Morandi	Ti'Era Worsley	Yang Zhang
Ruth Edri	Sissy Wong	Tilman Steinmetz	Yessy Eka Ambarwati
Ryan Nixon	Song Wang	Tim Hartelt	Yetunde Adaramola
Saed Sabah	Soon Lee	Tina Vo	Yetunde Mabadeje
Sahar Alameh	Soonhye Park	Tirza Vargas	Yilmaz Kara
Sakine Çiftaslan	Soo-Yean Shim	Tom Reshef Israeli	Ying-Chih Chen
Salwa Ali	Spencer Eusden	Tongtong Guan	Yi-Ning Huang
Sam Evans	Stacy Olitsky	Trevion Henderson	Yiru Wang
Samantha Nevado	Stefanie Marshall	Troy Sadler	Yiwen Li
Samantha Viano	Stephanie Tracey	Uchenna Miles	Yong Xie
Sara Heredia	Stephanie Wilkerson	Ülkü Seher Budak	Youngjin Choi
Sara Satanassi	Stephen Burgin	Uma Ganesan	Yu Shuwen
Sarah August-Henry	Stephen Trembath-Reichert	Umar Adam	Yu-Hui Chang
Sarah Voss	Stephen Witzig	Usman Ijaz	Yu-Jan Tseng
Sarika Kewalramani	Steven Courchesne	Valarie Akerson	Yujing Guo
Scarlett Calvin	Sule Aksoy	Valeria Vendries	yurdagul Bogar
Scott Cohen	Suna Ryu	Vanessa de Andrade	Yushuang Liu
Selcuk Kilinc	Susannah Sandrin	Vered Alboher Agmon	Yuxi Huang
Selvet Ece Genek	Sushma Sardana	Victor Murphy	Zachary Patterson
Sevim Bezen	Suzanne Patzelt	Wanjoo Ahn	Zahra
Shallom Lumor	Syed Nauman Wazir	Wardell Powell	Baradaranshoraka
Shan Lin	Sylvia Faustine	Wei-Ting Li	Zeyu Han
Shanel Lightfoot	Taiwo Ogundapo	Weiwei He	Zeyuan Wang
Shani Goldstein	Tajinder Saroya	William Lindsay	Zhen Xu
Shannon Davidson	Tamar Fuhrmann	William McComas	Zhimeng Jiang
Shannon Navy	Tamar Ginzburg	William Romine	Zoubeida Dagher
Shanshan Lu	Tamara Heck	Winter Allen	
Shari Watkins	Tamara Turski	Wonyong Park	
Sharon Ndubuisi		Xianqing Bao	

NARST Presidents

1928 W. L. Eikenberry	1954 George G. Mallinson	1980 John W. Renner	2004 Charles W. (Andy) Anderson
1929 W. L. Eikenberry	1955 Kenneth E. Anderson	1981 Stanley L. Helgeson	2005 John R. Staver
1930 W. L. Eikenberry	1956 W. C. Van Deventer	1982 Stanley L. Helgeson	2006 James A. Shymanksy
1931 Elliot R. Downing	1957 Waldo W. Blanchet	1983 Carl F. Berger	2007 Jonathan F. Osborne
1932 Elliot R. Downing	1958 Nathan S. Washton	1984 Ann C. Howe	2008 Penny J. Gilmer
1933 Francis D. Curtis	1959 Thomas P. Fraser	1985 Ertle Thompson	2009 Charlene M. Czerniak
1934 Ralph K. Watkins	1960 Vaden W. Miles	1986 David P. Butts	2010 Richard A. Duschl
1935 Archer W. Hurd	1961 Clarence H. Boeck	1987 James P. Barufaldi	2011 Dana L. Zeidler
1936 Gerald S. Craig	1962 Herbert A. Smith	1988 Linda DeTure	2012 J. Randy McGinnis
1937 Walter G. Whitman	1963 Ellsworth S. Obourn	1989 Patricia Blosser	2013 Sharon J. Lynch
1938 Hanor A. Webb	1964 Cyrus W. Barnes	1990 William G. Holliday	2014 Lynn A. Bryan
1939 John M. Mason	1965 Frederic B. Dutton	1991 Jane Butler Kahle	2015 Valarie L. Akerson
1940 Otis W. Caldwell	1966 Milton P. Pella	1992 Russell H. Yeany	2016 Mary M. Atwater
1941 Harry A. Carpenter	1967 H. Craig Sipe	1993 Emmett L. Wright	2017 Mei-Hung Chiu
1942 G. P. Cahoon	1968 John M. Mason	1994 Kenneth G. Tobin	2018 Barbara Crawford
1943 Florence G. Billig	1969 Joseph D. Novak	1995 Dorothy L. Gabel	2019 Gail Richmond
1944 Florence G. Billig	1970 Willard D. Jacobson	1996 Barry J. Fraser	2020 Tali Tal
1945 Florence G. Billig	1971 Paul D. Hurd	1997 Thomas R. Koballa, Jr.	2021 Eileen R. C. Parsons
1946 C. L. Thield	1972 Frank X. Sutman	1998 Audrey B. Champagne	2022 Renée Schwartz
1947 Earl R. Glenn	1973 J. David Lockard	1999 Joseph S. Krajcik	2023 Gillian Roehrig
1948 Ira C. Davis	1974 Wayne W. Welch	2000 David F. Treagust	2024 Jomo Mutegi
1949 Joe Young West	1975 Robert E. Yager	2001 Sandra K. Abell	2025 Jerome Shaw
1950 N. Eldred Bingham	1976 Ronald D. Anderson	2002 Norman G. Lederman	2026 Jennifer Adams
1951 Betty Lockwood	1977 O. Roger Anderson	2003 Cheryl L. Mason	
1952 Betty Lockwood	1978 Roger G. Olstad		
1953 J. Darrell Barnard	1979 James R. Okey		

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

JRST Editors

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

Emeritus Members

Alan McCormack	George Bodner	Julia Clark	Rachel Mamlok-Naaman
Albert Nous	Gerald Krockover	Larry Enochs	Richard Haney
Altaf Qadeer	Gian Pedemonte	Larry Yore	Richard Walding
Andree Tiberghien	Glenn Berkheimer	Leonie Rennie	Robert Dehaan
Ann Osman	Glenn Markle	Linda Phillips	Robert Poel
Avi Hofstein	Gottfried Merzyn	Lowell Bethel	Robert Sherwood
Barbara Crawford	Guilford Bartlett	Lynn Bryan	Robert Williams
Carl Angell	Hans Andersen	Mansoor Niaz	Rodney Doran
Charles Anderson	Helmut Dahncke	Manuel Sequeira	Roger Olstad
Charles McFadden	Herbert Thier	Marianne Barnes	Ronald Anderson
Dale Baker	Ivo Lindauer	Marlene Thier	Ryda Rose
David Haury	J. Prather	Mary Atwater	Sherry Southerland
David Kennedy	J. Swift	Michael Agin	Stanley Helgeson
Donald Riechard	Jacqueline Mallinson	Michael Padilla	Sue Tunnicliffe
Donald Schmidt	James Poth	Michael Piburn	Sung Jae Pak
Doris Simonis	James Shymansky	Nitza Barnea	Uri Ganiel
Ed Van Den Berg	Jane Kahle	Obed Norman	Vincent Lunetta
Edward Smith	Jay Lemke	Onno De Jong	Wayne Welch
Eileen Parsons	Jim Minstrell	Paul Joslin	William Holliday
Ellen Simmons	John Christopher	Peter Hewson	William Jaffarian
Elsa Feher	Joseph Novak	Peter Okebukola	



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)	Year	Awardee(s)
1986	Anton E. Lawson	2012	Charles W. (Andy) Anderson Larry Yore
1987	Paul DeHart Hurd	2013	Dale R. Baker
1988	John W. Renner	2014	Glen Alkenhead Richard Gunstone Frances Lawrenz
1989	Willard Jacobson	2015	Richard A. Duschl Meshach Mobolaji Ogunniyi
1990	Joseph D. Novak	2016	Lynn D. Dierking John N. Falk Dana L. Zeidler
1991	Robert L. Shrigley	2017	Avi Hofstein
1992	Pinchas Tamir	2018	Marissa Rollnick Jonathan Osborne
1993	Jack Easley, Jr.	2019	Mary M. Atwater Maria Pilar Jiménez-Aleixandre
1994	Marcia C. Linn	2020	Judy Dori Saouma Bou Jaoude
1995	Wayne W. Welch	2021	Valarie Akerson Greg Kelly
1996	Carl F. Berger	2022	Fouad Abd-El-Khalick Gail Jones
1997	Rosalind Driver	2023	Franz X. Bogner Okhee Lee
1998	James J. Gallagher	2024	Angela Calabrese Barton Julie Luft
1999	Peter J. Fensham	2025	Sherry Southerland
2000	Jane Butler Kahle	2026	Mei-Hung Chiu Sibel Erduran Troy Sadler
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		



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
2026	Dr. Sage Andersen Scott Cohen	María González-Howard Patrick J. Enderle



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
2026	Megan Ennes Li Ke

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 Richard A Duschl Gillian Roehrig
2022	Peter A. Okebukola
2023	Julie Bianchini Ron Blonder Patricia Friedrichsen
2024	Elizabeth Mavhunga Carla Zembal-Saul Renee' Schwartz Christina Schwarz Lynn Bryan

2025	Janet Carlson M. Gail Jones Hosun Kang Katherine L. McNeill Felicia Moore Mensah Eileen Parsons Bhaskar Upadhyay
2026	Tali Tal Elizabeth Davis Aslı Sezen-Barrie Mercy Ogunsola-Bande Umesh Ramnarain

Excellence in Mentoring Award

The NARST Excellence in Mentoring Award recognizes an exceptional mentor from the NARST community who has impacted graduate student growth both professionally and personally.

Year	Awardee(s)
2024	Janet Carlson
2025	Ron Blonder
2026	Dr. Angela Chapman



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

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

*Tie

Research Worth Reading Awards (RWR)

Year	Awardee(s)	Year	Awardee(s)
2026	Jessica L. Alzen, Jason Y. Buell, Kelsey Edwards, Brian J. Reiser, Cynthia Passmore, Bill Penuel, Chris D. Griesemer, Yang Zhang Characterizing variations in the figured worlds of teachers and students in science class	2026	Regina McCurdy The science relevancy bridge: Connecting intersectionality and science identity in science learning experiences
		2026	Daniel Pimentel Learning to evaluate sources of science (mis) information on the internet: Assessing students' scientific online reasoning



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

NARST Standing Committees

Awards Committee	
Final Year	Board Liaison
2028	Shari Watkins American University
Outstanding Doctoral Research Award	
Final Year	Committee Leadership
2026	Dina Tsybulsky (Chair) Technion, Israel
2027	Julianne Wenner (Incoming Chair) Clemson University
Members	
2026	Mindy Chappell University of Illinois Urbana-Champaign
2026	Mary Short George Washington University
2026	Stephanie Batres Spezza University of Illinois - Chicago
2026	David Stroupe Michigan State University
2026	Noemi Waight University at Buffalo
2027	Tamar Fuhrmann Teachers College/Columbia University
2028	Neha Anand Midway University
2028	Shannon Davidson University of Alabama
2028	Ayça K. Fackler University of Missouri
2028	Symone Gyles University of California, Irvine
2028	Lama Jaber Florida State University
2028	Li Ke University of Washington
2028	Shelley Rap Weizmann Institute of Science
2028	Tammie Visintainer San Jose State University

Early Career Research Award	
Final Year	Committee Leadership
2026	Uchenna Emenaha (Chair) The University of Texas at San Antonio
2027	Meg Blanchard (Incoming Chair) North Carolina State University
Members	
2026	Juan Diaz Mount Aloysius College
2026	Katherine Doerr Mount Aloysius College
2027	Elizabeth (Betsy) Davis University of Michigan
2027	Gary William Wright University of Missouri
2027	Hyesun You University of Iowa
2028	Rowhea Elmesky University of Washington in St. Louis
2028	Preeti Gupta Member AMNH
2028	Daniel Morales-Doyle University of Illinois Chicago
2028	Wardell A. Powell Framingham State University
2028	Neta Shaby University of Southampton

NARST Standing Committees

Awards Committee (cont.)	
Distinguished Contributions to Science Education Through Research	
Final Year	Committee Leadership
2026	Saouma BouJaoude (Chair) American University of Beirut, Lebanon
2027	Okhee Lee (Incoming-Chair) New York University
Members	
2026	Carla Johnson NC State University
2026	Gail Jones NC State University
2027	Ron E. Gray Northern Arizona University
2028	Angela Calabrese Barton University of Michigan
2028	Pei-Ling Hsu University of Texas at El Paso
2028	Jenny Martin Australian Catholic University
2028	Bhaskar Upadhyay University of Minnesota
NARST Fellow Award	
Final Year	Committee Leadership
2026	Lezly Taylor (Chair) Virginia Polytechnic Institute and State University
2027	Helena Aptyka (Incoming-Chair) University of Cologne, Germany
Members	
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
2028	Elizabeth Edmondson Virginia Commonwealth University
2028	Katherine McNeill Boston College

Elections Committee	
Final Year	Committee Leadership
2026	Nazan U. Bautista (Immediate Past Chair) Miami University
2027	Muhammad Abd Hadi Bunyamin (Chair) Universiti Teknologi Malaysia
2028	Preethi Titu (Incoming-Chair) Kennesaw State University
Members	
2026	Angela Chapman University of Texas Rio Grande Valley
2026	Susie M. Cohen Trinity International University
2026	Tim Klavon Black Hills State University
2027	Jonah B. Firestone Washington State University
2027	Samuel Severance Northern Arizona University
2028	Meredith Bittel University of Kansas
2028	Sonya Martin Seoul National 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 (Immediate Past Chair) University of North Carolina at Charlotte
2027	Iliana Esther De La Cruz (Chair) Texas A&M University
2028	Maria R. Maulucci (Incoming-Chair) Barnard College
Members	
2026	Laura Peña-Telfer Georgia State University
2027	Bolaji Bamidele Utah State University
2027	Devasmita (Deva) Chakraverty Indian Institute of Management Ahmedabad
2027	Dominick Fantacone SUNY Cortland Director of Research and Sponsored Programs
2027	Khanh Q. Tran Purdue University
2028	Ashley Easley University of Michigan, Ann Arbor
2028	Monica Miles Member University of Buffalo
2028	Ali Muller Rowan University
2028	Greses Perez Tufts University
Board Member Liaison	
2028	Terrell Morton University of Illinois Chicago

Membership Committee	
Final Year	Committee Leadership
2026	Joi Merritt (Chair) James Madison University
2028	Theila Smith (Incoming-Chair) NYC Department of Education
Members	
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	Khadija Zogheib Florida State University
2028	Rebekah Hammack Purdue University
2028	Shulamit Kaponâ Technion Israel Institute of Technology
2028	Jonathan Mccausland Ioana University
2028	Johan Noel Tabora Northwestern University
Board Liaison	
2026	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	Committee Leadership
2026	Xin Xia (Co-Chair) University of Virginia
2027	Arya Karumanthra (Co-Chair) Indiana University
Members	
2026	Austin R. Jenkins Purdue University
2026	Muhammad Guntur Purwanto (Guntur) University of Minnesota
2026	Kristal Louise Turner University of Calgary, Canada
2027	Selvet Ece Genek The Ohio State University
2027	Dilara Goren Bogazici University, Turkey
2027	Wei-Ting Li National Sun Yat-sen University, Taiwan
2027	Souhaila Nassar Boston University
2027	George Schafer Drexel University
2027	Stephanie Tracey Clemson University
Board Member Liaison	
2026	Collins Moga University of Mass Dartmouth

International Committee

Final Year	Committee Leadership
2026	Arif Rachmatullah (Co-Chair) SRI International
2027	Sahar Alameh (Co-Chair) University of Kentucky
Members	
2026	Estelle Blanquet University of Bordeaux - France
2026	Christelle Fayad Texas Christian University
2027	Shirly Avargil Technion Junior Faculty, Israel
2027	María Helena Salas Cossio Universidad Alberto Hurtado
2027	Keren Dalyot Weizmann Institute of Science, Israel
2027	Tim Hartelt University of Kassel
2027	Argyris Nipyrakis University of Crete, Greece
2027	Giulia Tasquier University of Bologna, Italy
2028	Keren Dalyot Weizmann Institute of Science, Israel
Board Member Liaison	
2026	Sara Salloum Ohio University

NARST Standing Committees

Program Committee	
Final Year	Committee Leadership
2027	Jennifer D. Adams (Co-Chair) University of Calgary, Canada
2028	Maria Varelas (Co-Chair) University of Illinois Chicago
Continuing	Mackenzie Kelley NARST Executive Director
Members	
2026	Rouhollah Aghasaleh Polytechnic University, Humboldt
2026	Rachel van Aswegen University of Virginia
2026	Selina Lynn Bartels Valparaiso University
2026	Julie C. Brown University of Florida
2026	Sanlyn Buxner University of Arizona
2026	Mila Rosa Librea Garden 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	Quentin Sedlacek Southern Methodist University
2026	Anita Schuchardt University of Minnesota

2026	Jill Wertheim WestEd
2026	Moyu (Molly) Zhang New York University
2027	Xornam Apedoe University of San Francisco
2027	Christine Bernhardt University of Maryland
2027	Jason Buell Northwestern University
2027	Sanlyn Buxner University of Arizona
2027	Uma Ganesan University of Texas Rio Grande Valley
2027	Christa Haverly Chicago Public Schools
2027	Erdogan Kaya The University of Texas at Arlington
2027	Kathryn Lanouette William & Mary School of Education
2027	Wonyong Park University of Southampton
2027	Takeshia Pierre Tufts University
2027	Elizabeth Xeng de los Santos CA Commission on Teacher Credentialing
2027	Ryan Summers University of North Dakota
2027	Hong H. Tran Purdue University
2027	Moyu (Molly) Zhang New York University

NARST Standing Committees

Professional Learning and Institutes Committee	
Committee Leadership	
2026	Amelia W Gotwals (Immediate Past-Chair) Michigan State University
2027	David Owens (Chair) Alabama School of Fine Arts
2028	Stephen B. Witzig (Incoming-Chair) University of Massachusetts Dartmouth
Members	
	Maram Al Aqra Sharajh Educational Academy
	Courtney Benal University of South Carolina
	Shondricka Burrell Morgan State University
	Kason Cheung Ka Ching The Education University of Hong Kong
	Cole Hatchard STEM Innovation Academy High School
	Jing LIN Beijing Normal University
	Vanessa Louis Marsal Family School of Education University of Michigan
	Justin McFadden University of Louisville
	Sara Wilmes Member Univ. of Luxemburg

	Alexander Paulchell-Lehan University of Arizona
	Fredyrose Ivan Pinar De La Salle Medical and Health Sciences Institute
	Swagata Sarkar Purdue University
	Cheyenne Woods California State University, Fresno
	Ella Yonai University of Georgia
	Yang Zhang Northwestern University
	Bo Zhu, Ph.D American Institute for Research
Board Liaison	
2026	Shiang-Yao Liu National Taiwan Normal University

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



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NARST Standing Committees

Research Committee	
Final Year	Committee Leadership
2026	Bryan H. Nichols (Immediate Past-Chair) Florida Atlantic University
2027	Colby Tofel-Grehl (Chair) Utah State University
2028	Alexander Bohn (Incoming-Chair) Northern Virginia Community College
Members	
2026	Michael Giamellaro Oregon State University
2026	Cesar Delgado North Carolina State University
2026	Mina Sedaghatjou Rowan University
2026	Carrie-Anne Sherwood Southern Connecticut State University
2027	Beth A. Covitt University of Montana
2027	Alexander Bohn Northern Virginia Community College
2027	Saramma Chandy Mumbai University
2028	Yurdagül Bogar Hakkari University
2028	Melissa Mendenhall Utah Valley State
2028	Maiza de Albuquerque Trigo University of Luxembourg
2028	Karen Woodruff Kean University
2028	Ezgi Yesilyurt, Ph.D. Weber University
Board Liaison	
2026	Meredith Park Rogers Indiana University

Scholarships Committee	
Final Year	Committee Leadership
2026	Jennifer Bateman (Immediate Past-Chair) Georgia Southern University
2027	Jomo Mutegi (Chair) Old Dominion University
Members	
2026	Christina Baze Northern Arizona University
2027	Julie Bianchini University of California, Santa Barbara
2027	Nivedh Jayanth Purdue University
2027	Marcus Kubsch Freie Universität Berlin
2027	Clara Mabour Tufts University
2027	Alexis Markavage Indiana University
2027	James Minogue NC State University
2027	Hopegay Williams University of West Indies, Mona
2028	Jonathan M. Barcelo Saint Louis University (Philippines)
2028	Danielle Malone Purdue University
2028	Jonathan Mccausland Iona University
2028	Peter Oyewole Kent State University
2028	Adepeju Prince Kent State University
2028	Senay Purzer Purdue University
2028	Rona Robinson-Hill Ball State University
2028	Jorge Solís University of Texas at San Antonio
Board Liaison	
2027	Kristin Guncel University of Arizona

NARST Standing Committees

Social Media, Website and Communications Committee

Final Year	Committee Leadership
2026	Gary Weiser (Immediate Past-Chair) Bill and Melinda Gates Foundation
2027	Stephanie Teeter (Chair) North Carolina State University
2028	Suzanne Poole Patzlelt (Incoming-Chair) Touro University, New Jersey
Members	
2026	Linsey Brennan Michigan State University
2026	Marti Canipe Northern Arizona University
2026	Steven Worker University of California, Agriculture and Natural Resources

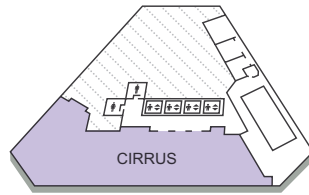
2027	Katerina Pia Gunter San Francisco State University
2027	Olayinka Mohorn University of Memphis
2027	Christina Schwarz Michigan State University
2028	Tyler Harper-Gampp North Carolina State University
2028	Ryan Summers University of North Dakota
2028	Carol C. Waters University of Houston-Clear Lake
Board Member Liaison	
2026	Patrick Enderle Georgia State University

Future NARST Meeting Dates

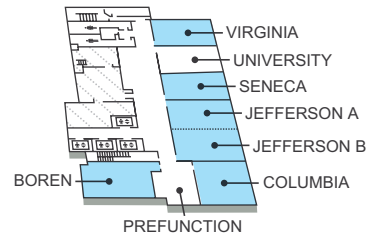
2027	March 14 - 17	Boston, MA
2028	March 19 - 22	Montreal, CA

Floor Plans and Capacity Charts

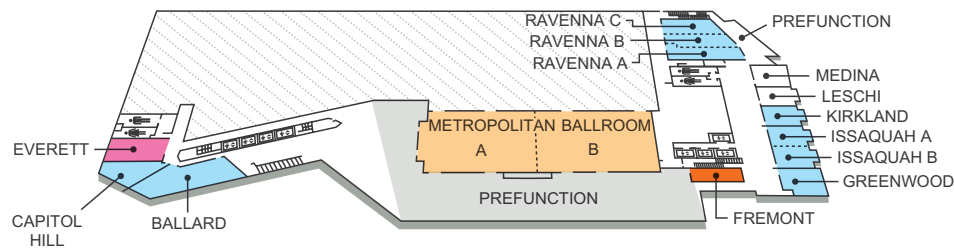
35th Floor – Pike Street Tower



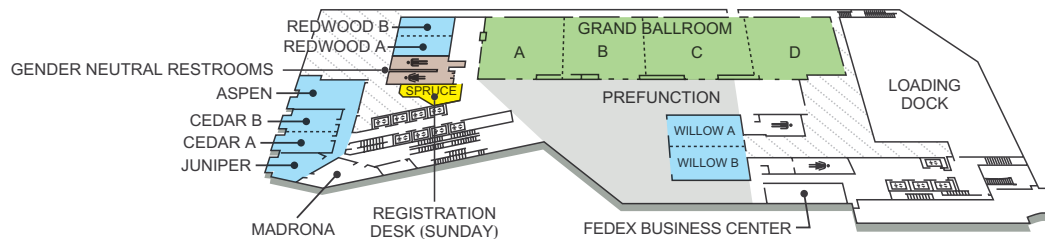
Fourth Floor – Union Street Tower



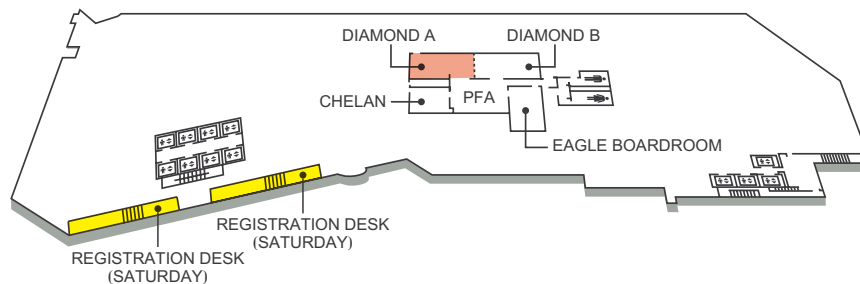
Third Floor



Second Floor



First Floor – Lobby Level



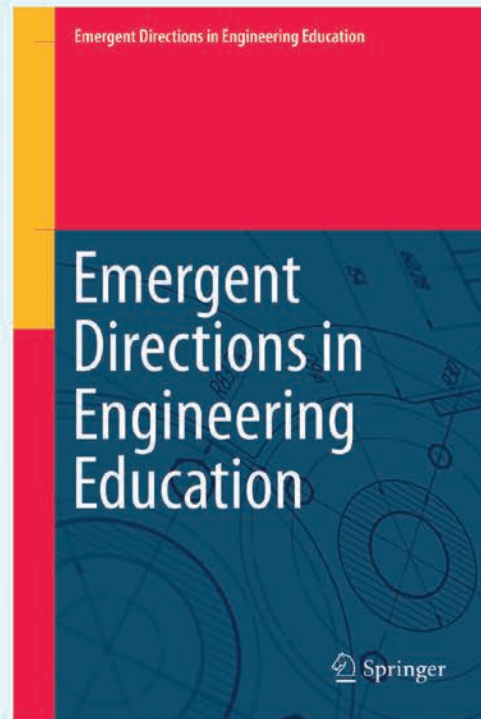
 Registration Desks	 NARST Board Meeting/ Graduate Student Forum/ SKAIDS Reception (Invitation Only)	 Education Breakout Session Rooms	 Gender Neutral Restrooms
 General Session/ Keynote Presentations/ Awards Presentation	 Graduate Student Lunch and Posterboard Session	 JRST Dinner (Invitation Only)	 Lactation Room
 Networking and Exhibits/ Breakfast (only on 2nd Floor)		 Prayer Room	

New Book Series!

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Series Editor:
Jeffrey Buckley



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NARST Conference and Virtual Events Accessibility Guidelines for Presenters

Slide Deck Presentations

(Adapted from AERA, AAAS, and the American Anthropological Association)

Design & Readability

- Use high-contrast text on solid backgrounds
- Use sans-serif fonts (minimum 18 pt)
- Keep slides clean and uncluttered
- Limit to ≤5 bullet points per slide
- Keep bullet points short (ideally one line)

Presentation Practices

- Read all text directly as presented on slides before expanding
- Clearly describe all visuals, including:
 - Images
 - Graphs & charts
 - Maps
 - Videos
- Provide context and meaning, not just description

Multimedia & Accessibility

- Use closed captions when spoken language is essential
- Provide audio description OR pause to explain visuals
- **Note:** ASL interpreters do not translate video content

Accessibility Check

Run an accessibility check to ensure:

- Proper color contrast
- Logical reading order (title → text → visuals)
- Alt text for all images
- Accessible tables

Poster Presentations

(Adapted from Yale Library Accessibility Guidelines)

Color & Visual Design

- Ensure strong contrast between text and background
- Do NOT rely on color alone to convey meaning → Use patterns, labels, or textures
- Avoid red/green-only distinctions (colorblind accessibility)

Typography

- Use sans-serif fonts
- Recommended sizes:
 - Title: 72 pt+ (ideal 158 pt)
 - Headings: 42 pt+ (ideal 56 pt)
 - Body: 24 pt+ (ideal 36 pt)
 - Captions: 18 pt+ (ideal 24 pt)

Layout & Organization

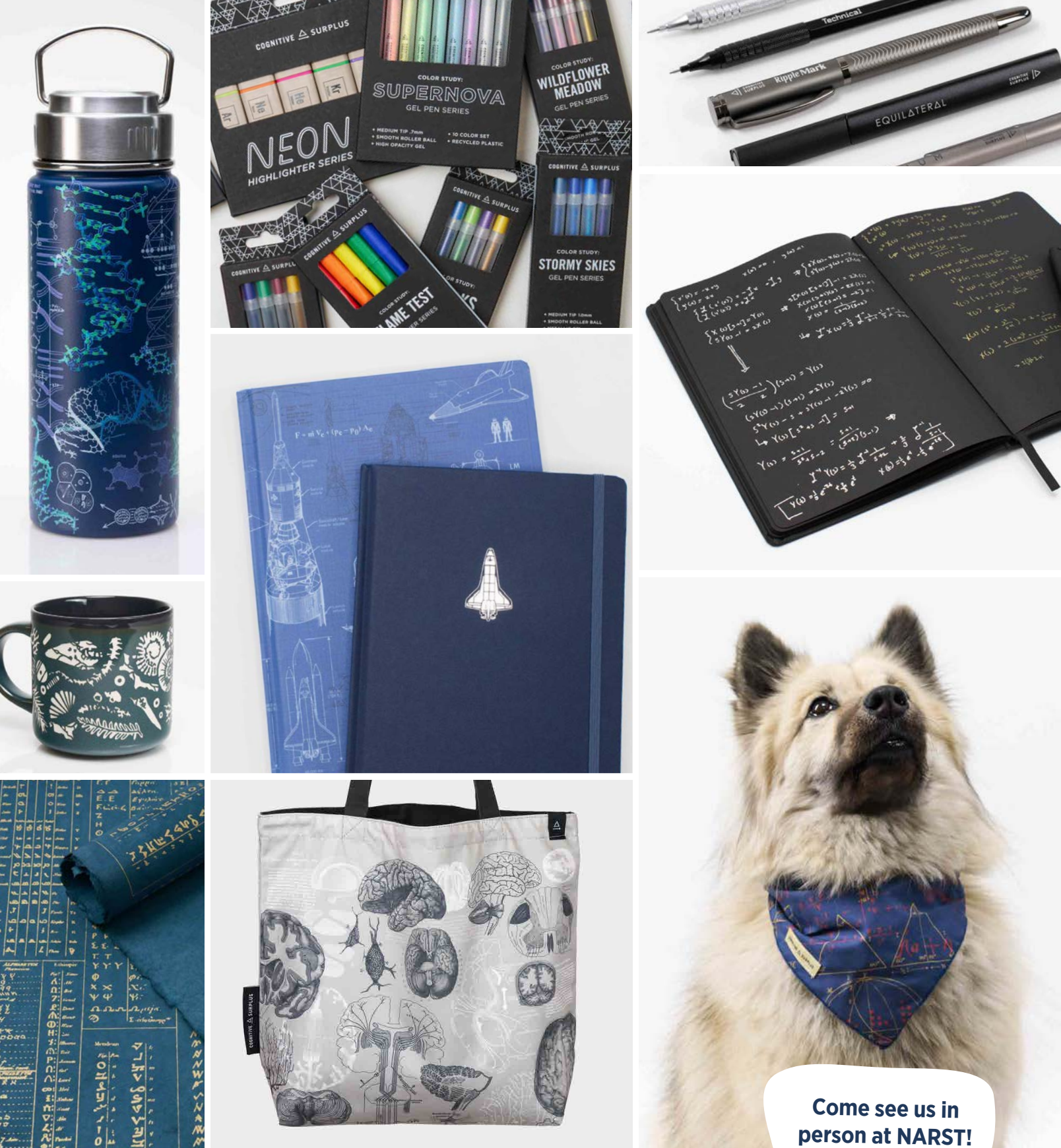
- Use spacing (negative space) to create structure
- Group related content clearly
- Guide readers using:
 - Numbering
 - Arrows
 - Clear section flow

Cultural & Navigation Considerations

- Be mindful of different reading directions
- Use visual cues to support navigation across audiences

Digital & Shared Posters

- Use built-in accessibility features (PowerPoint, Word, etc.)
- Ensure correct reading order:
 - PowerPoint: *Arrange* → *Selection Pane*
- Add alt text to all visuals
- Use “Save as Adobe PDF” (NOT “Print to PDF”) to preserve accessibility
- Use document styles for screen reader compatibility



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Come see us in person at NARST!

NARST 2027 Conference Theme

Prepared by Maria Varelas, NARST President-Elect

Braiding Pasts, Presents, and Futures: Crossing Borders in Performing Science Education Research

NARST is turning 100 years old! As our association is reaching its centennial milestone, we are all called to reflect, to act, and to imagine the future of science education and science education research. This invites us to rekindle commitments to diversity of people, scholarship, communities, approaches, and journeys that constitute our collective pursuit of strengthening science literacy. It is a time to celebrate our varied histories, trajectories, identities, languages, geographies, and ways of being and engaging in the world, learn from the past, and envision spaces and places where science education transforms lives.

The Akan people's *sankofa*, the Greeks' *anamnisi*, the Māori people's *ka mua, ka muri*, the Jewish people's *l'dor v'dor*, the Arab culture's *irji' lita'khudh al-hikma*, Latin America's *rescate de la memoria movements*, and ample other cultural wisdom inspire us to reach back to construct what we may have forgotten, silenced, lost, missed, and achieved. These ways of remembering illuminate our present praxis and craft the promise of imagined new futures. Considering science education as practices that can empower life and liberty for all peoples compels us to embrace expansive views of how knowledge is produced, valued, and used. It challenges us to disrupt hierarchies that constrain access and transformation and to uphold the axiom that high-quality science education is a human right. The Greek song O Thromos / The Street—"The street had its own history; Someone wrote it with paint on

the wall; It was only one word, 'freedom'; And then they said children wrote it"—invigorates for me this calling. It inspires interrogating our pasts, learning from children, youth, adults, and elders with whom we live, work, teach, and study, and pondering how science education scholarship contributes to vibrant communities, to freedom in all its forms, and to hope for humanity.

At the NARST centennial conference, let us ponder about knowledges and identities, share wide-ranging scholarship, elevate varied voices, grapple with challenges and opportunities, and leverage the arts as a way of knowing and being. Let us engage with realities while problem posing and problem solving, support one another through mentorship, learn from each other, and consider critical love in our research and in our interactions to re-collect and re-cognize. Science education and the research pursued by NARST members have shaped, and been shaped by, who we have been, who we are becoming, and who we will be as an association entering its second century. It is my hope that the 2027 centennial conference creates places and spaces for our growing, diverse, global community to perform collaboration, mutual learning, the wisdom of many, and border crossing in topics, framings, methods, and presentation formats. In doing so, we can amplify goals and aspirations of science education scholarship and practice that strive toward transformation.

“Science education and the research pursued by NARST members have shaped, and been shaped by, who we have been, who we are becoming, and who we will be as an association entering its second century.”

- Maria Varelas, NARST President



NARST

A global organization for improving
science education through research

100th NARST Annual International Conference

Boston, MA | March 14-17, 2027



*Braiding Pasts, Presents, and Futures:
Crossing Borders in Performing Science Education Research*



Virtual Conference Day

9 April 2026

Strand 11 Stand-alone Paper Set 1

Strand 1: Science Learning: Development of student understanding

9-Apr-26, 8:30-10:00

Location: Zoom 1

Stand-Alone Paper

Uncovering the effect of drawing and self-explanation strategies on learning outcomes in science education

shuwen yu*, beijing normal university, China

manman Tian, Zhuhai Wanzai Primary school, China

sihui zhu, beijing normal university, China

ABSTRACT

In this study, we explored the effects of generative learning strategies on elementary students' science learning outcomes, focusing on drawing (DR) and self-explanation (SE). A quasi-experiment with 92 third-grade students (10-11 years old) randomly assigned to DR or SE groups was conducted. Quantitative analyses revealed no significant pre-test difference ($p > 0.05$) or immediate post-test difference ($p > 0.05$). However, the DR group outperformed the SE group on the delayed test ($p < 0.001$) with a lower “faded effect” of knowledge retention. These findings address a gap in elementary non-multimedia observational contexts, expand generative learning theory by validating drawing's long-term benefits via visual encoding, and hold broad relevance for educators. They provide empirical grounding for optimising science instruction, offering pragmatic recommendations for drawing-based teaching in diverse educational settings.

Stand-Alone Paper

Mapping Systems Thinking Pedagogies in Social Science Education: Implications for Science Teaching and Learning

Roe Peretz*, The Technion, Israel

ABSTRACT

This paper synthesizes findings from a scoping review of systems thinking pedagogies in social science education (2015–2025) with an emphasis on sustainability. Using Arksey and O'Malley's framework and PRISMA-ScR reporting, nineteen studies met the inclusion criteria after database searches and screening. Across contexts—K–12, undergraduate, graduate, and professional/community learning—interventions typically blended visual mapping and feedback-loop activities with dialogic or project-based learning; conceptual works developed

frameworks that have yet to be widely validated empirically. Common analytical tools included causal loop diagrams, concept maps, soft-systems methods, and, in advanced settings, system dynamics or network analysis. Sustainability was integrated through SDG-aligned tasks, socio-ecological casework, and participatory co-learning designs. The review highlights three field-level challenges: (a) heterogeneous measures that limit cross-study synthesis, (b) underassessment of advanced competencies (e.g., leverage points, emergence), and (c) small, context-bound samples. Implications for science education include scaffolded curricula from mapping to modeling, use of validated rubrics, and policy-aligned authentic projects. The paper closes by assessing the likely impact on professional members and offering practical steps to strengthen instructional design and research quality.

Stand-Alone Paper

Challenging Marginalization: Intersectional Counter-narratives of Undergraduate Minoritized Women in Engineering

Nicola Law*, Teachers College, Columbia University, USA

Felicia Mensah, Teachers College, Columbia University, USA

ABSTRACT

Persistent underrepresentation in engineering constrains diversity of perspectives, limiting innovation and equitable problem-solving. Women, particularly those with intersecting marginalized identities, face compounded barriers including stereotypes, gatekeeping practices, and exclusionary institutional norms. This qualitative multiple-case study draws on intersectional feminist theory and counter-narrative methodology to examine how four minoritized undergraduate women in northeastern U.S. engineering programs describe and resist these systemic challenges. Data sources included reflective worksheets and semi-structured interviews, analyzed thematically to identify recurring patterns in participants' redefinitions of engineering identity, strategies for navigating institutional barriers, and the influence of intersecting social identities on their experiences. Findings highlight three themes: (1) collective reimagining of engineering to center ethics, collaboration, and social responsibility; (2) strategic acts to contest stereotypes and prove mastery; and (3) intersectional narratives illustrating the compounding effects of race, gender, culture, and socioeconomic status. These counter-narratives disrupt dominant discourses of meritocracy and technical legitimacy, offering actionable insights for fostering inclusive engineering education. Implications include embedding reflective narrative practices into curricula, increasing representation, and revising institutional policies to address intersectional barriers. This study contributes to equity-oriented pedagogy by centering lived experiences as a foundation for transformative change in engineering education.

Stand-Alone Paper

Relationships to STEM Knowledge in an Elite School

Majd Zouda*, University of Toronto, Canada

ABSTRACT

Despite plethora of research about STEM education, a still underexplored area of such research is elite schools. Elite schools are well-known for their roles in socializing their students into elite groups and preparing them to assume leadership roles/positions, thereby contributing to social stratification. When acknowledging increased influences of STEM discourses on educational practices, and possible roles of STEM education in contributing to social (in-)equity, examining how STEM education is conceptualized and practiced in elite schools can provide better understanding of, and new insights on, privilege making and social (in-)equity. Using Critical Discourse Analysis, this research examines meanings of excellence and distinction in STEM (education) in an elite, independent, co-educational high school in Canada. It examines these meanings via the lenses of the school educators, and in how the school presents itself to the public. Findings revealed an overarching discourse of leadership that largely shaped valued STEM learning experiences. Findings also revealed particular meanings of excellence in STEM (education) that involve, among others, emphases on solid STEM foundations. These meanings can support elite students to construct harmonized 'relationships to STEM knowledge' that would allow them to develop a sense of entitlement to privilege and to envision leadership roles.

Stand-Alone Paper

Fostering Young Women's Physics Identity: Longitudinal Analysis of an Inquiry-Based Intervention Program on Climate Physics

Paula Becker*, Heidelberg University of Education, Germany

Peter Wulff, Ludwigsburg University of Education, Germany

ABSTRACT

Physics literacy is essential for informed participation in 21st-century societies, yet young women remain underrepresented in advanced physics courses and degree programs. Drawing on physics identity theory and findings by Cribbs et al. (2021) on the link between identity, self-efficacy, and STEM career intentions, this study examines a five-day extracurricular program designed to strengthen self-efficacy, physics identity, and the intention to study physics among young women in their final years of secondary school. The program combined inquiry-based learning on climate change with gender-inclusive strategies, including role models and same-gender settings.

Across three iterations (N = 40; M_{age} = 17.4), participants completed validated questionnaires at pre-test, post-test, and three-week follow-up, with a control group (N = 84) for comparison. Linear mixed models showed significant self-efficacy gains in the intervention group and small but significant increases in intention to study physics. Physics identity was the strongest predictor of intention, consistent with Cribbs et al., while self-efficacy showed a positive trend.

Results indicate that short-term, theoretically grounded programs can promote young women's engagement with physics and foster aspirations for further study.

Multi-Strand (1/2/3) Stand-alone Paper Set

Strand 1: Science Learning: Development of student understanding

9-Apr-26, 8:30-10:00

Location: Zoom 2

Stand-Alone Paper

The impacts of media-multitasking on the use of reading strategies and effects in science reading

Yajing Gu*, BNU, China

Lei Huang, CCNU, China

ABSTRACT

Science reading is an important way to improve citizens' scientific literacy, but compared with paper reading, screen reading is easily disturbed by other media activities, affecting the effectiveness of scientific communication. This study investigated the differentiated impacts of media multitasking (MMT) on adolescents' science reading strategy use and comprehension. A 2×3 experimental design involved 48 junior high students, categorized by reading ability (high/low) and interference (none, video, or dialogue). A Python-based program simulated a multi-task screen reading environment, collecting behavioral data, self-reported strategies, and comprehension outcomes. Results indicated a marginal main effect of interference on reading duration and highlighting, with dialogue interference prompting greater compensatory effort. Video interference significantly impaired recall and recognition. Crucially, a marginal interaction between interference and reading ability emerged for higher-order comprehension: high-ability students showed resilience, with reflection and evaluation scores even improving under video interference, suggesting strategic mind-wandering. Low-ability students were more vulnerable, particularly for essay questions, though dialogue interference unexpectedly facilitated their short-answer comprehension. No significant mediating role was found for the measured reading strategies. This research reveals MMT's varied effects based on individual ability, offering insights for optimizing digital reading environments.

Stand-Alone Paper

Tipping the Balance: Sources of Confusion in Understanding Dynamic Equilibrium

Tamara Dawud*, University of Haifa, Israel

Sebahat Gok, Northwestern University, USA

Sharona T. Levy, University of Haifa, Israel

Uri Wilensky, Northwestern University, USA

ABSTRACT

This narrative literature review examines whether students' difficulties in understanding dynamic equilibrium (DE) are shared across biology, chemistry, and physics. Although DE has

been studied separately in each domain, it is a systemic phenomenon involving static macro-level behavior emerging from dynamic micro-level interactions. Defined by the balance of opposing influences within systems, DE is foundational but represented differently across disciplines and is not taught as a unifying concept. These representational differences contribute to persistent misconceptions and hinder knowledge transfer between domains. We analyzed 54 empirical studies, identified through major academic databases such as ERIC and Scopus. The analysis focused on students' misconceptions, alternative concepts, and mental models across six phenomena: homeostasis and ecological balance (biology), chemical equilibrium and diffusion (chemistry), and constant electric current and uniform motion (physics). Data were coded deductively and inductively. The findings revealed three interrelated categories of difficulties: understanding complex systems (e.g., compartmentalized views, macro–micro confusion, feedback misconceptions, and equating equilibrium with stasis), mathematical reasoning (e.g., confusing base quantities with rates and rigid procedural use), and content-specific challenges tied to particular representations or disciplines. We propose developing cross-disciplinary DE representations that highlight system levels, emergence, feedback, and rate-based reasoning to foster robust, transferable understanding.

Stand-Alone Paper

Development and Application of Electric Circuit Models in Electric Vehicle Design

Cynthia Lima*, The University of Texas at San Antonio, USA

Jorge Solis, The University of Texas at San Antonio, USA

Nikolaos Gatsis, The University of Texas at San Antonio, USA

ABSTRACT

This study aims to examine how a group of fifth-grade multilingual students develop and apply electric circuit models to design an electric vehicle. By leveraging the opportunities presented by the Next Generation Science Standards (NGSS), and addressing the challenges associated with the meaningful integration of science and engineering, this research employs a design-based science learning environment that prioritizes modeling. The curriculum is designed to encourage students to construct and apply electric circuit models and articulate their thought processes using diverse semiotic modalities. The electric vehicle unit was implemented with a group of 21 fifth-grade learners, the majority of whom were emergent bilinguals. Employing a case study methodology and qualitative data analysis, the study identified the types of electric circuit models created and utilized by the students in their electric vehicle designs. The findings revealed that students developed four different types of electric circuit models, which were subsequently applied in the context of electric vehicle design. Insights from this study will contribute to the existing literature on integrated STEM education and enhance our understanding of how asset-oriented instructional strategies can bolster scientific and engineering knowledge among emergent bilingual populations.

Stand-Alone Paper

“Be Humane”: Care Shaping Epistemic Negotiations in Scientific Experimental Design

Wenya Yang*, Ruixiang Experimental School, China

Wanjun Ding, Ruixiang Experimental School, China

Kangni Chen, Ruixiang Experimental School, China

Hua Hu, East China Normal University, China

ABSTRACT

Care constitutes a critical moral and ethical dimension in the creation of scientific knowledge, yet its role in shaping epistemic processes remains under-explored. Grounded in care epistemology, this study adopts the care practice model and the AIR epistemic cognition model to examine how care shapes epistemic negotiations within classroom communities regarding plant experimental design. The findings reveal that a student's need to care for plants shapes his personal epistemic ideal, which is recognized by the community. After the teacher adjusted the epistemic aims, the community's caring actions, under the guidance of the teacher, drove the emergence of diverse reliable processes. The study findings emphasize that care, while facilitating the community's epistemic negotiations, also breaks down the oppositional relationship between humans and the post-human world in science learning.

Stand-Alone Paper

Unpacking Modeling-Based Learning in Kindergarten: A Micro-Level Discourse Analysis

Loucas Louca*, European University Cyprus, Cyprus

ABSTRACT

This case study explores how Modeling-based Learning (MbL) unfolds in a kindergarten science classroom through a micro-level analysis of the 24 children's discourse (aged 5-6) during a 35-minute whole-class discussion on water diffusion. Discourse data were examined using four analytic frameworks to capture mechanistic and analogical reasoning, MbL phases, and the teacher's discursive responses. Findings indicate that kindergarteners can engage in complex mechanistic reasoning when supported through structured modeling cycles and teacher facilitation. Analogical reasoning appeared less frequently and was not directly supported. The study highlights the importance of scalar-level reasoning and the role of teacher scaffolding, including the use of dramatic play. These findings contribute to kindergarten science education research and underscore the potential of MbL in supporting their reasoning.

Strand 12 Stand-alone Paper Set

Strand 12: Technology for Teaching, Learning, and Research

9-Apr-26, 8:30-10:00

Location: Zoom 3

Stand-Alone Paper

Differences in Teachers' Artificial Intelligence Behavioral Intentions: A Comparative Study of Vietnam and Taiwan

Xuan-Cuong Trinh*, National Dong Hwa University, Taiwan

Shih-Wen Chen, National Dong Hwa University, Taiwan

Xuyen Nguyen Thi My, National Dong Hwa University, Taiwan

ABSTRACT

Despite rapid implementation of policies to integrate Artificial Intelligence (AI) into education, clear evidence on teachers' motivations for AI adoption in cross-national contexts remains scarce. Using the Unified Theory of Acceptance and Use of Technology (UTAUT), this study assesses determinants of teachers' behavioral intentions (BI) to adopt AI in education. Survey data were collected from secondary school teachers in Vietnam (n = 358) and Taiwan (n = 345) and analyzed through multi-group structural equation modeling (SEM) with measurement invariance testing to ensure valid comparisons. The results show that facilitating conditions significantly affect intention in both countries, with a stronger effect in Taiwan, underscoring the importance of access to resources and governmental support. For Taiwanese teachers, effort expectancy plays a role as the most powerful factor, whereas performance expectancy and social influence play a larger role among Vietnamese teachers. These cross-country patterns are consistent with differences in educational systems and AI policy advancement and point to the need for teacher support programs and localized strategies for each country.

Stand-Alone Paper

An Open versus Commercial Digital Biology Textbook: Student Performance, Access, Use and Textbook Purchasing Trends

Christine Schlendorf*, Farmingdale State College, USA

Janaiyah Hipps, Farmingdale State College, USA

Denise Lopez, Farmingdale State College, USA

ABSTRACT

This study used a mixed-methods approach to explore student performance data (N=164) and survey data (N=140) to examine differences in student performance, textbook use, and access when using a commercial digital textbook compared to an open access digital textbook in an introductory biology college course. A total of 164 students were used in the study, approximately half using the open access digital textbook, while the other half used the commercial digital textbook. Course performance was measured by comparing the average of four exams. To measure differences in textbook usage, access and purchasing trends, a survey was administered at the end of the semester. Results revealed that there was

no significant difference in course performance when using the commercial digital textbook versus an open access digital textbook. However, survey data revealed that the open access digital textbook had a better overall rating with a medium to large effect size. Regarding accessibility to the various digital textbooks, there was no significant difference in textbook use whether students were using the commercial digital textbook or open access digital textbook. Finally, results from this study found that course textbook costs can adversely affect student success in a college science course.

Stand-Alone Paper

Enhancing High School Students' Self-Regulation with an AI-supported Engineering Design Process

Esen Uzuntiryaki Kondakci, Middle East Technical University, Turkey

Irem Incecay, Middle East Technical University, Turkey

Elif Yilmazoglu, Middle East Technical University, Turkey

Selcuk Kilinc*, Texas A&M University, USA

ABSTRACT

This study examined the role of the integration of customized artificial intelligence (CustomGPT) within an engineering design-based STEM learning environment in the development of students' self-regulation (SR) processes. Using Zimmerman's cyclical model of SR as a theoretical framework, the study focused on four key processes: goal setting, strategic planning, monitoring, and self-reflection. A qualitative design was employed with six high school students enrolled in an innovation club as an extracurricular activity. The participants engaged in a STEM activity that involved designing a permaculture area as a solution to drought, while receiving metacognitive support from CustomGPT, developed by one of the researchers of the study. Data were collected through semi-structured interviews, think-aloud protocols, and reflective journals. Directed content analysis indicated improvements in students' SR processes. They set more structured goals, made more systematic plans, monitored their performance more effectively, and assessed their work based on predefined goals. The findings highlight the potential of customized AI tools to serve as metacognitive scaffolds that enhance SR in STEM education. This study contributes to the growing body of research on AI-supported learning and offers implications for integrating AI to support SR in engineering design-based STEM contexts.

Stand-Alone Paper

When AI is Involved: An Exploratory Study of Pre-service Teachers Planning Science Lessons with ChatGPT

Xinyu He, University of Georgia, USA

Emily Adah Miller, University of Georgia, USA

Tingting Li, Washington State University, USA

ABSTRACT

This study examines how ChatGPT, as a representative form of AI, influences pre-service science teachers' (PSTs) collaborative lesson planning in a science methods course. Grounded in sociocultural perspectives on learning and Strasser's (2022) human-machine interaction framework, the analysis applies two lenses: tool use and social interaction. Eighteen PSTs in six groups planned a week-long socio-scientific issue unit on hurricanes; three groups were selected for in-depth analysis, including two that used ChatGPT and one that did not. Findings present the dynamic comparison between groups using ChatGPT and the group that didn't. These insights suggest that in AI-era learning, emphasis may shift from final products toward the processes through which learners interact with each other and focus on their own expectations. The study contributes a dual-lens framework for analyzing AI-mediated learning and informs discussions on AI's role in science education.

Multi-Strand (14/12) Stand-alone Paper Set

Strand 12: Technology for Teaching, Learning, and Research

9-Apr-26, 8:30-10:00

Location: Zoom 4

Stand-Alone Paper

Core Competencies of Teachers in the Age of AI: Teacher as Designer in Science Education

Taesoo An*, Seoul National University, Korea, Republic of

Sonya Martin*, Seoul National University, Korea, Republic of

ABSTRACT

This conceptual paper proposes a framework for two core teacher competencies, digital integration and automation design, that are essential for meaningful and ethical AI integration in inquiry-based science classrooms. Drawing on scholarly literature, global policy documents (e.g., UNESCO, OECD), and illustrative classroom cases from the United States, South Korea, and Turkey, the paper explores how teachers can move beyond passive tool use to become designers of AI-supported instruction. The conceptual framework integrates TPACK, AI literacy, and design-based pedagogy to examine how teachers maintain pedagogical agency while leveraging AI tools. Thematic synthesis of literature and cases reveals how these competencies support formative assessment, workflow automation, and responsive feedback while addressing algorithmic bias and contextual equity. This work emphasizes that AI integration may risk instructional standardization and inequity unless accompanied by strong teacher design capacities. The paper contributes a theoretical foundation for teacher education, professional learning, and policy, aiming to empower science teachers to critically and creatively shape AI use in ways that promote inquiry, diversity, and pedagogical integrity.

Stand-Alone Paper

Should We Use Artificial Intelligence for Science Learning Assessment?

Eunbyul Cho*, Seoul National University, Korea, Republic of

Sonya Martin*, Seoul National University, Korea, Republic of

ABSTRACT

This conceptual paper interrogates whether and how AI should be used for science learning assessment, advancing an ethically grounded hybrid model in which AI augments, not replaces, human judgment. Synthesizing AI ethics, educational assessment theory, and cases from science education, the paper analyzes four assessment dimensions—purpose, content, principles, and assessor qualifications. The analysis finds that AI can exhibit competence and reliability for some cognitive targets, yet poses ethical risks, including limited accountability for consequential decisions, privacy violations in affective/behavioral measures, cultural–linguistic bias, fairness threats, and weak relationality with learners. Across six science assessment cases (e.g., automated scoring of argumentation, simulation-log feedback, multimodal writing classification), explainability and validity gaps persist, especially for non-standard responses and diverse expression. The paper argues for explicit philosophical foundations and institutional safeguards (explicability, contestability, privacy protections, bias auditing, teacher agency) to guide adoption. It contributes a framework that helps science educators decide what AI should assess, how, and under which human-in-the-loop conditions to protect inquiry, equity, and the teacher-student relationship. This framework not only clarifies the ethical boundaries of AI in science assessment but also offers actionable design principles that can inform teacher preparation, policy development, and future research on equitable assessment practices.

Stand-Alone Paper

Youth Disorientation in Times of Climate Crises: A Three-Lenses Framework for Agency

Giulia Tasquier*, University of Bologna, Italy

Francesca Pongiglione, University Vita-Salute San Raffaele, Italy

Elena Ricci, University of Verona, Italy

ABSTRACT

This conceptual paper examines how science education can respond to the growing sense of disorientation experienced by young people in the face of the climate crisis. While concern and awareness are high, students often report frustration and uncertainty about how to meaningfully engage with such a complex, systemic, and politicised problem. Educational responses frequently reduce climate change to scientific knowledge or behavioural prescriptions, overlooking the complex tensions students navigate. We argue that disorientation should not be treated as a deficit, but as a signal of epistemic and moral engagement—an invitation to develop more sophisticated forms of reasoning. To support this, we propose a conceptual framework grounded in interdisciplinary dialogue. The framework articulates three analytical lenses—epistemic, ethical, and systemic—which

together provide a structure for designing a space for climate agency. Rather than prescribing solutions, this framework wants to support the development of sustainable forms of reasoning, which consist of developing the capacity to navigate tensions, interrogate systems, and nurture a sense of hope toward alternative futures. In doing so, it positions science education as a space of orientation—where students can begin to make sense of their role and find a position in a world shaped by crisis.

Stand-Alone Paper

Clicking Toward Climate Justice: Reimagining Digital Platforms for Collective Action

Andrea Weinberg*, Arizona State University, USA

Michelle Jordan*, Arizona State University, USA

Victoria Desimoni, Arizona State University, USA

Iveta Silova, Arizona State University, USA

Rajul Pandya, Arizona State University, USA

ABSTRACT

Aligned with the NARST 2026 theme of Joyful Transgressions and Radical Imagination in Science Education, this study centers educator and youth voices in reimagining how digital platforms could become spaces of possibility for transformative climate learning. We explore how these platforms are currently used, and also how they might advance efforts to radically reimagine education to foster joy, connection, agency, and collective action in the face of ecological and social crises. Using survey data from youth and educators, we examine patterns of use, perceived effectiveness, and alignment with cognitive, socioemotional, and behavioral learning goals. Findings reveal a mismatch between what learners value and what platforms deliver, with youth in particular calling for localized, interactive, emotionally resonant, and justice-oriented content. To this end, this work engages the question: How might we design digital spaces for climate education that resist deficit framings, cultivate hope, and invite learners to imagine and enact more equitable, sustainable futures?

Stand-Alone Paper

Through different eyes: Intuitive and cultural worldviews as predictors of learning in a climate exhibit

Indiana Plant*, University of Utah, USA

Catie Nielson, University of Nevada, Las Vegas, USA

Jordan Giron, University of Utah, USA

Lynne Zummo, University of Utah, USA

ABSTRACT

Museums are uniquely positioned to connect climate science with diverse public worldviews, yet little is known about how such worldview constructs shape engagement with exhibit messaging. This study examines how Climate Concern (CC), Human Exceptionalism (HE), and Theistic Stewardship (TS) influence visitor uptake of four strategic frames — Hope, Local, Community, Gain — in Hopeful Climate, a U.S. climate exhibit. Eighty-two adult visitors (Nov

2024 - Jul 2025) completed surveys and a spoken interview question regarding a visitor's perceived exhibit messaging. Latent trait scores for HE and TS were estimated from Likert scales via Bayesian item response theory, and CC via the Six Americas Super Short Survey. Responses were coded for frame uptake and analyzed using logistic regression. HE significantly and negatively predicted spoken frame uptake, even when controlling for CC, suggesting that beliefs in human-nature separation reduce receptivity to exhibit messaging. CC showed a marginal positive association with typed uptake, while TS had no significant effect. Findings indicate that countering HE through narratives of human-ecosystem interdependence and leveraging CC with solution-oriented frames may improve climate learning across ideological lines. This work offers actionable insights for designing inclusive, worldview-responsive climate communication in informal learning spaces.

Multi-Strand Poster Session (breakout rooms)

9-Apr-26, 10:30-12:00

Location: Zoom 1

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

Making Space for Science: How a STEM Makerspace Shapes Elementary Students' Science Attitudes.

Anthony Timpano*, Curtin University, Australia

Rachel Sheffield, Curtin University, Australia

Rekha Koul, Curtin University, Australia

ABSTRACT

This presentation focuses on qualitative findings from a doctoral study exploring elementary students' experiences in a STEM Makerspace. Upper-elementary students participated through questionnaires, classroom observations and semi-structured focus group interviews. Directed by Social Constructivism, Constructionism and Social Cognitive Theory, the research explored how students made sense of their experiences in a STEM Makerspace and how those experiences influenced their engagement with learning science. Preliminary thematic analysis revealed five intersecting dimensions that shaped students' motivation and engagement in the Makerspace: Hands-on Making, Peer Collaboration, Autonomy and Ownership, Physical Environment and resources, and Teacher support. Students described the Makerspace as a setting where science learning was enjoyable, exploratory, and socially meaningful. Many expressed increased confidence in their abilities to experiment, solve problems, and share ideas. The findings underscore how thoughtfully designed STEM learning environments cultivate scientific interest, positive attitudes toward science, and a sense of belonging. Implications are offered for science educators aiming to foster engaging and motivational science experiences for elementary students.

Strand 2: Science Learning: Contexts, Characteristics and Interactions

Poster

Characterizing the Ecological Factors Influencing First-Year STEM College Students' Engagement

Uche Osuji*, Georgia State University, USA

Suazette Mooring, Georgia State University, USA

Ciara Glover, Georgia State University, USA

ABSTRACT

This qualitative study investigated the ecological factors influencing first-year college students' engagement in STEM. The study comprised 16 participants from two minority-serving institutions, one with primarily Black students and the other a Hispanic-serving institution. The Bronfenbrenner Person-Process-Context-Time framework was used to characterize interactions between students and their environments. Inductive and deductive qualitative analyses were done by coding themes from the data using a grounded theory approach. The data analyses revealed interactions with family, peers, college courses, campus organizations, and extracurricular activities as proximal factors that either help or hinder first-year STEM college students' engagement. Students identified these factors as significantly, moderately, or minimally impacting their STEM experience. This study provides insights into specific interactions and contexts that may shape outcomes such as academic achievement and social integration. This work will provide educational policymakers with direction for programs targeting first-year STEM majors.

Strand 2: Science Learning: Contexts, Characteristics and Interactions

Poster

Scoping Citizen Science for formal science education connection-making

Erin Sperling, Wilfrid Laurier University, Canada

G. Michael Bowen*, Mount Saint Vincent University, Canada

ABSTRACT

Citizen Science is a term that is growing in the public consciousness, with variations in meaning, but is generally conceived as projects involving members of the general public, mainly non-experts in science, interacting with some aspects of real-world science (Eitzel et al, 2017). These interactions may be through data collection and/or analysis, with and/or for practicing scientists (Land-Zandstra et al., 2021). This study is part of a broader Citizen Science research project with several motivations: how science as a practice is conducted (Osborne et al., 2022); how science facts are hardened; by issues related to the public's impoverished understanding of science knowledge – much previously identified before the pandemic (see Funk et al., 2019); and how Citizen Science may offer entry points to climate change education (Neves, Boaventura & Galvao, 2024). Building on the conference theme of joyful transgressions and radical imagination in science education, we feel this project is attending to many aspects of the potential of science education to transcend boundaries for more holistic learning and action experiences for learners. In addition to these concerns, we

wonder about the affordances of various role(s) in citizen science toward socioecological wellbeing in a time of global climate crisis.

Strand 7: Pre-service Science Teacher Education

Poster

Design-Based Research for Fostering Criticality Through a One Health Perspective: A Microbiota-Focused Learning Sequence

Irene González-Costa*, Universidade De Santiago de Compostela, Spain

Blanca Puig, Universidade De Santiago de Compostela, Spain

Paloma Blanco-Anaya, Universidade De Santiago de Compostela, Spain

ABSTRACT

This study applies a Design-Based Research (DBR) methodology to train pre-service secondary science teachers in the design and implementation of a learning sequence (LS) aimed at fostering criticality—the integration of critical reasoning, reflection, and action—within a socio-scientific context. The chosen context was the human microbiota, approached through the interdisciplinary lens of One Health (OH), which emphasizes the interconnectedness of human, environmental, and animal health. After iterative cycles of design, classroom implementation, and reflection, the study produced a refined and context-sensitive LS titled “A single microbiota”, which promoted critical engagement and decision-making among students. This work highlights the potential of DBR to bridge research and teaching practice while contributing to the professional development of science teachers in the post-truth era.

Strand 7: Pre-service Science Teacher Education

Poster

Development of MORE-Link schema and its validation in enhancing pre-service chemistry teachers' scientific information reasoning

Like Deng*, the Faculty of Artificial Intelligence in Education, Central China Normal University, China

ABSTRACT

Against the backdrop of the Internet and Generative Artificial Intelligence (GAI), Scientific Information Reasoning (SIR) has emerged as a critical scientific practice. However, the science teacher community, as “digital immigrants” in the GAI age, faces severe challenges in SIR teaching. This study examined the applicability of the traditional Model-Evidence Link (MEL) schema in SIR, identified its limitations, and proposes the Model-Opinion/Evidence-Reliability Link (MORE-Link) schema. Furthermore, this study proposes an SIR instruction model based on MORE-Link for pre-service teacher training.

To validate the effectiveness of MORE-Link as a scaffold for SIR instruction, this study constructed an SIR literacy framework and measurement instruments. Adopting a single-group quasi-experimental design, 20 pre-service chemistry teachers participated in a 3-hour

SIR workshop and completed pre-test and post-test assessments. Results indicated their inadequacies in SIR and significant post-intervention improvements across all components ($p < 0.001$), with large effect sizes (0.87–1.01).

Findings from this study demonstrate that: (1) Compared with MEL, MORE-Link can effectively assist “outsiders” in avoiding cognitive misunderstandings within SIR; (2) The current state of pre-service chemistry teachers' SIR literacy is far from satisfactory, with typical misconceptions detected, making targeted training highly necessary; (3) MORE-Link facilitates learners' conceptual transformation and holds promising prospects for SIR teaching.

Strand 8: In-service Science Teacher Education

Poster

Examining the impact of teachers' beliefs about student ability to their changes in practice

Andrea Phillips*, Utah Valley University, USA

Meredith Park Rogers, Indiana University, USA

ABSTRACT

The purpose of this study was to examine the influence of teachers' beliefs about their students' ability on their transfer of student-centered practices. The teachers in this study participated in a professional development program focused on the use of modelling through scientific representations. This paper investigates two Kindergarten teachers who participated in the program and who also co-planned as they were teaching partners at the same school. Findings show how one teacher focused on her own teaching goals rather than what her students lacked. This led to successfully engaging the students in the creation of scientific representations. The other teacher was limited by her beliefs about her students' abilities, resulting in more teacher-centered practice. She explained her reason for this approach was to avoid students' having negative emotions if they were to experience failure. Implications include the need for reshaping teachers' beliefs about students' abilities as a prerequisite for successful transfer of learning from professional development into classroom practice.

Strand 8: In-service Science Teacher Education

Poster

When students' literacy proficiency frames the negotiation of care ethics in planning for science education

Rafael Lopes*, USP, Brazil

Daniela Scarpa, USP, Brazil

Danusa Munfurd, UFABC, Brazil

ABSTRACT

This study examines how teachers in Brazil's Adult and Youth Education (AYE) negotiate an ethic of care when engaged in discussions about literacy challenges of historically marginalized students in in-service teacher education meetings.. Drawing on DisCrit and Noddings' framework of care in education, we analyze how professional development spaces within schools can foster or constrain inclusive pedagogical practices. Using a microethnographic approach, we conducted eight months of participant observation in an urban public school recognized for innovative inclusion strategies, recently challenged by policy changes. Data come from a transcribed teacher meeting discussing a diagnostic literacy assessment. Discourse analysis reveals socially constructed movements between aesthetic care - planning based on assumed needs and institutional priorities - and authentic care, where teachers adapt practices to students' characteristics, foster peer support, and extend competence beyond their original subject areas. One case illustrates how collaborative structures once enabled such expansion, but current conditions hinder it. Findings show how science teaching intersects with literacy and how in-school teacher education can advance caring practices.

Strand 10: Curriculum and Assessment

Poster

Do instructors' learning assessment practices align with the course's expected learning outcomes?

Hong Tran*, Virginia Tech, USA

Edward Berger, Virginia Tech, USA

Anyerson Cuervo-Basurto, Virginia Tech, USA

ABSTRACT

The primary purpose of the current study was to examine how instructors perceive and describe their learning assessment practices for a foundational undergraduate course in the context of adapting a learning system to more fully understand the phenomenon and the support needed. The research method utilized was transcendental phenomenography with data collected from 21 engineering instructors. The most important findings were that the instructors were aware of the importance of aligning assessment with expected learning outcomes of the course, but their final decisions on designing assessments prioritized students getting reasonable grades. Further, even though all instructors used assessment results to inform teaching and learning, the effectiveness of the practice might be limited because the instructors did not completely enact assessment with respect to the expected learning outcomes, and the used assessment methods were not able to assess a wide range of attributes. Since appropriate assessment practices improve both instructor teaching and student learning, implications from this study are applicable for not only researchers who examine the implementation of learning assessment but also educators who aim to improve the quality of assessment practice.

Strand 12: Technology for Teaching, Learning, and Research

Poster

Transitioning Cognitive Acceleration through Science Education to Digital: Exploring Alternatives to Experimental Tools

Mourad El Karkri*, University of Jaén, Spain

Marta Romero-Ariza, University of Jaén, Spain

Antonio Quesada, University of Jaén, Spain

Israel Díaz-Santibañez, University of Jaén, Spain

ABSTRACT

This paper proposes a transition from the conventional laboratory-based implementation of the Cognitive Acceleration through Science Education (CASE) programme to a digital alternative. Traditionally, CASE has been designed to enhance students' scientific reasoning through direct interaction with real experimental materials in laboratory settings. Numerous empirical studies involving early secondary students (typically aged 13–14) across various countries have demonstrated the programme's effectiveness in developing the ability to control variables—a core scientific inquiry skill (Adey et al., 2004; Shayer & Adey, 1981). Such evidence supports CASE's role in promoting cognitive development by actively engaging students in hands-on experimental tasks that foster higher-order thinking (Adey & Shayer, 1994). Given the increasing accessibility and sophistication of digital technologies, this study explores alternative approaches to implementing CASE via technologically enhanced experiences. Digital resources such as interactive simulations and virtual laboratories present promising opportunities to address challenges inherent in physical labs, including resource limitations, safety concerns, and scalability (de Jong, 2006; Rutten, van Joolingen, & van der Veen, 2012). These tools also offer enhanced visualization and immediate feedback, which are conducive to inquiry-based learning and metacognitive engagement (Gilbert, 2005; Venville & Oliver, 2015).

Strand 12: Technology for Teaching, Learning, and Research

Poster

Empowering Equity in STEM: A Research-Based Robotics Camp for Equity-Deserving Youth in Southwestern Ontario

David Potocek*, St. Clair College, Canada

Karamjeet Dhillon, St. Clair College, Canada

John Lopez, St. Clair College, Canada

Sonja Popovski, St. Clair College, Canada

ABSTRACT

This study investigated the outcomes of the 2024 OVIN Regional Future Workforce grant, Empowering Equity in STEM Pilot Program, a five-week robotics summer camp hosted by a Southwestern Ontario College. The camp was designed to provide equity-deserving youth from Grades 5-12 with early, hands-on exposure to science, technology, engineering, and mathematics (STEM) learning aligned with the automotive and mobility sectors as well as

Ontario based science and math curricula. Developed in partnership with organizations such as Black Boys Code, Hangout for Youth, WEST, and local school boards, the program engaged 185 underserved youth from across the area. Using LEGO SPIKE Prime robotics kits and a custom-built digital learning platform, the camp integrated coding, design thinking, and entrepreneurial skill-building into Ontario curriculum-aligned lessons. A qualitative research design guided by semi-structured interviews with camp staff and ethnographic field observations assessed the camp's effectiveness in fostering STEM interest and confidence. Results demonstrated high levels of engagement, improved facilitator teamwork and problem-solving skills, and increased awareness of STEM-related careers from participants. The study offers insights into inclusive, community-driven modes for early STEM engagement and implications for future program design and workforce development in Ontario's automobility ecosystem.

Strand 12: Technology for Teaching, Learning, and Research

Poster

Evaluating AI Technology's Potential and Limitations in Formative Assessment for Elementary Science Projects

Irit Hof-Nahor*, Oranim Academic College, Israel

ABSTRACT

This paper investigates the potential of Generative Artificial Intelligence (AI) as a tool for educators in the formative assessment of science and technology research projects within elementary education. Advancing effective teaching and learning through technology requires carefully examining AI's educational capabilities and limitations. Research project assessment is a professional and intensive process, involving a significant investment of resources and considerable time. The use of artificial intelligence

holds great potential for streamlining this process. This study provides an evidence-based analysis through case studies, involving authentic research posters. The findings reveal notable disparities between human assessment feedback and responses generated by two AI tools: Gemini and Lamda-AI, a specialized chatbot for science educators. The AI systems demonstrated significant limitations in identifying mistaken scientific assumptions, synthesizing critique from visual and textual data, detecting safety guideline violations and pinpointing unreliable sources of information. On the other hand, their strength was manifested in their ability to deliver positive, prompt, and personalized feedback, which may promote student engagement and motivation. The study concludes that while AI tools hold considerable promise for advancing technology applications in education, critical oversight and interpretation by professional science educators remain vital to ensure the integrity and quality of formative assessment.

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

Poster

Case Study of Preservice Teachers' NOS-Specific PCK in a History and Philosophy of Science Course

Connor Taylor*, Appalachian State University, USA

Nathan Rocheleau, Appalachian State University, USA

Khadija Fouad, Appalachian State University, USA

ABSTRACT

Research on preservice teachers' Nature of Science (NOS)-specific Pedagogical Content Knowledge (PCK) remains scarce, particularly in secondary contexts where NOS integration into instruction is critical yet under-explored. This mixed methods case study investigates how a 16-week NOS-focused secondary science history and philosophy course shapes preservice teachers' NOS conceptions and pedagogical reasoning.

Three data sources provide methodological triangulation: (1) the Views of Nature of Science Questionnaire–Form C (VNOS-C) to document conceptual shifts, (2) a two phase modified Content Representation (CoRe) matrix with embedded oral interviews to elicit pedagogical reasoning, and (3) NOS-integrated lesson plans - developed as a second phase of the CoRe process - to capture instructional application. Independent scoring by all three authors will further strengthen reliability.

Anticipated outcomes include progression from naïve to informed NOS views, increased specificity in instructional design, and more intentional alignment between NOS principles, activities, and assessments. This study offers rare empirical insight into NOS-specific PCK development in secondary preservice contexts, informing teacher preparation programs seeking to embed epistemologically rich science teaching.

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

Poster

Integrating Drama into Family Resemblance Approach-Based NOS Teaching: Insights from Pre-service Teachers

Demet Sahin Kalyon*, Tokat Gaziosmanpasa University, Turkey

Zoubeida R. Dagher, University of Delaware, USA

ABSTRACT

Drawing on pre-service teachers' views, this study evaluates the integration of creative drama into Nature of Science (NOS) teaching grounded in the Reconceptualized Family Resemblance Approach (FRA). A 10-week design alternated between drama sessions, each covering one of five FRA components—aims and values, scientific knowledge, scientific practices, methods and methodological rules, and the social-institutional system of science—and discussion sessions linking activities to epistemic, cognitive, and social dimensions of science. Participants were 38 pre-service elementary teachers in Türkiye. Data from five

open-ended questions were thematically analyzed. Findings show that drama increased awareness of FRA components, corrected misconceptions, and made abstract concepts more concrete, memorable, and engaging. The embedded explicit-reflective approach enhanced motivation, collaboration, and a holistic view of science. Reported professional gains included greater awareness of scientific processes and values, and personal growth in critical thinking, communication, and teamwork. Many intended to adapt FRA-based drama for primary classrooms, anticipating improved student engagement, retention, and understanding, alongside suggestions for age-appropriate content, timing, and materials. This study demonstrates the potential of combining FRA with drama to bridge theory and practice, enrich NOS instruction with socially contextualized learning, and prepare future teachers with creative, student-centered strategies to foster scientific literacy.

Strand 14: Environmental Education and Sustainability

Poster

Drama Practices in Science Education: A Review of Graduate Theses on Sustainable Development Goals

Sakine Çiftaslan*, Yıldız Technical University, Turkey

Bülent Güven, Canakkale Onsekiz Mart University, Turkey

Fatih Kana, Canakkale Onsekiz Mart University, Turkey

ABSTRACT

Addressing today's global challenges requires sustainable and inclusive solutions, particularly in education. The Sustainable Development Goals (SDGs) provide a strategic framework for tackling environmental, social, and economic issues. Science education plays a crucial role in developing individuals' problem solving skills and fostering innovative solutions. Integrating drama practices into science education has emerged as an effective instructional method, supporting students in engaging with complex real-world problems. Drama applications enhance students' understanding of scientific concepts by enabling experiential learning and deepening retention.

This study examines graduate theses in Turkey that incorporate drama practices in science education within the context of SDGs. The research employs document analysis to explore the content, duration, and thematic distribution of drama applications in these studies. Findings indicate that drama-based approaches effectively support SDGs by facilitating the exploration and resolution of everyday challenges. Moreover, the study highlights the presence of long-term interventions in graduate research, emphasizing the significance of sustained educational engagement. The integration of sustainability concepts into science education is identified as a crucial tool for fostering environmental awareness and responsible citizenship.

Strand 14: Environmental Education and Sustainability

Poster

Pre-service Teachers' Perspectives in Response to their Climate Emotions

Emily Olsen*, The Pennsylvania State University, USA

Aubrey Grzywacz, The Pennsylvania State University, USA

Julia Plummer, The Pennsylvania State University, USA

ABSTRACT

Recent research has begun to investigate how people experience climate emotions (Clayton et al., 2017, 2021; Hickman et al., 2021; Schwartz et al., 2022); however, there is little research at the intersection of eco-anxiety and climate anxiety in learning settings with youth ages 18-24 compared to other age groups (Author et al., 2024). A single case study was conducted with a focus on investigating the nuance in the intersection of climate emotions and climate change education with pre-service teachers in that age range. A theoretical framework of emotions as social (Ahmed, 2015; Dewey, 1894; Nussbaum, 2001; Shields, 2002; Solomon, 2000) and a humanizing research frame (San Pedro & Kinloch, 2017) were used. Data collection about the case consisted of field memos, interviews, and artifacts to aid in the data triangulation (Yin, 2018). Findings highlight the importance of emotions in the pre-service teacher's recognition of climate change impacts, taking action, community-oriented learning environments, relationships with the more-than-human world, and confidence in teaching climate change to future students. This study provides an example of a way to teach climate science that provides for the whole learner and is an example of humanizing research in a university setting with pre-service teachers.

Strand 2: Science Learning: Contexts, Characteristics and Interactions

WIP Roundtable

Science Interest: Elementary and Middle School Science Experiences Inside and Outside the Classroom

Katherine Dabney*, Virginia Commonwealth University, USA

Gerhard Sonnert, Harvard-Smithsonian Center for Astrophysics, USA

Susan Sunbury, Harvard-Smithsonian Center for Astrophysics, USA

Philip Sadler, Harvard-Smithsonian Center for Astrophysics, USA

ABSTRACT

This study explores the association of elementary school science experiences, elementary teacher encouragement to select a STEM career path, and middle school science grades with students' middle school science interest, using a logistic regression analysis. Additional analyses were run to examine how family interest and attitudes toward STEM are related to students' science interest at the end of middle school. The data set included more than 4,000 youth participants across wide demographic differences. The initial results show that both positive elementary school science experiences, elementary teacher encouragement to select a STEM career path, and middle school science grades are strongly associated with

students' science interest at the end of middle school. A series of subsequent logistic regression models showed that students who had a variety of individual family interests and attitudes toward STEM 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, teacher encouragement, academic achievement, and family interest and attitudes toward STEM for young children.

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

Roundtable

Sustaining Academic Motivation Among Science Education Master's Students During the Pandemic: Perceptions and Adaptations

Nurcan SARIASLAN, Ministry of National Education, Turkey

Cansel Kadioglu Akbulut*, Tokat Gaziosmanpasa University, Turkey

ABSTRACT

The COVID-19 pandemic created significant challenges for higher education, particularly for graduate students. This qualitative case study examined the academic motivation of 19 students enrolled in a science education master's program at a state university in Türkiye during the pandemic. Participants, selected through maximum variation sampling, included 14 females and 5 males who participated in semi-structured online interviews. Data were collected using a Participant Information Form and a Semi-Structured Interview Form developed by the researchers and analysed through content analysis. Four themes emerged: intrinsic motivation, extrinsic motivation, amotivation, and changes in motivation. Intrinsic motivation was primarily driven by professional development and personal growth. Extrinsic motivation stemmed from obtaining a diploma and having sufficient exam scores. Amotivation was observed in a smaller number of participants who reported applying to the master's program without a clear goal. While many participants reported increased self-efficacy during their graduate studies, decreases in motivation and interest were also noted. Some managed these declines through motivational regulation strategies. The findings suggest that intrinsic motivation was a critical factor in sustaining academic engagement during the pandemic, underscoring the importance of providing motivational support in graduate programs, particularly in times of crisis.

Strand 11: Cultural, Social, and Gender Issues

WIP Roundtable

Parenting while pursuing STEM degrees in Higher education: experiences and institutional practices

Tirza Vargas Giron*, Southern Illinois University, USA

ABSTRACT

The landscape of higher education in the United States is increasingly shaped by demographic diversity and evolving enrollment patterns, challenging the traditional

stereotype of college students as young, white, and financially dependent. Non-traditional students are a growing population, including pregnant and parenting students whose diverse experiences are often obscure under the non-traditional broad label. Pregnant and parenting students represent around 18% of undergraduate population. They face unique challenges balancing academic, professional, and caregiving responsibilities, which are exacerbated by socioeconomic constraints contributing to higher attrition rates in comparison with non-parenting students.

Parenting status, however, is an overlooked identity in STEM fields, which are characterized by rigid academic norms, gendered expectations and high workload demands that might reduce persistence and retention. Guided by Intersectionality theory (Crenshaw, 1989; Collins & Bilge, 2020) and the socioecological perspective (McLeroy 1988) this study employs narrative inquiry to explore how overlapping identities such as parenthood, gender, race, and student status shape STEM students' experiences across personal, relational, institutional, and policy contexts. As a work in progress, this research addresses gaps in understanding parenting student experiences in STEM higher education and invites dialogue on strategies, theoretical frameworks, and policy innovations to foster equitable, inclusive learning environments.

Strand 11: Cultural, Social, and Gender Issues Roundtable

Photovoicing the affective journeys of women science teachers in Bangladeshi secondary schools

Shamnaz Arifin Mim*, McGill University, Canada

ABSTRACT

This study examines the affective dimensions of women science teachers' identity formation in Bangladesh, where they constitute only 24% of the science teaching workforce. Despite their critical role, little is known about how these teachers navigate a masculinized field and how emotions influence their professional trajectories. The research draws on a conceptual framework connecting science teacher identity with emotions to investigate how affect shapes, and is shaped by, women's experiences of becoming and remaining science teachers. In 2025, data were collected from ten women science teachers teaching general science in grades 6 to 8 in Dhaka. Using a Participatory Visual Approach, participants engaged in a photovoice process, taking 7–10 photographs of their daily lives in response to guided prompts. The images and captions offered insights into both professional and personal spheres, revealing how emotions are embedded in and responsive to structural conditions, interpersonal relationships, and material realities of teaching. Findings highlight the complexity of identity construction, showing that affect is central to sustaining these women in their roles. This is among the first studies to explore South Asian women science teachers' identity through visual methods, offering nuanced understandings of the interplay between emotions and identities in science education.

Strand 11: Cultural, Social, and Gender Issues

Roundtable

Underrecognized: Examining Underrepresented Physics, Astronomy, and Engineering Students' Perceived Recognition

Christy Metzger*, University of Delaware, USA

ABSTRACT

This study explores how physics, astronomy, and engineering majors discuss sources of perceived recognition and how it is related to the formation of their physics and engineering identities. Recognition is used as a critical lens to examine how a lack of recognition from professors influences students' need to seek recognition from other sources and hinders the development of their physics or engineering identity. The data was collected utilizing a qualitative methodology of semi-structured interviews with 22 physics, astronomy, and engineering students who are underrepresented genders, races or ethnicities. Findings examined students' perceived positive, negative, or absent recognition from different sources. The sources include professors, classmates, friends, family, advisors, and teaching assistants. The results show that recognition types and sources varied by year of study and major. Implications are discussed for how negative and absent recognition impacts the development of underrepresented students' physics and engineering identities.

Strand 12: Technology for Teaching, Learning, and Research

Roundtable

Who Gives Better Feedback—Humans or AI? Integrating AI into Science Microteaching Feedback Cycles

Franklin Allaire*, University of Houston-Downtown, USA

ABSTRACT

This mixed methods study explored how elementary teacher candidates perceived the usefulness, specificity, and trustworthiness of feedback from human (peer) and AI sources as part of structured microteaching in a science methods course. Conducted at a Minority-/Hispanic-Serving Institution with a predominantly Hispanic female cohort ($n = 44$), the research addresses a gap in empirical comparisons of AI and human feedback in teacher preparation. Findings indicate that while participants valued both sources, peer feedback was generally seen as more credible and contextually relevant. AI feedback, provided by Nova Veridian (ChatGPT 4.0), was often helpful for clarifying goals and offering next steps, aligning with “feed up” and “feed forward” functions. However, it frequently lacked the personalization and contextual nuance provided by human peers. Most participants favored a hybrid approach, blending AI's efficiency with the relational depth of human mentorship to support confidence, reflection, and identity development. The study highlights the importance of integrating AI ethically while preserving the relational foundations of teacher education.

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

The Nature of Science in Physics Education: Perspectives from Malaysian Secondary Teachers

Siti Hidayana Nassiri, Universiti Teknologi Malaysia, Malaysia

Muhammad Abd Hadi Bunyamin*, Universiti Teknologi Malaysia, Malaysia

Noorzana Khamis, Universiti Teknologi Malaysia, Malaysia

ABSTRACT

Understanding the nature of science (NOS) is critical for effective physics instruction, particularly in distinguishing between scientific theory and scientific law. This study examines Malaysian secondary school physics teachers' conceptions of this NOS element using open-ended questionnaires. Six teachers participated, and their responses were analyzed thematically and categorized into informed, emergent, and naïve perspectives. Findings show that informed teachers articulated the tentative, evidence-based nature of theories in contrast to the relative stability of laws. Emergent teachers demonstrated partial understanding, while a naïve teacher oversimplified the distinction, viewing theories as unproven and laws as absolute truths. These variations suggest that teachers' conceptions of NOS can influence their instructional practices and their students' scientific reasoning. The study underscores the need for targeted professional development and explicit NOS instruction to foster a more sophisticated understanding of science among both teachers and students.

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

Mindset in Physics and AI Use Behaviors in the Digital Transformation Era

İpek Derman*, Hacettepe University, Turkey

Sevim Bezen, Hacettepe University, Turkey

ABSTRACT

This study examines the relationship between pre-service physics teachers' mindset in physics and their use of artificial intelligence (AI) during the learning process. Designed as a qualitative case study, the research involved semi-structured interviews with 14 pre-service teachers who used ChatGPT in core physics courses such as mechanics and electricity. Data were coded according to growth and fixed mindset indicators, while AI use was categorized as either supporting or not supporting the mindset. Findings revealed that most participants associated physics achievement with innate intelligence and used AI mainly to obtain quick answers or find solutions to given problems. Only one participant demonstrated growth mindset characteristics, using AI for exploration, deepening the learning process, and generating new questions. Four profiles were identified based on mindset and AI use, with the majority falling into the "fixed mindset-non-growth-supporting AI use" category. The study shows that mindset plays a decisive role in shaping the pedagogical potential of AI

tools and that approaches fostering a growth mindset are needed to reveal the transformative role of AI in physics learning.

Strand 12: Technology for Teaching, Learning, and Research

Stand-Alone Paper

From Tool to Teammate: Reimagining Student-AI Collaboration in Engineering Design-Based STEM

Selcuk Kilinc*, Texas A&M University, USA

Elif Yilmazoglu, Middle East Technical University, Turkey

İrem İncecay, Middle East Technical University, Turkey

Esen Uzuntiryaki Kondakci, Middle East Technical University, Turkey

ABSTRACT

This study explores the co-construction of a metacognitive partnership between high school students and a pedagogically-designed AI tool in an engineering design-based STEM activity. While generative AI shows potential for supporting self-regulated learning (SRL), the dynamic nature of the student-AI relationship remains underexplored. We conducted a qualitative single-case study with ninth-grade students using the “EDP Helper,” a custom tool integrating the Engineering Design Process (EDP) and Zimmerman’s (2000) SRL model through Socratic dialogue. Data from interviews, AI chat logs, and opinion transcripts reveal a developmental partnership that progresses through three stages: (1) The AI as an External Regulator, providing essential scaffolding but risking dependency; (2) The AI as a Reflection Partner, catalyzing a shift to metacognitive inquiry; and (3) The AI as a Critical Partner, where students demonstrate agency by negotiating and verifying the AI’s input. This study contributes to the “scaffold, reflect, and negotiate” model of student-AI interaction, offering substantive implications for designing educational technologies that evolve with the learner to cultivate autonomy and critical agency, rather than acting as static information sources.

Multi-Strand (12/7) Stand-alone Paper Set

9-Apr-26, 10:30-12:00

Location: Zoom 3

Strand 12: Technology for Teaching, Learning, and Research

Stand-Alone Paper

Enhancing STEM Education with Generative AI: Insights from Students and a Teacher in Thailand

Parin Chawalit*, California State University, San Bernardino – MA in STEM Education (Class of 2025), USA

Xinying Yin*, California State University-San Bernardino, USA

ABSTRACT

This qualitative case study explored how generative AI (GenAI) tools supported STEM education in a Thai secondary school. During a one-day STEM camp, 50 students (grades 9–11) and one science teacher used ChatGPT and Gemini in a bridge design challenge. The study examined GenAI's influence on student learning within the engineering design process (EDP), student motivation, and teacher perceptions. Thematic analysis of observations, surveys, interviews, and AI interaction logs found GenAI mainly supported early design phases—brainstorming, comparing materials, and visualizing structures. Challenges included students' weak prompt-writing skills, difficulty interpreting vague or irrelevant AI responses, and limited application of AI feedback during testing and revision. Students' learning and motivation varied based on their digital literacy, confidence, and prior experience, with some students preferring familiar platforms (e.g., Google and YouTube). The teacher valued GenAI as a scaffold for creativity and discussion but noted risks of over-reliance, uncritical copying, and equity gaps for under-resourced students. She emphasized the need for prompt literacy, critical evaluation, and structured integration across all EDP phases. This study adds to research on GenAI in non-Western K–12 STEM contexts, highlighting the importance of culturally responsive pedagogy, ethics instruction, and teacher facilitation for effective AI use.

Strand 12: Technology for Teaching, Learning, and Research

Stand-Alone Paper

Generative AI as Science Tutors: Can LLMs Combine High-Level Problem Solving and Advanced Tutoring?

Paul Tschisgale*, Leibniz Institute for Science and Mathematics Education, Germany

Peter Wulff, Ludwigsburg University of Education, Germany

ABSTRACT

Generative AI offers novel opportunities for individualized and adaptive science learning, for example through large language model (LLM)-based feedback systems. To date, most research on such systems has focused on supporting conceptual understanding. Our study addresses a more complex and multifaceted practice: science problem solving in the domain of physics. To advance our understanding of how AI can support science problem solving, we first examined the capabilities of recent LLMs to solve advanced science problems. To examine the tutoring, we developed an LLM-based feedback system grounded in evidence-centered design to assess the complexity of students' problem-solving processes. Using data from student interactions with the system, we investigated how learners perceive the LLM-generated feedback in terms of usefulness, as well as perceived and actual correctness. Our findings indicate that LLMs can solve advanced science problems on par with, or even better than, high-performing students. However, while problem-solving capabilities were high, producing feedback that was both useful and accurate proved more challenging. Although, students generally perceived the feedback as useful and physically correct, it occasionally contained errors. We problematize the unreflected use of LLMs and LLM-enhanced feedback systems, and outline requirements for implementing LLMs in productive ways for improving science learning.

Strand 12: Technology for Teaching, Learning, and Research

Stand-Alone Paper

A Friend, Instructor, Browser, Partner? Interaction Modes in Student–AI Science Learning Conversation

Carolina Sotério*, Teachers College, Columbia University, USA

Tamar Fuhrmann, Teachers College, Columbia University, USA

Jonathan Pang, Teachers College, Columbia University, USA

Paulo Blikstein, Teachers College, Columbia University, USA

ABSTRACT

This study examines how students make sense of generative AI through their interactions with a conversational chatbot (ChatGPT) in a science learning context. We analyzed conversations between fourteen ninth- and tenth-grade students and Lab-on-a-Bot, a component of a learning system that also included a hands-on experiment book, Lab-on-a-Book. From 278 chatbot messages, we identified four roles students assigned to the bot (Instructor, Browser, Reflective Partner, and Human), which reflected distinct mental models of the chatbot's purpose and capabilities. By tracing individual trajectories, we reveal how learners negotiated the chatbot's role and shifted throughout their conversations. These findings contribute to bridging learning sciences, human–AI interaction, and constructionist design by illustrating how effective learning with AI can emerge when students have agency to reinterpret and reshape the technology to meet their needs.

Strand 5 Stand-alone Paper Set

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

9-Apr-26, 10:30-12:00

Location: Zoom 4

Stand-Alone Paper

A Systematic Review of Theoretical and Conceptual Frameworks in STEM Education Research

Dhanya Attipetty*, University of Minnesota, USA

Anita Schuchardt, University of Minnesota, USA

ABSTRACT

The use of theoretical and conceptual frameworks to structure a research study is considered a fundamental research practice within the education research community. However, learning how to use frameworks can be challenging due to the abstract nature of theorizing research. Additionally, the characteristics of theoretical and conceptual frameworks can sometimes vary across different STEM education disciplines and even conflict with each other. A systematic literature review was conducted to explore how STEM education researchers characterize theoretical and conceptual frameworks. This review followed

structured procedures including search protocol development, screening, and data extraction. To identify relevant papers, backward and forward citation searches of five seminal papers were conducted. After title and abstract screening, 133 papers were selected for full-text review. Final inclusion criteria narrowed the set to 41 papers. Data extraction involved identifying relevant passages from each paper, which were then analyzed using inductive thematic coding. Nine broad themes emerged for how researchers define, distinguish, and use theoretical and conceptual frameworks. This systematic review consolidates characterizations of theoretical and conceptual frameworks to provide clarity in their interpretation and use. Guidance on the construction and application of frameworks was synthesized to create a useful resource for newcomers to STEM education research.

Stand-Alone Paper

What does our curriculum allow for? Exploring the lived curriculum in science education

Shauna Schechtel*, Queen's University, Canada

Amanda Bongers, Queen's University, Canada

ABSTRACT

In science education, there has been a shift to explore students' affective experiences. The challenge for science educators is to recognize that the lens through which they understand lived experiences and curriculum is not the only possibility. Specifically, students can learn more than pedagogical content knowledge and disciplinary skills. Students learn about science, specifically what counts as data, who counts as a scientist, and what the goal of science is. These questions reflect what science practitioners and educators prioritize through what we value and what is allowed for in practice. This study explores students' experiences of laboratory learning activities as lived, rather than as planned by the learning outcomes. Participant observations and interviews were the approaches undertaken for data generation. Students shared that the goal of laboratory learning activities was to collect the right data and that they should remove themselves from the research process, as they add error to the experiment. These findings help us understand what students learn about science from laboratory learning activities. The experiences of students are also reflected in the implicit curriculum of science culture. Understanding students' lived experiences informs pathways for curricular reform and highlights what could be possible.

Stand-Alone Paper

Enhancing Conceptual Understanding with an AI Tutor: A Field Study in Undergraduate Physics

Tilman Steinmetz*, University of Tübingen, Germany

Burde Jan-Philipp, University of Tübingen, Germany

Peter Gerjets, The Leibniz-Institut für Wissensmedien, Germany

ABSTRACT

This study investigates the learning effectiveness of an AI-supported learning environment designed in alignment with the Electricity with Potential (EPo) concept - a subject-specific teaching approach addressing common misconceptions about voltage in simple DC circuits. The AI tutor follows a reactive tutoring approach, responding to student questions, prompting reflection, and offering quizzes, while a memory function condenses prior interactions to maintain context. In a randomized field study within an undergraduate physics lab course (N = 190), both control and treatment groups received identical EPo-based lab manuals; the treatment group's manual was embedded in the AI environment. Conceptual understanding was measured using a two-tier instrument ($\alpha = .73$) and analyzed via ANCOVA with motivation as a covariate. Results showed a significant positive effect for the treatment group ($\eta^2 = .04$). User experience ratings were predominantly positive, indicating meaningful engagement. Findings suggest that integrating subject-specific pedagogical concepts into AI tutors can enhance conceptual understanding in authentic learning settings. Future work will include a qualitative analysis of AI-student interactions.

Stand-Alone Paper

Negotiating social and epistemic participation in undergraduate physics group work

Tom Reshef-Israeli*, Technion - Israel Institute of Technology, Israel

Shulamit Kapon, Technion - Israel Institute of Technology, Israel

ABSTRACT

Teamwork is commonplace in undergraduate physics laboratory courses; however, maintaining collaboration that supports the learning of all the participants is far from straightforward. While the role of framing in students' learning has been extensively studied in science education, less is known about the moment-to-moment interplay between social and epistemic framing in undergraduate lab teams, and how these dynamics shape students' learning and participation in such settings. This study was designed to better understand the dynamics between epistemic and social frames in an undergraduate collaborative inquiry in physics, and the participants' alignments in these frames. To do so, methods from ethnography and sociolinguistic discourse analysis were combined to track a pair of undergraduate physics students who collaborated over a full semester in an open inquiry project within the framework of a mandatory project-based laboratory course. The data included 40 hours of videotaped participant observations of authentic lab work and post-course interviews with the students and the instructor who guided their inquiry. The analysis revealed recurring patterns linking the epistemic and social dimensions, thus providing insights into how collaborative learning unfolds when partners have different socio-epistemic framings, and practical suggestions for instructors for better facilitation of group work in undergraduate labs.

Stand-Alone Paper

Active Learning Through Reflection Journals in Introductory Biology

Christel Whitehead*, University of Alabama Birmingham, USA

Peggy Biga, Texas State University, USA

Mary Ann Bodine Al-Sharif, University of Alabama Birmingham, USA

ABSTRACT

Active learning introduces student activity into traditional lectures using student-centered pedagogical strategies requiring deeper thinking, increased engagement, and understanding. This study utilized transformative learning and cognitive constructivism while implementing reflection journals in introductory biology courses to connect topics to real world scenarios while encouraging new methods of material engagement. Fostering active and collaborative learning has enhanced student learning and attitudes. Attitude refers to students' recognition of the importance of learning the subject matter. Understanding connections of learning and attitude is imperative for educators. Engaging classroom experiences can transform students' interest in science. This study compares undergraduate students enrolled in introductory biology laboratories at a Southeastern US university, providing insight into how students view the relationship between science and the real-world. Journal prompts guide students to the correlation between the material and application. Pre-and post-surveys were utilized to measure changes in attitude toward the relationship between science and society. Qualitative data from reflection journals is analyzed utilizing Braun and Clarke's thematic analysis using deductive and inductive methods to depict student interest and motivation. Students' writings were analyzed and compared to surveys and grades. This study demonstrates that simple, deliberate modifications like journal reflections significantly impact students' approach, attitude, and knowledge application.

Multi-Strand (3/6/13) Stand-alone Paper Set

9-Apr-26, 12:30-14:00

Location: Zoom 1

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

Stand-Alone Paper

Developmental Patterns in Early Childhood Scientific Thinking: Critical Inquiry, Hypothesis Testing, Analytical Interpretation and Metacognition

Elif OZTURK*, Giresun University, Turkey

ABSTRACT

In an era where early scientific thinking forms the foundation for lifelong learning, understanding how these skills develop in the early years is essential for shaping effective science education. This study explores how young children's scientific thinking unfolds across four key dimensions—Critical Inquiry, Hypothesis Testing, Analytical Interpretation, and Metacognitive Awareness—during formative years of early and middle childhood. Drawing on data from 282 children aged five to eight in Türkiye, the study employed the Scientific Thinking Skills Assessment Tool (STS-AT), a validated, play-based, and culturally responsive instrument, to capture nuanced patterns of growth. Results reveal a distinct progression: Critical Inquiry shows rapid development between the ages of five-six, while Hypothesis Testing and Analytical Interpretation accelerate markedly after age six. Metacognitive Awareness grows steadily across ages and emerges as the strongest partner to Critical Inquiry, reinforcing the role of reflective thinking in inquiry-based learning. The absence of gender-based differences highlights the potential of equitable environments to nurture all learners' reasoning skills. These findings emphasize the urgency of integrating sustained, open-ended scientific exploration and metacognitive support into early curricula—creating opportunities for children to question, test, reflect, and reason in ways that lay a solid foundation for lifelong scientific literacy.

Strand 6: Science Learning in Informal Contexts

Stand-Alone Paper

Impact of Personalized Narrative on Audience Engagement with Light Pollution Planetarium Show

Elise Abbott*, The Pennsylvania State University, USA

Julia Plummer, The Pennsylvania State University, USA

Christopher Palma, The Pennsylvania State University, USA

Hailey Bowers, The Pennsylvania State University, USA

Clinton Kellick, The Pennsylvania State University, USA

Thomas Gaudin, The Pennsylvania State University, USA

ABSTRACT

The planetarium is a unique teaching tool that can immerse audiences not only in three-dimensional visualizations, but also in stories and narratives. In an effort to determine how different types of narratives in the planetarium impact audience engagement, understanding, and motivation, we presented one of two shows to 52 families, centered on the topic of Artificial Light at Night (ALAN), its consequences, and possible solutions. Show A was designed with narrative and interactive elements that targeted a local audience; show B presented the same content in the style of a documentary, without the personalized narrative elements. Analysis of pre/post surveys indicates that families from both groups showed a significant increase in awareness of ALAN and motivation to make changes to reduce light pollution. Some measures indicated greater improvement in some specific knowledge areas for show A, but the increase in awareness, opinions, and motivation regarding light pollution was not significantly different between the two shows. Overall findings indicate planetarium education improves public investment in and concern for the

issue, emphasizing the potential benefits of using this medium for further science outreach endeavors.

Strand 6: Science Learning in Informal Contexts

Stand-Alone Paper

Exploring the Impact of Facilitating Afterschool STEM Activities on College Students' Interest, Confidence, and Skills

Alexandria Hansen, California State University, Fresno, USA

Amaya De Vore*, California State University, Fresno, USA

Myunghwan Shin, California State University, Fresno, USA

ABSTRACT

This study examines the development of Science, Technology, Engineering, Mathematics (STEM) interest, confidence, and skills among college students who served as facilitators in an afterschool program in which they engaged underserved youth in Maker-based STEM activities. Using a Service-Learning model, college students received formal training and course credit for working with youth over the course of a semester at a large public university in the western United States. Participants (n=146) included both STEM majors and future teachers. Grounded in sociocultural and constructionist learning theories, this quantitative study used a pre/post-survey design to measure changes in college students' STEM interest and confidence, STEM teaching confidence, and growth in 21st century skills. Results revealed significant gains in all areas measured. Specifically, the highest gains were observed for the content areas of Engineering and Science. This experience also greatly increased college students' problem-solving and collaboration skills. This research highlights the value of embedding Service-Learning experiences in courses for both STEM majors and future teachers. For STEM education more broadly, this study offers a scalable program model to enhance university-community partnerships through afterschool programs that feature college student facilitators with the larger goal of increasing youth interest and confidence in STEM.

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

Stand-Alone Paper

Mapping the landscape of stem and ssi integration: research trends and educational implications

Dilek Karışan*, aydin adnan menderes uni, Turkey

Dana Zeidler, university of south florida, USA

ABSTRACT

This study examines research on the integration of STEM education and socioscientific issues (SSI) based on defined criteria. A literature review was conducted using Google Scholar and Web of Science with the keywords "STEM and SSI integration," resulting in 56 studies that met inclusion criteria. Data were analyzed through document analysis, focusing on publication year, participant profiles, research types, designs, and formats. Findings indicate growing interest in STEM-SSI integration, reflected in an increasing number of publications.

Mixed methods and qualitative approaches are most common, while theoretical and review studies are also significant; quantitative research is less frequent. Journal articles make up the majority of publications, with book chapters and conference papers appearing less often. Regarding participants, undergraduate students, in-service teachers, and middle school students are most frequently studied, followed by pre-service teachers and elementary students. Overall, the literature emphasizes interpretive, practice-oriented approaches and highlights teacher development and student engagement. The notable presence of theoretical work suggests ongoing efforts to define and strengthen the pedagogical framework. Findings underscore the potential of SSI-based STEM education to promote critical thinking, reasoning, decision-making, and scientific literacy, and recommendations are offered to inform effective instructional practices in science education.

Strand 13: History, Philosophy, Sociology, and Nature of Science
Stand-Alone Paper

Learning about Science by Doing Real Science: Fostering NOS Understanding through Citizen Science

Haya Ben Simon*, Technion, Israel

Leah Yifrach*, Technion, Israel

Dina Tsybulsky, Technion, Israel

ABSTRACT

Citizen science is a collaborative approach to scientific research that actively engages individuals from diverse backgrounds, such as students, in real scientific investigations. Our study explored the pedagogical potential of citizen science projects to cultivate the Nature of Science (NOS) understanding. We focused on the “Sleep Project,” where students investigated sleep patterns through a two-phase inquiry. The first phase involved analysis of adolescent sleep data; the second involved experimental research on sleep patterns using *Drosophila Melanogaster* flies. The learning sequence was designed to immerse students in genuine scientific practices, including hypothesis formation, data collection and analysis, and critical reflection. Qualitative content analysis of classroom discussions, student artifacts, and pre/post tests revealed multiple expressions of NOS aspects. Quantitative analysis of pre/post tests indicated a significant improvement in students’ understanding of the aspects of knowledge revision, theory in science, aims in science and practices in science. This study emphasizes the potential of CS as a dynamic educational framework that fosters NOS understanding.

Strand 4 Stand-alone Paper Set

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

9-Apr-26, 12:30-14:00

Location: Zoom 2

Stand-Alone Paper

Improving Students' Conceptual Understanding of Cell Division and CT through Unplugged CT Science Module

Ceren Çem*, Yıldız Technical University, Turkey

Mustafa Topçu, Yıldız Technical University, Turkey

ABSTRACT

Computational Thinking (CT), as an essential 21st century skill, has been increasingly involved in K-12 education. CT proposes a potential as being an effective cognitive tool in explaining complex processes in science such as cell division. The cell division topic comprises abstract and complex concepts, and sequential process that students have low level of conceptual understanding on this subject. Previous research on CT suggests that it is an effective approach to support students' understanding of complex scientific concepts and to enhance their science learning. Therefore, the present study aimed to improve 7th grade students' conceptual understanding of cell division and CT competencies through an unplugged CT integrated cell division module. This study is a qualitative study, utilizing concept and sequencing rubrics in assessing conceptual understanding, and algorithm concept rubric to assess CT competencies for the data analysis. The results of this study indicates that implementation of the module resulted in improvement of conceptual understanding on cell division and CT competencies. Thus, CT can be used as an effective cognitive tool not only for improving students' CT competencies but also for their conceptual understanding. This study contributes to progressing literature on CT integration and presents insights to science practitioners and researchers.

Stand-Alone Paper

The Effects of Web 2.0-Supported Argumentation on Students' Science Achievement and Attitude toward Technology

Birsu Bozkurt*, Yıldız Technical University, Turkey

Mustafa Topçu, Yıldız Technical University, Turkey

ABSTRACT

This study investigates the effects of technology-supported argumentation practices on 6th-grade students' academic achievement in the unit of "Sound and Its Properties" and attitudes toward technology. Conducted in a Western Türkiye state school during the 2024–2025 academic year, the research compares students taught with technology-supported argumentation to those taught with traditional argumentation practices. The study was carried out with two classes of 6th-grade students (n=48) in a public middle school in Pendik, Istanbul. A quasi-experimental pre-test/post-test control group design was employed. The

experimental group (n=24) was instructed through Web 2.0-supported argumentation activities, while the control group (n=24) received instruction based solely on argumentation. Data were collected using the 6th Grade Sound and Its Properties Achievement Test and the Attitudes toward Technology Scale. Because the pre-test results did not meet the normality assumption, the Wilcoxon Signed Rank Test was used for within-group comparisons, and the Mann-Whitney U Test was applied for between-group comparisons. Findings revealed that both groups improved their academic achievement from pre-test to post-test, with the experimental group showing greater gains. Additionally, students in the experimental group demonstrated significantly more positive attitudes toward technology, while no meaningful change was observed in the control group.

Stand-Alone Paper

Effect of Educational Digital Game-Supported Science Lessons on Middle School Students' Academic Achievement in Science

Sakine Çiftaslan*, Yıldız Technical University, Turkey

Aslı Görgülü Arı, Yıldız Technical University, Turkey

ABSTRACT

In today's digital age, students' interest in digital games is increasing. In this study, the effect of teaching applications supported by educational digital games coded using the graphics-based programming language Scratch on the academic achievement of 7th grade students in the "Reproduction, Growth, and Development in Living Things" unit was examined. Within the scope of the Science course, during the four-week application process, lessons were taught to the experimental group using educational digital games, while the control group was taught using traditional methods. The sample of the study consisted of a total of 36 students enrolled in a middle school in the Fatih district of Istanbul during the 2023–2024 academic year. The lessons were conducted in line with the objectives of the Ministry of National Education's Science Teaching Program (2018), and educational digital games developed in addition to the curriculum were used in the experimental group. Quantitative data were collected using the "Reproduction, Growth, and Development Unit Achievement Test" developed by Aygün (2019). The data were analyzed using the Mann-Whitney U test in SPSS; the findings showed that the educational digital game-supported instruction applied in the experimental group significantly increased students' academic achievement.

Strand 11 Stand-alone Paper Set 2

Strand 11: Cultural, Social, and Gender Issues

9-Apr-26, 12:30-14:00

Location: Zoom 3

Stand-Alone Paper

The roles of epistemological versus factual security in evolution acceptance by religious students

Andrea Phillips*, Utah Valley University, USA
Jade Sorensen, Brigham Young University, USA
Jamie Jensen, Brigham Young University, USA
Traegan Webb, Brigham Young University, USA

ABSTRACT

The purpose of this study was to characterize, using interview data, the nature of university students' reconciliation of evolution and religious belief. Data was collected from a large private western university, and consisted of interviews of students whose prior survey responses indicated acceptance of contradictory statements about Biblical stories and evolution. Findings reveal the distinction between epistemological and factual reconciliation between science and religion, and provide distinct features of reconciliatory and non-reconciliatory responses. Implications are discussed for evolution instructional strategies, specifically a focus on epistemological reconciliation between evolution and religion.

Stand-Alone Paper

Breaking STEM Barriers Through Robotics, Team Roles, and Gender Dynamics

Shani Goldstein*, Technion, Israel Institute of Technology, Israel
Shahaf Rocker Yoel, Technion, Israel Institute of Technology, Israel
Yehudit Judy Dori, Technion, Israel Institute of Technology, Israel

ABSTRACT

The global STEM shortage and persistent gender gap represent major challenges in education and workforce development. We investigated how structured team roles and gender influence the development of self-efficacy and STEM career choice through the FIRST robotics program. The research extends social cognitive career theory (SCCT) by integrating team role analysis with gender dynamics, providing a novel framework that maps how team positions provide varying access to self-efficacy sources.

A mixed-methods study with 407 high school students and FIRST alumni identified four role: internal management, external management, technical expertise, and social leadership.

Findings show that all participants reported enhanced self-efficacy when holding team roles. However, gender-specific patterns emerged: women demonstrated improved self-efficacy primarily through managerial roles, while men showed broader improvements across technical, social, and internal managerial positions. Despite the program's equity goals, men occupied significantly more internal managerial positions than women. Qualitative analysis of 1,721 interview statements revealed that most of personal development experiences came from participants in managerial roles, suggesting these positions provide particularly rich developmental opportunities.

The study proposes a refined SCCT-based framework linking team roles, gender dynamics, and self-efficacy. It offers practical guidance for designing inclusive STEM programs that promote meaningful leadership opportunities for all students.

Stand-Alone Paper

Using Emotion to Understand a Black Woman Preservice Teacher's Justice-oriented Science Teaching and Identity Development

Erin Cox*, University of Michigan, USA

Elizabeth Davis, University of Michigan, USA

ABSTRACT

Although emotions shape individuals' learning processes, less is known about how emotions experienced during science learning may contribute to longer-term discipline identity development – including among teachers of science. We draw on Vygotsky's sociocultural theory of “perezhivanie” as a lens for understanding emotions' developmental potential. We focus on Rhea, a Black woman who was a non-traditional college student, coming later in life to an undergraduate elementary teacher education program. We employ emotional discourse analysis to understand how Rhea's science identity development, learning, and teaching constructed, and were constructed by, her emotions. Findings indicate that Rhea's self-positioning within larger sociocultural discourse framings in science learning and teaching (framings that could be identified as traditional vs. justice-oriented) led to both conflicting and dynamic emotions. These emotions, in turn, seemed to promote both positive and negative science identity development. Ultimately, the emotions attached to Rhea's experiences with science informed Rhea's emotional trajectory with regard to justice-oriented science learning and teaching. The study has implications for understanding preservice elementary teachers' identities as teachers of science, and, in particular, how Black women coming to elementary teaching may move toward justice-oriented and joyful science teaching despite potentially negative emotional experiences with science as children and youth.

Stand-Alone Paper

Are We Telling the Right Stories? The Narrative Effect's Role in Developing Equitable Science Pedagogy

Megan Allen*, Harvard Graduate School of Education, USA

Enrique Suárez, University of Massachusetts Amherst, USA

ABSTRACT

Examining out-of-school science educators' biases and how to disrupt them is an important goal of science teacher education. While several studies have researched the role of social interaction in developing teacher pedagogy, the influence of emotionality in passing down narratives has remained relatively unexamined when considering its influence on educators and their equity-oriented teaching practices. Drawing on Social Psychology constructs, we defined the “Narrative Effect” as the process of building on others' experiences to influence their own lesson designs and teaching. Subsequent to our implementation of a PD workshop for STEM graduate students who teach middle schoolers in an out-of-school program, we analyzed both pre-teaching and post-teaching interviews, coding for utterances that contained information on expected and/or actual experiences in the classroom. Our

analysis indicates that: (1) participants tended to form negative narratives based on their interactions with the students in the program and one another; (2) participants changed their lessons based on these narratives to decrease their complexity, without prior interactions with students. Our findings suggest that science educators must be made aware of this pattern and intend to intervene in their own practice, this “Narrative Effect” can exacerbate inequities in science education for minoritized groups.

Stand-Alone Paper

Women’s Belonging and Longing: The Affective Push and Pull Within and Beyond Physics

Shamnaz Arifin Mim*, McGill University, Canada

Allison Gonsalves*, McGill University, Canada

ABSTRACT

This research is motivated by concerns about gendered and racialized participation in physics, and our interest to understand how affects shape the trajectories of marginalized students in physics. We present an analysis of four women’s narratives about longing and belonging in physics. The data was collected using the River of Life tool and narrative interviewing, yielding life stories that detail the affective push and pull of life in and out of physics. Drawing on Sarah Ahmed’s concepts of orientations and stickiness, we examine how women narrate important affects that shaped their sense of belonging to physics and their longing for a different physics. We investigate how affects influence feelings of belonging in the moment, shaping experiences of orientation or disorientation, and how these affects can stick to participants in ways that influence their identity trajectories through physics. Our emphasis on identifying actions driven by longings brings attention to the agentic ways that women in physics can create new landscapes, allowing for new orientations to physics, and new possibilities for belonging.

Strand 6 Stand-alone Paper Set

Strand 6: Science Learning in Informal Contexts

9-Apr-26, 14:30-16:00

Location: Zoom 1

Stand-Alone Paper

Reimagining Science Capital through Accessible Museum Experiences for Brazilian Blind and Deaf Visitors

Gabriela Heck, Federal University of Rio Grande do Sul (UFRGS), Brazil

Jessica Norberto Rocha*, CECIERJ foundation, Brazil

ABSTRACT

This empirical study explores how accessible science museum experiences can foster and expand the Science Capital of people with sensory disabilities. Through a qualitative case study conducted in a Brazilian science and technology museum, five adults, three blind and two Deaf, engaged in a guided visit to a climate change exhibition. This exhibition provided multisensory and bilingual resources, including audio description and videos in Brazilian Sign Language (Libras). Data were collected through pre- and post-visit interviews, Science Capital Index questionnaires administered before and after the visits, and observations of the visits. The data was triangulated and its thematic analysis revealed three core categories: (1) Mechanisms of In/Exclusion in Museums and Science, (2) Scientific Content in Context, and (3) Attitudes, Values, and Science-Related Dispositions. Findings demonstrate that accessibility fosters scientific engagement, promotes identity shifts, and transforms participants' perceptions of who can be a scientist. The comparison of the scores of the Science Capital Index questionnaires indicates an increase for all participants, reflecting a gain in scientific knowledge and shifts in their perceptions, understandings of science, and their scientific identity. This study contends that science education must be reimagined with accessibility as a creative and justice-oriented foundation, rather than an afterthought.

Stand-Alone Paper

"Look, I Am Bendy": Embodied, Constructionist STEM Learning During a Biomedical Engineering Activity

Zahra Baradaran Shoraka*, University of Iowa, USA

Kay Ramey*, University of Iowa, USA

ABSTRACT

This study examines how 10 elementary students (ages 8–11) engaged in an engineering design activity to explore the role of biomedical engineers. Students constructed spine models, designed prosthetic discs, and tested materials via compression and bending tasks. Pre- and post-surveys showed increased understanding of what biomedical engineers do (from 10% to 90%) and greater interest in engineering as a career (from 30% to 60%). Drawing on constructionist and embodied learning theories, our video analysis, using reflexive thematic analysis, revealed four themes: developing an engineering mindset, embodied learning and anatomical exploration, exploring material properties through interaction, and social collaboration and peer feedback. These findings suggest that constructionist and embodied learning approaches are effective in cultivating engineering mindsets, facilitating the learning of anatomical concepts, and strengthening engineering interests among young learners.

Stand-Alone Paper

Barriers and Supports in Rural Informal STEM Learning: A Sociocultural and Structural Perspective

Julia Moro*, University of South Carolina, USA

Devan Jones, University of South Carolina, USA

ABSTRACT

This theoretical study examines how sociocultural and structural factors shape participation and engagement in rural informal STEM learning (ISL) environments. Drawing on Vygotsky's sociocultural learning theory, the analysis synthesizes literature from three thematic frameworks: (1) informal STEM learning, (2) structural and rural barriers, and (3) sociocultural perspectives on learning. Findings indicate that programs integrating cultural relevance, community-based designs, and strong family involvement foster sustained participation among marginalized learners. Addressing rural inequities requires both infrastructure-level solutions, such as policy reform, transportation access, and internet connectivity, and place-based strategies that leverage community assets, including intergenerational ties and local knowledge. Culturally aligned program designs that reflect community values and lived experiences can strengthen STEM identity and persistence. Limitations within the literature highlight the need for more longitudinal, multi-site, and resource-diverse studies. This work offers a strengths-based conceptual model for rural STEM engagement, linking equity-focused program design to policy and practice. For educators, researchers, and policymakers, it provides actionable strategies for fostering culturally relevant, accessible, and equitable STEM learning opportunities that align with the realities of rural communities.

Stand-Alone Paper

Productive Talk as Identity Work in a Virtual STEM Program for Girls of Color.

Sharon Ndubuisi*, Florida State University, USA

Kadijah Zogheib*, Florida State University, USA

Valerie Dada, Babcock University, Nigeria

ABSTRACT

In the evolving landscape of science education, fostering identity-affirming learning spaces has become essential, especially for historically marginalized youth in STEM. This qualitative study examines how productive and accountable talk moves supported science learning and STEM identity development for girls of color in a virtual informal STEM program designed as a counterspace. To attend to this gap, this study explores discourse practices in an informal virtual setting. Drawing on six interactive sessions with diverse female STEM role models, we analyzed transcripts and chat interactions through the lens of productive talk and science identity frameworks. Discourse analysis focused on talk moves such as revoicing, pressing for reasoning, and encouraging peer contributions. Findings suggest that talk moves, used by both role models and participants, helped cultivate recognition, belonging, and competence in STEM. Girls engaged in scientific reasoning affirmed one another, and connected lived experiences to science concepts, positioning themselves as capable and valued STEM thinkers. These findings highlight the power of intentional discourse in informal virtual environments to challenge deficit narratives and foster identity work alongside science learning.

Stand-Alone Paper

Capturing chemistry in situ: Student interactions and skills in an energy-themed chemical escape room

Shelley Rap*, Weizmann Institute of Science, Israel

Inbal Salomon-Hai, Weizmann Institute of Science, Israel

Ron Blonder, Weizmann Institute of Science, Israel

ABSTRACT

This study examines how 21st-century skills manifest in situ during a Chemistry Educational Escape Room (ChEsRm) activity, using video recordings from participants' body-mounted cameras. The ChEsRm integrated curriculum-based chemistry content on energy, renewable resources, and natural gas into a puzzle-based game setting. Four 12th-grade chemistry students participated in the activity, which required applying disciplinary knowledge (e.g., thermodynamics, redox, acid-base reactions, and enthalpy) to solve theoretical and experimental puzzles and challenges. Adopting a qualitative case study design, video data were segmented and deductively coded into four domains: 21st-century skills, application of chemistry knowledge, student–student interactions, and student–teacher interactions. The findings revealed the frequent use of communication, teamwork, leadership, problem solving, creativity, initiative, and ethical conduct. Students applied chemistry concepts authentically, expressed high engagement, and often experienced flow characteristics. The teacher acted primarily as facilitator, fostering autonomy while offering minimal but timely guidance. Methodologically, this study demonstrates the potential of body attached video cameras to capture real-time learning interactions beyond self-reported measures. Pedagogically, it positions ChEsRms as powerful learning environments that blend disciplinary knowledge with the development and assessment of essential skills, while transforming science learning into an engaging, collaborative, and empowering experience.

Strand 7 Stand-Alone Paper Set

Strand 7: Pre-service Science Teacher Education

9-Apr-26, 14:30-16:00

Location: Zoom 2

Stand-Alone Paper

Integrating Socioscientific Issues and STEM in Microteaching: A Practical Approach for Pre-Service Science Teachers

Dana Zeidler, usf, USA

Dilek Karisan*, aydin adnan menderes uni, Turkey

ABSTRACT

This study examined the effect of integrating STEM (Science, Technology, Engineering, and Mathematics) and socioscientific issues (SSI) into micro-teaching on pre-service teachers' computational thinking skills, technological pedagogical content knowledge, and their views

on the integration of STEM and SSI. The research study group consists of 31 pre-service teachers, selected using an easily accessible sampling method, which is one of the purposeful sampling methods. A mixed-methods research design was employed for the study, combining both quantitative and qualitative approaches. The findings indicate that integrating STEM and SSI into micro-teaching positively influenced the pre-service teachers' computational thinking and technological pedagogical content knowledge. Additionally, this integration was aligned with the development of critical thinking, problem-solving abilities, and interdisciplinary connections. The pre-service teachers expressed positive views on integration before and after the implementation, noting the benefits of increased student engagement and the relevance of real-world issues in the classroom, as well as challenges to be overcome. Overall, the study highlights the potential of STEM-SSI integration in teacher education aimed at enhancing teaching practices that foster practical, yet meaningful and impactful, learning experiences.

Stand-Alone Paper

Three Lenses on Learning: Analyzing Preservice Teacher Model Revision Through Sociocultural, Cognitive, and Multimodal Frameworks

Jaclyn Murray*, Mercer University, USA

Alex St. Louis*, Mercer University, USA

ABSTRACT

This study investigates how preservice elementary teachers (PSTs) revise their scientific models of a melting ice phenomenon through a structured peer critique activity. Using an integrated theoretical framework that combines sociocultural, cognitive, and multimodal perspectives, the research analyzes the changes between PSTs' initial and revised models. The methodology is an interpretive case study, examining the model revision process of a cohort of PSTs in a science methods course.

Key findings show that the peer critique acted as a catalyst for significant conceptual and representational change. PSTs appropriated new visual tools, such as arrows to denote energy transfer, and linguistic scaffolds, like explanatory keys, from their peers' work. This process was not merely cosmetic; it was the tangible evidence of a deeper conceptual shift, as the social interaction created the necessary "dissatisfaction" with their initial ideas and made more scientific concepts intelligible and plausible. The study concludes that engaging in such multimodal critique apprentices PSTs into the "genre" of scientific modeling, enhancing both their conceptual understanding and their representational competence.

Stand-Alone Paper

Pre-Service Secondary Science Teachers' Ideas About Disinformation and How They Should Address It

Elizabeth Hufnagel*, University of Maine, USA

ABSTRACT

In this exploratory study, six pre-service science teachers' conceptualizations of disinformation and how to address it in their classrooms were examined in the discourse of a science methods course. Grounded in the ethnographic research cycle, iterative analyses of the discourse revealed tensions across the pre-service teachers' conceptualizations of disinformation and how they would address disinformation in their classrooms. These tensions are discussed in detail and provide important implications for supporting new science teachers in confronting disinformation in their classrooms.

Stand-Alone Paper

*Long-term changes in Elementary BEd students' conceptions of science:
Comparing responses across decades*

G. Michael Bowen*, Mount Saint Vincent University, Canada

Gerald Tembrevilla, Mount Saint Vincent University, Canada

ABSTRACT

For a number of reasons replication studies are uncommon in educational research. One of the earlier Canadian Nature of Science studies (conceptualized as conceptions of science at the time) was conducted in the mid-1980's using both closed- and open-questions to examine what understandings about science and its practices were held by elementary teacher candidates. The study elicited and conceptualized their understanding of science and how various contextual variables may have influenced that understanding. Since then, there have been profound changes in Canadian K-12 science education as well as in the news and social information landscape. This paper reports on a repeat of that earlier study using a similar population of students in a similar academic setting allowing us to compare current and past responses regarding knowledge about science and its practices. Despite the many changes in Canadian K-12 science education and in the information landscape, comparisons between the current response and past responses were in many cases more similar than they were different. The paper discusses these similarities and the few differences in detail, and the implications of these findings for elementary science methods courses in Canada.

Stand-Alone Paper

Analysis of elementary PST collaboration during interdisciplinary and inquiry-based curriculum development using design-based thinking approaches

Margery Gardner*, Colgate University, USA

Karen Harpp*, Colgate University, USA

Joyce Zheng*, Colgate University, USA

ABSTRACT

Elementary pre-service teachers (PSTs) often have limited STEM backgrounds and few opportunities for interdisciplinary curriculum design. The NSF-funded Virtual Galapagos (VG) program is a two-year, 10-week summer program that aims to build PST capacity in inquiry-based, interdisciplinary science teaching using design thinking (DT) approaches. A total of 18

PSTs collaborated in teams to develop multi-day lessons plans integrating earth science, biology, ecology and mathematics focused on the Galapagos Islands and guided by the 5E instructional model. Data included 156 minutes of transcribed ideation sessions which was coded using ten predefined DT ideation activities alongside brainstorming sessions that was visualized into word clouds. Frequency analysis showed Elaboration (n=216), Idea Statements (n=173), and Posing Questions (n=166) as most commonly appearing codes. Co-occurrence mapping reveals strong pairings between Elaboration and Idea Statements and between Elaboration and Different Angles which suggests depth-building and perspective-taking in idea refinement. Findings indicate PSTs were most comfortable generating, expanding, and clarifying ideas. Results highlight the value of structuring DT-based sessions to promote these processes, contributing to teacher preparation research on collaborative, creative, and interdisciplinary STEM curriculum design.

Strand 8 Strand-alone Paper Set

Strand 8: In-service Science Teacher Education

9-Apr-26, 14:30-16:00

Location: Zoom 3

Stand-Alone Paper

Teachers' Perceptions Following AI-Driven Professional Development in Unmanned Vehicles Instruction

Amona Abu-Younis Ali*, Technion – Israel Institute of Technology, Faculty of Education in Science and Technology, Israel

Shahaf Rocker Yoel, Technion – Israel Institute of Technology, Faculty of Education in Science and Technology, Israel

Dov Dori, Technion – Israel Institute of Technology, Faculty of Data and Decisions Science, Israel

Yehudit Judy Dori, Technion – Israel Institute of Technology, Faculty of Education in Science and Technology, Israel

ABSTRACT

This study investigates the perceptions of engineering and technology (E&T) high school teachers following an artificial intelligence (AI)-driven professional development (PD) program focused on integrating unmanned autonomous vehicle (UAV) instruction into secondary science, technology, engineering, and mathematics (STEM) education. The program combined educational robotics, deep learning, and autonomous system design, delivered through both theoretical instruction and project-based learning (PBL) workshops, to prepare teachers for the demands of 21st century education. Thirty teachers participated in the theoretical component, and approximately one-third completed the full program, which included intensive hands-on activities. Qualitative data were collected through open-ended questionnaires, semi-structured interviews, and a detailed case study of an exemplary teacher. Findings indicate significant gains in teachers' technical proficiency, confidence, and

ability to embed 21st century skills into student projects, alongside challenges such as technical complexity, limited resources, and time constraints. Personal characteristics had a statistically significant effect on teachers' perceptions. Experienced, highly educated participants emphasized implementation and challenges, while less experienced provided more critical feedback. These results highlight the potential of AI-driven PD to inform educational policy and guide for designing and implementing future PD programs, fostering sustainable integration of AI and autonomous vehicle technologies into high school STEM curricula.

Stand-Alone Paper

Investigating Secondary Science Teachers' Epistemic Beliefs, Motivations, and Perceptions of Modeling Instruction in Reform-Oriented PD

Khalid Alharbi*, North Carolina State University, USA

Soonhye Park, North Carolina State University, USA

Laura Chalfant, North Carolina State University, USA

Grace Carroll, North Carolina State University, USA

Katherine Glover, North Carolina State University, USA

Matt Reynolds, North Carolina State University, USA

Lynn Huff, North Carolina State University, USA

Scott Ragan, North Carolina State University, USA

Jason Painter, North Carolina State University, USA

ABSTRACT

This study explores in-service secondary science teachers' epistemic beliefs, motivations, perceptions of the Modeling Instruction (MI) approach, and their plans to implement it. The participants were involved in an intensive professional development (PD) program focused on MI approach. Employing a qualitative research design, the study used a survey to examine teachers' motivations and conducted interviews to investigate their epistemic beliefs and perceptions of Modeling Instruction. Data were analyzed using both inductive and deductive approaches. Major findings include: (1) most teachers held either instructive or transitional epistemic beliefs, reflecting more teacher-centered views. (2) teachers' desire to attend the PD was influenced by multiple motivations simultaneously, (3) teachers' motivations were more teaching-focused than student learning-focused, and (4) Teachers' epistemic beliefs and motivations were closely related to how they perceived MI and their intention to implement it. Specifically, teachers with internal motivation and those holding more student-centered beliefs reported stronger support for MI, greater confidence, and fewer perceived barriers. In contrast, those with instructive beliefs or concerns about contextual constraints expressed more hesitation. These findings highlight the importance of designing PD programs that address not only instructional content but also the motivational, and contextual factors influencing teachers' adoption of reform-based approaches like MI.

Stand-Alone Paper

Developing Effective Strategies for Challenges in Acquiring Relational Reasoning Skills - an Indicator of Teachers' Expertise

Vered Agmon*, Iasi university, Israel

ABSTRACT

This mixed-methods study examines in-service biology teachers, teaching 7-12 grades, who acquired Relational Reasoning skills (RRs), including analogy, antinomy, anomaly, and antithesis, through explicit meta-strategic training. Parts of it were previously presented. This version offers extension and complementary qualitative results. The study arises from biology teachers' need to explain complex principles in broad contexts, to enhance students' scientific knowledge in evolving circumstances. Mixed data analysis revealed a significant relationship between intervention teachers' knowledge level and their ability to develop strategies to overcome difficulties in applying RRs. Profiles were characterized by teachers' ability to create effective strategies. Teachers who demonstrated a higher level of knowledge (36%) developed their effective strategies. Only 16% of them successfully created strategies to use the four skills, indicating their expertise. Teachers with moderate knowledge performance (36%) progressed by relying more on external sources, including the relations mapping tool provided through mediation and examples from colleagues. In contrast, teachers with insufficient knowledge (28%) struggled to create effective strategies for overcoming the challenges of RRs, resulting in negligible progress. Developing strategies for coping with difficulties in acquiring skills can be an indicator of expertise in teachers' professional development, alongside domain knowledge and experience.

Strand 8 Strand-alone Paper Set

Strand 8: In-service Science Teacher Education

9-Apr-26, 14:30-16:00

Location: Zoom 3

Stand-Alone Paper

Comparing the Burnout Trends of Early Career STEM Teacher Leavers and Stayers

Shannon Navy*, Kent State University, USA

Ella Yonai, Auburn University, USA

ABSTRACT

Although it is known that early career teachers need quality support to mitigate effects of burnout, little is known about how burnout may impact teachers' decisions to stay or leave the profession. To increase the knowledge in this area, this paper focuses on the overall burnout trends of a group of early career science, technology, engineering, and mathematics (STEM) teachers over two years and how those trends compare between teachers who stayed in the teaching profession and teachers who left the teaching profession. The participants are 27 early career STEM teachers in the United States. Four of the teachers left teaching at different time points in the study. Data sources included three burnout surveys, a

pre-interview, and an end-of-year interview each year of the study. For the four leavers, an exit interview was also conducted. The quantitative data revealed the depersonalization and emotional exhaustion dimension scores of burnout were mostly higher than the median for the leavers in this study and the personal accomplishment dimension scores were mostly lower than the median for the leavers in the study. The study highlights the connection of burnout to teacher retention and the importance of recognizing early career STEM teacher burnout.

Closing Remarks

9-Apr-26, 16:00-

Location: Zoom 1



Conference Day 1

19 April 2026

New Member Welcome Session

19-Apr-26, 7:00-

Location: Willow A (L2)

Social Event

Welcome Session

Organizers

Joi Merritt, James Madison University, Harrisonburg, VA, USA

Rebekah Hammack, Purdue University, West Lafayette, IN, USA

Contributors

Rebekah Hammack, Purdue University, West Lafayette, IN, USA

Pre-conference workshops

19-Apr-26, 8:10-11:45

Pre-Conference Workshop

Centering Joyful Transgression and Radical Imagination: Equity and Ethics Considerations

Location: Willow A (L2)

Organizers

María S. Rivera Maulucci, Barnard College Columbia University

Iliana De La Cruz

Dominick Fantacone, SUNY Cortland, USA

Abstract

The Equity & Ethics Committee Pre-Conference Workshop recognizes the newly selected Jhumki Basu Scholars, gathers former Basu Scholars and invites participants from the broader NARST Community for a session focused on welcoming, mentoring, and collaborative community-building related to the conference theme. Following an opening

ceremony and ice-breakers, an expert panel will share insights about their work to center joy and radical imagination as they work for equity and social justice in science education. The panel will be followed by roundtable discussions, and whole group sharing. Participants will leave with a better understanding of some of the equity and ethics considerations for imagining how we can ensure a just science education for all.

Pre-Conference Workshop

Mapping Research for Science Media Literacy: From Why to What and How

Location: Ravenna AB (L3)

Organizers

Jonathan Osborne, Stanford University, USA

Douglas Allchin, Stanford University, USA

Abstract

Scientific misinformation on the internet, social media and other sources has reached crisis proportions. This workshop focuses on envisioning and sharpening the relevant educational research. First, what core concepts and competencies need to be taught? Allchin (Science Education, 107(2023), 261–274) has proposed a set of ten basic competencies. Are these complete and well formed? What else is needed? Participants will develop a repertoire of aims for future research. Second, how should we teach these concepts, particularly by using an inquiry learning approach? Namely, how can we reorient the familiar methods of teaching scientific practices and the nature of science to this new, less familiar context? To explore this approach, participants will engage in two model lessons (one on the social structure of expertise, one on credibility in a historical case) and discuss the (re)framing of inquiry to this new domain. Participant teams will then sketch a research project of their own, focusing on the what and the how of the teaching — and how to measure student learning.

Pre-Conference Workshop

Behind the editor's desk: Learning to publish and review for the Journal of Research in Science Teaching (JRST)

Location: Ravenna C (L3)

Organizers

Matthew Kloser, University of Notre Dame, USA

Dana Vedder-Weiss, Ben Gurion University of the Negev

Edna Tan, University of North Carolina Greensboro, USA

Contributors

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

Matthew Kloser, University of Notre Dame, USA

Edna Tan, University of North Carolina Greensboro, USA

Elif Ozulku, University of Notre Dame, USA

Till Bruckerman, Leibniz University Hannover, Germany

Miray Tekkumru-Kisa, University of Illinois, USA

Gur Arie Livni Alcasid, University of the Negev, Israel

Abstract

Publishing and peer review are essential to the dissemination, vitality and integrity of science education research, and the advancement of dialogue among scholars and the development and introduction of new ideas. Yet for many early scholars, these processes remain opaque. This interactive workshop, led by the Journal of Research in Science Teaching (JRST) editorial team, invites participants to explore the review process from the inside out. Through hands-on engagement with an actual manuscript (shared with author permission), participants will draft, discuss, and refine reviews, and compare their feedback to real reviews and editorial decisions. They will also discuss strategies to manage (as authors) reviews and how to cope with the emotional burden attached to receiving a critical review and the experience of rejection. They will reflect on how reviewing and authorship are part of scholarly formation. The dual goals of the workshop are to (1) strengthen participants' own capacities as authors for JRST; (2) help participants develop the skills and insight needed to provide reviews that are constructive, balanced, and helpful to authors and editors and potential reviewers, associate editors, or editors. Designed particularly for graduate students and early career scholars, this workshop transforms the publishing and peer review process by fostering transparency, equity, and care in the advancement of science education.

Pre-Conference Workshop

Engaging with Animals: Incorporating Interspecies Empathy into Science Education Research & Pedagogy

Location: Issaquah AB (L3)

Organizers

Bryan Nichols, Florida Atlantic University, FL, USA

Sarah Brenkert, Florida Atlantic University, FL, USA

Emily Bernhardt, Florida Atlantic University, FL, USA

Abstract

This workshop will introduce participants to the concept of education for interspecies empathy. It will cover some of the successful pedagogies to leverage it for conservation, and related evaluation tools and results from work done at zoos, aquaria, and field sites. Students of all ages often find animals, especially wildlife, highly engaging. A primary goal of the workshop will be to inspire and help researchers, evaluators, and educators to more effectively coordinate projects. As we learn more about the cognitive abilities and emotions of other animals, from orca to octopuses, our science learners are often both highly engaged and concerned. Workshop participants will get a chance to learn from a science education professor and two experienced informal educators and evaluators who work directly with wildlife in education programs at two Association of Zoos & Aquariums accredited facilities in the Seattle area: the Seattle Aquarium (educating over 50,000 students per year) and the Woodland Park Zoo, which sees over a million visitors per year. Take advantage of NARST's

location this year and learn from experts in the Advancing Conservation through Empathy for Wildlife Network (ACE), which partners with 27 zoos and aquaria across North America to create and share effective practices to foster empathy for animals and people. Participants will leave even more inspired to make the world a better place for people and wildlife, with new tools to teach and research interspecies empathy, and new networks and collaborators to get involved in this interesting and growing research area.

Pre-Conference Workshop

Integrating Science with Machine Learning for Upper Elementary Grades

Location: Greenwood (L3)

Organizers

Ezgi **Yesilyurt**, Utah State University, UT, USA

Contributors

Dilara Kara-Zorluoglu, University of Nevada Las Vegas, NV, USA

Refika Turgut, University of South Carolina-Upstate, SC, USA

Erdogan Kaya, The University of Texas at Arlington, TX, USA

Ezgi Yesilyurt, Utah State University, UT, USA

Elif Adibelli-Sahin

Hasan Deniz, University of Nevada, Las Vegas, NV, USA

Abstract

This workshop engages participants in integrating AI literacy with science concepts (grades 3-5) through hands-on activities and educational robotics. The workshop demonstrates how to train AI models for image recognition in science contexts and apply these models with Finch 2 robots to deepen understanding of both AI literacy and science concepts. Participants will train image recognition machine learning/AI models using real-world applications and program Finch 2 robots to respond to AI predictions. Participants will leave with standards-aligned lesson plans, practical experience with accessible AI tools like Google Teachable Machine, and strategies for addressing both NGSS science standards and AI4K12 guidelines in their classrooms.

Pre-Conference Workshop

Science Education Research as Non-Extractive, Community-Centered Praxis:

Responding to Pressing Challenges Together

Location: Capitol Hill (L3)

Organizers

Uma Ganesan, The University of Texas Rio Grande Valley, TX, USA

Miriam Ortiz, The University of Texas Rio Grande Valley, TX, USA

Contributors

Miriam Ortiz, The University of Texas Rio Grande Valley, TX, USA

Angela Chapman, The University of Texas Rio Grande Valley, TX, USA

Alejandro Gallard, Georgia Southern University, GA, USA

Uma Ganesan, The University of Texas Rio Grande Valley, TX, USA

Enrique Suarez, University of Massachusetts-Amherst, USA

María González-Howard, The University of Texas at Austin, USA

Alexander Eden, Salem State University, USA

Abstract

This LARIG-sponsored pre-conference workshop addresses a critical challenge in science education research: moving from extractive to community-centered research practices. As the field increasingly recognizes the importance of socially relevant, educationally meaningful research that responds to real-world community challenges, this workshop provides a collaborative space for science education researchers to reimagine their research praxis. Building on LARIG's webinar from Fall 2025, this workshop invites participants to actively workshop their own community-oriented projects while learning from facilitators' experiences partnering with science teachers and community organizations. Through interactive presentations, case study analyses, and collaborative workshoping sessions, participants will explore how to center communities in research design, build authentic partnerships, and challenge deficit-based approaches. The workshop directly addresses the NARST 2026 conference theme "Joyful Transgressions and Radical Imagination in Science Education" by transgressing traditional extractive research paradigms and radically reimagining university-community relationships in science education research. Participants will leave with concrete strategies for developing community-centered research, expanded networks of like-minded colleagues, and renewed commitment to research as praxis that genuinely serves community needs.

Pre-Conference Workshop

Cultural and Place-Based Learning from Duwamish Community Members

Indigenous Science Knowledge Research Interest Group (ISK RIG)

Location: Off-site

Organizers

Julie Robinson, University of North Dakota, ND, USA

Filiberto Barajas-Lopez, University of North Dakota, ND, USA

Abstract

The ISK RIG has blossomed over the past few years into a highly participatory and engaged group of members. We are a diverse group of educators, researchers, practitioners, and students from a vast array of global contexts and communities. The networks and partnerships expanding from on-going opportunities for ISK members to meet and share are resulting in collaborative projects, writing, book proposals, and collective learning and discourse. The ISK membership continues to seek even more engagement with each other

and with the communities that are local to our annual conference sites as a way to deepen the respect and learning about the spaces and histories that we visit as we gather. Over the past years, our preconference workshops have allowed ISK members to learn about and with the Indigenous community members, and we propose another such opportunity for our members this year to connect to place, culture, community, and each other in ways that honor the Tribal Nations of the region in which we will be guests. As such, the following goals and essential questions continue to guide our work together:

- How can we connect to place personally, emotionally, and educationally?
- How do place-based connections enhance STEM learning and conceptual understandings?
- How do we situate our research and methodologies within place and culture?
- How does place and nature-based teaching support Indigenous Ways of Learning?
- How can community and cultural connections support students' sense of stewardship and kinship with their place?

Pre-Conference Workshop

Playful Futurism for Radical Imagination in Science Education

Location: Kirkland (L3)

Organizers

Isis Howard, University of Calgary, Canada

Mindy Chappell, University of Illinois, USA

Abstract

As a central theme of NARST 2026 radical imagination is necessary for us to live in a future-oriented present and project transformative change. In imagining transformative futures, it is necessary to ensure that we are shifting our frame so that capitalistic, inhumane and unempathetic futures that continue to oppress marginalized communities are not reinforced. Tina Campt's idea of "historical present" describes way that past racial injustices are lived in the present, combined with a Swahili understanding of time as event/experience-oriented—sasa—the now, recent past and immediate future (Mbiti), allows us to think of living desired futures in the present. In this workshop we will use the overarching prompt, "what are my desires for a radically different future?" and "how can I live that future in the present?" to imagine a liberatory science education through tangible and ephemeral art-making. Inspired by a workshop entitled, "Imaginarium: Art for social change," This workshop will engage participants in acts of playful futurism by creating playing with materials to create artwork that represents future orientations of science education as a way of articulating the ways we could live this future in the present and creating tangible, incremental change in our teaching, research and lived communities.

Pre-Conference Workshop

Contributing to Theory through Science Education Research

Location: Columbia (L4)

Organizers

Katharine Doerr, Malmö University, Sweden

Contributors

Kevin Nguyen, Sonoma State University, USA

Katerina Günter, Umeå Universitet, Sweden

Bjørn Johannsen, University College Copenhagen, Denmark

Tatiane Russo-Tait, University of Georgia Athens, GA, USA

Katharine Doerr, Malmö University, Sweden

Abstract

This workshop will support early career science education researchers in developing their capacity to make meaningful theoretical contributions. While many studies in the field focus on practical solutions, the demand for research that advances theory remains a central challenge—particularly for those who are transitioning from STEM disciplines and/or those new to qualitative inquiry. Drawing on diverse theoretical paradigms, including feminist, posthuman, intersectional, and critical frameworks, the facilitators will guide participants in exploring how theory informs - and is informed by method; and how explanatory frames shape knowledge production. Over four hours, participants will engage in two main activities: a jigsaw analysis of selected research articles authored by the facilitators, followed by collaborative creation of zines. Zines are booklets blending text and illustration as a form of epistemic agency and creative scholarship. The activities are designed to foster shared meaning, build community, and support participants in connecting theoretical insights to their own research. The workshop is a condensed version of a three-day summer school held in conjunction with the ESERA meeting in 2025, adapted to increase accessibility for North America-based scholars. It also connects to a NARST roundtable presentation of the summer school's capstone project. Participants will leave with a deeper understanding of theoretical frameworks, a digital zine artifact, and new scholarly relationships. This session offers a launching point for developing ideas and networks that will support ongoing engagement with theory in science education research during NARST 2026 and beyond.

Graduate Student Luncheon

19-Apr-26, 11:45-12:45

Location: Metropolitan Ballroom A/B (L3)

Organizers

Collins Moga, University of Massachusetts Dartmouth, Massachusetts, USA

Arya Karumanthra, Indiana University Bloomington, Indiana, USA

Xin Xia, University of Virginia, Charlottesville, Virginia, USA

Presidential Welcome

19-Apr-26, 13:00-13:15

Location: Grand Ballroom (L2)

Keynote Address

19-Apr-26, 13:15-14:30

Location: Grand Ballroom (L2)

Dance as Resistance: Embodiment, Joy, and Radical Imagination

Speaker

Ms. Melba Ayco, founder and Artistic director of Northwest Tap Connection

Abstract

Melba Ayco is the Artistic Director of Northwest Tap Connection, and the creator of African American Odyssey, a touring performance inclusive of spoken word, dance, and music that expresses the history and struggles of African Americans from a place of pride.

This keynote explores dance as a powerful form of resistance grounded in Black and Indigenous traditions. Movement is more than artistic expression—it carries memory, culture, survival, and collective hope. Through embodied practice, dance tells stories that have often been silenced and creates space for healing, connection, and political imagination. In times when science education can feel rigid and disconnected from lived experience, dance reminds us that knowledge is not only intellectual but also physical, relational, and deeply human. Drawing on community-rooted traditions, this talk invites science education researchers, practitioners and activists to think differently about learning: as something lived in the body, shaped by history, and fueled by joy. What might it mean to see resistance not only in protest, but in celebration, rhythm, and shared movement? By honoring embodied ways of knowing, we open possibilities for more inclusive, life-affirming approaches to education—approaches grounded in creativity, dignity, and collective flourishing.

Northwest Tap Connection (NTC) is a race and social justice dance studio that was founded and deeply rooted in rhythm tap. In addition to tap, NTC cultivates a broad spectrum of dance styles, such as African, jazz, modern, ballet, swing, ballroom, and hip-hop into its curriculum and performances. NTC is dedicated to developing the whole dancer through a love of dance, personal discipline, respect for the community, respect for fellow dancers and artists, and knowledge of the history of various art forms. NTC fosters an environment where dancers can grow artistically and technically, while also developing self-esteem, leadership skills and social responsibility

Cultivating Scientific Explanations and Argumentation

Strand 1: Science Learning: Development of student understanding

19-Apr-26, 14:45-16:15

Location: Ravenna AB (L3)

Stand-Alone Paper

Exploring the Relationship between Changes in Dialogue and Student Language Use in Generative Science Classrooms

Alison Warren*, Purdue University, USA

Brian Hand, University of Iowa, USA

Derek Rodgers, University of Iowa, USA

ABSTRACT

The goal of this study was to investigate how student dialogic participation may influence their individual knowledge generation and epistemic tool usage. The Next Generation Science Standards and Framework for K-12 education call to better explore and understand the role of language and literacy in science education, as current education trends emphasize the importance of engaging students in the practices of science, including argumentation and communicating ideas. This research study consisted of a single case study of a high school biology classroom, where student dialogic interactions were mapped alongside their in-class written tasks. Students were broken into two groups, dialogic and non-dialogic based on evidence of their verbal participation in the class, and subsequently, their writing was scored to explore their self-authored work. Findings from this study suggest that students who were participating in classroom dialogue were more likely to engage in the use of writing as an epistemic tool as opposed to a communicative one, generating more science ideas across units and using more modes of representation that were embedded within their written work.

Stand-Alone Paper

Socially Mediated Metacognition in Socioscientific Issues: How Conversational Dynamics Shape Collaborative Reasoning

Sumaiya Tabassum*, University of Nebraska–Lincoln, USA

Alex Sobotka, Iowa State University, USA

Asghar Gill, University of Nebraska–Lincoln, USA

Jenny Dauer, University of Nebraska–Lincoln, USA

ABSTRACT

When solving complex Socioscientific issues (SSIs), science is only part of the equation—decisions also hinge on how people share, challenge, and refine ideas together. This study examines how undergraduates in a science literacy course engaged in socially mediated metacognition (SMM)—the regulation and monitoring of thinking through peer interaction—while working through a structured decision making (SDM) task on plastic pollution. Four team discussions, each involving four students (n=16), were coded for metacognitive and transactive moves using the SMM framework. Conversational moves were analyzed (n=430),

revealing wide variation in transactive-to-metacognitive (T:M) ratios across teams, revealing three key patterns: (1) all groups exhibited high frequencies of non-elaborate assessments, limiting evaluative depth; (2) teams with more balanced transactive-to-metacognitive (T:M) ratios engaged in richer collaborative discourse; and (3) idea and feedback requests were rare, indicating that peer-initiated regulation is an underdeveloped skill. These findings reveal how conversational dynamics can either strengthen or limit collaborative reasoning in SSI contexts and suggest the value of targeted scaffolds—such as structured prompts or discussion roles—to foster deeper, more equitable collaboration.

Stand-Alone Paper

Linking Scientific Argumentation and Epistemic Beliefs to Cultivate Informed Learners: Evidence from Survey Analysis

Jing Lin*, Beijing Normal University, China

Letong Zhang, Renmin University of China, China

Knut Neumann*, Leibniz Institute for Science and Mathematics Education at Kiel University, Germany

Mei-Hung Chiu, Taiwan Normal University, Taiwan

ABSTRACT

Scientific argumentation is not just a skill; it serves as a pathway for students to understand the nature of knowledge and the nature of knowing in science. Although there have been calls to connect scientific argumentation instruction with the development of students' epistemic beliefs, the specific nature of their relationship remains unclear. This study addressed this gap by collecting and analyzing survey data from 266 fifth- and seventh-grade students. Results showed that sophisticated epistemic beliefs, particularly those concerning certainty, development, and justification, were positively associated with stronger claims and reasoning components, while beliefs about sources of knowledge were negatively related to reasoning. Conversely, key components of scientific argumentation, such as claims and reasoning, were connected to multiple dimensions of epistemic beliefs. These findings highlight a bidirectional relationship between the two constructs, suggesting that instruction in scientific argumentation should explicitly incorporate the development of epistemic beliefs. In practice, targeted interventions that promote critical evaluation of knowledge, support evidence-based reasoning, and address naive beliefs about sources of knowledge may foster deeper epistemic understanding and more robust scientific argumentation competence, thereby facilitating in students the ability for lifelong learning and equipping students to navigate an increasingly uncertain future.

Stand-Alone Paper

Moving beyond the claim: Examining how elementary science students construct evidence-based explanations during science gameplay

Georgia Hodges*, University of Georgia, USA

Kayla Flanagan, University of Georgia, USA

Lourdes Gaibisso, University of Mississippi, USA

ABSTRACT

Immersive learning environments, such as serious educational games (SEGs), can enhance elementary students' science learning by enabling exploration of scientific phenomena in ways traditional instruction cannot replicate. While prior research supports their potential, less is known about the mechanisms that support learning in these contexts. This paper reports findings from a multi-year project that designed, tested, and refined a SEG focused on three-dimensional science learning through human body systems. Grounded in situated cognition, the game immerses players in authentic scenarios that require the use of science practices to progress through six levels of gameplay. This convergent mixed methods study employed pre- and posttests and embedded gameplay data (200 data points) from elementary learners ($n = 179$) to examine how students construct evidence-based explanations before, during, and after a two-week intervention. Findings show (1) significant learning gains from gameplay; (2) design heuristics that scaffold explanation construction; (3) gains linked to in-the-moment feedback; and (4) the importance of deliberate practice of targeted science practices. This study advances research on immersive learning environments and offers actionable insights for educators, researchers, and developers committed to creating ambitious science learning experiences for elementary learners.

Talk, Debate, and Collaborative Meaning-Making in Science Education

Strand 2: Science Learning: Contexts, Characteristics and Interactions

19-Apr-26, 14:45-16:15

Location: Jefferson A (L4)

Stand-Alone Paper

Processual Responsiveness in Facilitating the Cogenerative Dialogues between High School Students and Scientists

Pei-Ling Hsu*, University of Texas at El Paso, USA

ABSTRACT

Science internships with scientists offer informative learning opportunities to high school students, but also pose relational and communicative challenges due to participants' different backgrounds and unfamiliarity to each other. Cogenerative dialogues (cogens), equitable and collaborative discussions aimed at improving collective practices, have been implemented to help participants improve science internships. However, there is limited understanding of how facilitators support cogenerative dialogues between scientists and high school students. This qualitative study examined how nine trained facilitators supported cogens within a university-based science internship for high school students and scientists. Drawing on the framework of processual responsiveness in dialogic facilitation, I analyzed facilitators' process reflexivity and relational reflexivity of facilitating cogens in the internship. Three key strategies reflecting their process reflexivity include clarifying the purpose of cogens, tailoring structure and support to address group needs, and adapting facilitation

practices to foster dialogues. Four main strategies reflecting their relational reflexivity include building trust, offering support, demonstrating empathy, and promoting fairness among participants. The study offers implications for preparing facilitators to foster equitable, inclusive, and responsive dialogue spaces in STEM internships and other educational settings.

Stand-Alone Paper

The Relationship Between Argumentation and Debate Opportunities and PISA Performance

Andy Cavagnetto*, Washington State University, USA

Shenghai Dai, Washington State University, USA

ABSTRACT

Argumentation has been a key component to advancing scientific literacy for the past 25 years. Its scarcity in science classrooms in the 1990s led to it becoming a major emphasis area for research, resulting in numerous studies and strategies focused on learning-to-argue and ultimately integration into state and national curricular standards around the world. Empirical studies focused on argumentation-to-learn in science have been reported but are limited in quantity and the scale examined. Thus, the case for argumentation as a vehicle to support science concept learning has largely relied on theoretical grounds. This study examined the extent to which opportunities for argumentation and debate are found in science classrooms and the relationship between such opportunities and student learning as measured by the PISA science assessment. The majority of students reported that opportunities to argue or debate occurred only “in some lessons” or “hardly/never”. Surprisingly, findings did not show a positive relationship between opportunities to argue/debate and PISA performance. Argumentation was not strongly positively or negatively related to performance. Debate showed a negative relationship with science performance in all but one country, including small to medium effect sizes in some. Potential explanations for these findings and implications are discussed.

Stand-Alone Paper

Tracing Knowledge Construction through Talk Turns in Collaborative CURE Labs: An Evolutionary Perspective

omowumi frieyo*, washington state university, USA

YETUNDE ADARAMOLA, washington state university, USA

Patrick Ochieng, washington state university, USA

Andy Cavagnetto, washington state university, USA

ABSTRACT

This study explores how undergraduate students collaboratively construct scientific knowledge through peer discourse in Course-Based Undergraduate Research Experiences (CUREs). Building on previous Premo et al., 2018 work, we apply a evolutionary lens to trace student interactions using a customized coding scheme. By examining how students

negotiate uncertainty, introduce variation, and scaffold shared understanding across structured (interdependency) and unstructured (comparison) conditions, we illuminate the evolutionary dynamics that characterize productive collaboration in scientific learning environments. Results indicate that the conditions of engagement greatly influence the characteristics of idea evolution in groups.

Stand-Alone Paper

Writing (Righting) Ethical Uncertainty? Tracing Young Children's More-than-Human Sensemaking Across an Integrative Science-Literacy Unit

Jon Wargo*, University of Michigan, USA

ABSTRACT

This paper investigates how young children navigated ethical uncertainty in an integrative science unit involving more-than-human entities (e.g., plants and earthworms). Drawing on sensemaking theory, which frames learning as a collaborative and contextually situated social process, the research foregrounds how children negotiated a series of ethical dilemmas during their multispecies encounters. Through interrogating small and whole group conversations, instructional materials, and child-produced artifacts (e.g., writing), findings show that children's conceptualizations of “living things” and their ensuing ethical responsibilities were shaped both by collective debate and experiential evidence. Notably, moments of disagreement—such as whether plants deserve the same care as animals—highlight the epistemic and affective dimensions underpinning young learners' process of recalibrating what counts as care in the science classroom. By centering multispecies vulnerability and interspecies relationality, the paper challenges dominant Western humanist frameworks to introduce an “environmental ethics of vulnerability” in elementary science practice. Suggesting that early science classrooms can function as rehearsal spaces for an emergent ethics of interspecies care, the paper closes by offering insights and implications for cultivating young children's ethical and epistemic agency in our era of ecological uncertainty.

Organizational Sensemaking and Reframing of Elementary Science Practices

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

19-Apr-26, 14:45-16:15

Location: Seneca (L4)

Stand-Alone Paper

Teachers' Persistence With a Science Education Innovation After Research Incentives and Accountability Are Withdrawn

Patrick Smith*, Horizon Research, Inc., USA

Sarah Carrier*, NC State University, USA

Christine Goforth, North Carolina Museum of Natural Sciences, USA

Lindsey Sachs, Horizon Research, Inc., USA

ABSTRACT

This paper reports on the sustained use of school-based participatory science (SBPS) projects by elementary teachers after the removal of research incentives and accountability structures. SBPS integrates citizen science into formal K–12 instruction, offering authentic engagement with scientific practices. As part of a five-year research initiative, teachers implemented two projects—CoCoRaHS (precipitation tracking) and Lost Ladybug (insect monitoring)—with support materials developed by the research team. Following the implementation phase, a survey assessed continued use, motivations, and reliance on support materials. Of 38 respondents, 53% reported ongoing use of at least one project, with CoCoRaHS being more frequently sustained. Teachers cited curricular alignment and instructional value as key motivators, while competing demands and contextual challenges hindered continued use. Notably, teachers who continued using Lost Ladybug were more likely to rely on support materials, suggesting project complexity influences material dependence. Findings support an emerging theory of SBPS, emphasizing the interplay between project characteristics, teacher context, and support resources. This research contributes to understanding the sustainability of educational innovations and highlights the importance of follow-up studies to assess long-term impacts beyond initial implementation.

Stand-Alone Paper

We can't stray outside of our packaged curriculum: Teacher autonomy and elementary science instruction

Laura Wheeler*, Brigham Young University, USA

ABSTRACT

The research explores how varying levels of teacher autonomy impact science teaching practices in elementary classrooms. Recognizing the challenge of fluctuating instructional time due to mandates and perceived science importance, this study addresses the gap in understanding how teacher autonomy influences science instruction. Utilizing a mixed-method explanatory sequential design, we combined quantitative surveys with qualitative interviews to examine 118 teachers in the Intermountain West. Our findings reveal that while teacher autonomy levels (general and science curricular) do not significantly predict the time spent on science teaching, they do influence the quality and approach of instruction. Teachers with high autonomy demonstrate greater innovation and personalization, while those with low autonomy often adhere strictly to prescribed curricula. This highlights the critical role of autonomy in fostering engaging, student-centered science education. We suggest that educators, trainers, and school leaders consider strategies to enhance teacher autonomy, enabling more effective adaptation of teaching materials and promoting enriched learning environments. This research underscores the importance of supporting teachers' professional judgment and provides actionable insights for improving science education practices across autonomy levels.

Stand-Alone Paper

Making Time, Making Sense: Cross-Level Organizational Sensemaking to Re-Frame Elementary Science Practices

Michelle Brown*, State College Area School District, USA

Carla Zembal-Saul, The Pennsylvania State University, USA

ABSTRACT

Many elementary teachers face constraints such as time, a prioritization of ELA and math, and a lack of professional learning opportunities to enact science sensemaking practices. Administrators at the school and district level can provide critical support to overcome these challenges. In this study, we examine how cross-level leadership enables elementary teachers to better navigate constraints to engaging in science sensemaking practices. We used an organizational sensemaking lens to analyze how 12 participants, spanning teachers, and school, district, and regional administrators, interacted in a professional learning session, along with analyses of participant interviews. Findings showed that participants followed a pattern of reframing science sensemaking, which often began with constraints (e.g., not enough time), to possibilities, enactments by administrators, and iterative reframing that resulted in a more supportive space to enact science sensemaking. This study helps illustrate the role of administrators in supporting elementary science sensemaking practices, and provides an example of the productivity of organizational frames to understand teacher learning.

Advancing Chemistry and Physics Learning Through Innovative Pedagogies
Strand 4: Science Teaching — Middle and High School (Grades 5-12): Characteristics and Strategies

19-Apr-26, 14:45-16:15

Location: Juniper (L2)

Stand-Alone Paper

Integrating Complexity with PCK: Dynamics of Teacher Learning in Chemistry Classrooms

Supawit Kanitjinda*, Kasetsart University, Thailand

Chatree Faikhamta, Kasetsart University, Thailand

ABSTRACT

Current models of Pedagogical Content Knowledge (PCK) specify what teachers know but offer limited accounts of how such knowledge is dynamically activated during teaching. This self-study integrates complexity science with the Refined Consensus Model (RCM) to examine how personal PCK (pPCK) and enacted PCK (ePCK) interact as a complex adaptive system. Using a five-year corpus from my chemistry teaching, I coded lessons for topic-specific PCK components—Knowledge of Students (KoS), Knowledge of Instructional

Strategies (KoS), curriculum, and assessment—and for complexity mechanisms (emergence, self-organisation, and non-linear feedback). Findings show that KoS and KolS dominate enactment, co-occurring in over 75% of coded episodes, while curriculum and assessment function as filters that shape options. Teacher learning is driven by cycles of disequilibrium and feedback that yield emergent, stabilised routines (“attractors”). Transformation of pPCK requires integrating knowledge, beliefs, and orientations with accumulated classroom and professional experience, and follows non-linear trajectories with phase transitions rather than steady accretion. The study contributes a mechanism-centred account of pPCK–ePCK relations and offers practical tools for complexity-aware planning and reflection to inform professional learning.

Stand-Alone Paper

A Fields-Based Approach to Energy Understanding: An RCT on the Role of Self-Efficacy

Nikola Schild*, IPN, Germany

Knut Neumann*, IPN, Germany

Jeffrey Nordine*, University of Iowa, USA

ABSTRACT

The traditional “forms-based approach” to energy instruction often fails to foster a robust, systemic understanding of energy. While conceptualizing potential energy as being stored in fields offers a more coherent alternative, concerns about its high level of abstraction have limited its adoption. This study investigates the effectiveness of the fields approach and examines its interaction with student self-efficacy. In a large-scale, randomized controlled trial (N=1076), we compared a fields-based instructional unit with a traditional forms-based unit. Multilevel analysis revealed a trend favoring the fields group in overall energy understanding. Contrary to concerns, the more abstract approach did not negatively impact student self-efficacy. Most importantly, a significant negative interaction emerged: the link between high self-efficacy and learning success was significantly weaker in the fields group. These findings suggest that the conceptual coherence of the fields approach acts as an equitable scaffold, making a deep energy understanding more accessible to students with lower initial confidence and helping to close achievement gaps.

Stand-Alone Paper

Characteristics of Student Guidance in a Chemistry-based Educational Escape Room

Hagai Zeira*, Technion, Israel Institute of Technology, Israel

Shirly Avargil, Technion, Israel Institute of Technology, Israel

ABSTRACT

Escape rooms are used as educational tools across a variety of fields, offering learners a social and collaborative learning experience. Learners solve puzzles that integrate content and

skills in order to “escape” the room, while the teacher acts as a remote observer, providing guidance when needed.

Despite the popularity of educational escape rooms, there is limited research on how teachers guide students during collaborative activities. Little is known about the strategies teachers use to support group work in dynamic and collaborative learning contexts, where problem-solving and collaboration intersect. Addressing this gap is essential for enhancing educational outcomes.

This study examines the characteristics of guiding high school students in a chemistry-based educational escape room. Eight chemistry teachers participated, and every instance of verbal guidance from a full game session was segmented into “comments” and analyzed using content analysis. Two dimensions were identified: (1) enacted guidance type, based on established frameworks from the literature, and (2) guidance topic, referring to the content of the guidance.

Theoretically, the findings expand models of teacher guidance to a novel, under-explored environment and offer actionable insights into teacher facilitation strategies that foster collaboration, engagement, and learning in educational escape rooms.

Stand-Alone Paper

Cross-Country Comparison of Chemistry Teachers' Experience with Emergency Remote Teaching

Shirly Avargil*, Technion Israel Institute of Technology, Israel

Anat Shauly, anat.shauly@campus.technion.ac.il, Israel

Jenna Koenen, Technical University of Munich, Germany

ABSTRACT

Pedagogical changes often stem from global events. One such shift was Emergency Remote Teaching (ERT) during COVID-19 lockdowns, a move to remote instruction due to crisis conditions. This study compares chemistry teachers' experiences in Israel and Germany during ERT. Semi-structured interviews were conducted with 14 high school chemistry teachers, seven from each country. Analysis revealed four main themes: teachers' professional knowledge, institutional support, personal and collaborative teacher-to-teacher support, and perception of teaching after ERT.

Challenges included lack of technological knowledge, inability to conduct laboratory experiments, and emotional difficulties. They used strategies like breakout rooms, household experiments, and recorded videos. German teachers relied on individual collaboration, while Israeli teachers emphasized Subject Specific PLCs. Teachers reflected on ERT practices they plan to retain, including student-centered learning and promoting self-regulated learning.

Teachers noted that online learning benefited students and their professional development, increasing assignment variety and adding interest. Collaboration and support were also

described. While Israeli and German teachers sought similar support, differences were attributed to available options in each country.

Further exploration of PCK, PK, AK, and knowledge of students in the context of ERT is needed. By highlighting cross-national insights, we offer implications for educators and policymakers preparing for future disruptions.

AI and Technology in STEM Learning

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

19-Apr-26, 14:45-16:15

Location: Aspen (L2)

Stand-Alone Paper

Self-Directed Learning Profiles and the Influence of Technology-Based Interventions Among STEM Undergraduates

Arif Rachmatullah*, SRI International, USA

Krystal Thomas, SRI International, USA

Jessica Mislevy, SRI International, USA

ABSTRACT

As online STEM course enrollment continues to grow, challenges such as high dropout rates and reduced engagement persist, particularly among students from historically marginalized groups. Self-directed learning (SDL), encompassing motivation, metacognition, and applied learning strategies, is critical for student success in these environments. This study identifies SDL profiles among 1,516 STEM undergraduates across four broad-access institutions and examines the impact of technology-based interventions on students' likelihood of belonging to each profile over time. Using model-based clustering, we identified three distinct SDL clusters: (1) highly self-regulated learners, (2) reflective but less confident learners, and (3) lower self-reported SDL skills. Multilevel models revealed that demographic and academic characteristics-- such as race/ethnicity, enrollment status, and Pell eligibility--significantly predicted cluster membership. Over time, students in the intervention group showed greater increases in membership probability for Cluster 1, indicating the effectiveness of embedded strategies-- prompts, videos, and peer interaction activities. Cluster 3 membership declined overall but not due to the intervention, while Cluster 2 remained stable. These findings highlight the value of a person-centered approach to SDL and suggest that technology-integrated supports can promote adaptive learning behaviors and equity in online STEM learning environments.

Stand-Alone Paper

Investigating Student Perceptions of AI-Generated Feedback and Scores for Physics Argumentation Essays

Winter Allen*, Department of Physics and Astronomy, Purdue University, USA

Anand Shanker, Purdue University, USA

N. Sanjay Rebello, Department of Physics and Astronomy, Purdue University, USA

ABSTRACT

Students in introductory physics courses often rely on ineffective problem-solving strategies, focusing on final answers rather than understanding underlying principles. Integrating scientific argumentation into problem-solving fosters critical thinking and links conceptual knowledge with practical application. By facilitating learners to articulate their scientific arguments for solving problems, and by providing real-time feedback on students' strategies, we aim to enable students to develop superior problem-solving skills. However, providing timely, individualized feedback to students in large-enrollment physics courses remains a challenge. Recent advances in Artificial Intelligence (AI) offer promising solutions. This study investigates the potential of AI-generated feedback on students' written scientific arguments in an introductory calculus-based physics course. Students constructed argumentation essays for quiz problems. Using Open AI's GPT-4o, we provided delayed feedback on student written scientific arguments and surveyed them about the perceived usefulness and accuracy of this feedback. These findings suggest that LLM-generated feedback can be both feasible and well-received, offering a scalable path toward real-time, individualized feedback in large courses.

Stand-Alone Paper

Game-Based vs. Simulation-Based Instruction: exploring the sequencing effect on the understanding of the Photoelectric Effect

Razan Hamed*, Purdue University, USA

Koushiki Pohit, Purdue University, USA

Sanjay Rebello, Purdue University, USA

ABSTRACT

The use of digital tools and multiple representations like educational games and interactive simulations is of great importance to physics education. This study investigates the sequencing effect of an educational video game 'Photon Jump' and the PhET Photoelectric Effect simulation on undergraduate students' understanding of the photoelectric effect. Using a counterbalanced quasi-experimental crossover design, two cohorts (N = 86) from engineering and elementary education physics courses experienced both interventions in opposite orders. Conceptual understanding was measured across three standardized assessments, complemented by open-ended reflection questions on students' preferences and perceived learning. Both modalities significantly improved performance ($p < 0.01$), with the game-first sequence yielding larger immediate gains and the simulation-first sequence

producing slightly higher final scores. However, sequencing effects were not statistically significant ($p = 0.18$). Findings underscore the complementary strengths of game-based and simulation-based instruction, highlighting the pedagogical value of integrating diverse representational formats to scaffold conceptual learning in complex physics topics.

Museum Innovation & Transformation

Strand 6: Science Learning in Informal Contexts

19-Apr-26, 14:45-16:15

Location: Virginia (L4)

Stand-Alone Paper

A Framework for Systematic Radical Reimagining of Science Museums

Alexandria Muller, Rowan University, USA

ABSTRACT

Science museums have long been spaces for collective imagining, fostering free-choice learning and public engagement with science. Yet, their histories of exclusion and oppression have hindered marginalized communities from fully participating in these futures. Building on Garibay and Olson's (2020) framework, this study examines how science museums envision and implement diversity, equity, accessibility, and inclusion (DEAI) initiatives to create more welcoming science learning experiences. Semi-structured interviews were conducted with 31 senior leaders from science museums. Using a combination of a priori and a posteriori coding, participant definitions of DEAI, implementation efforts, and perceived challenges were analyzed.

Findings resulted in a four-part framework for DEAI work in science museums: (1) increasing representation of communities; (2) removing barriers to engagement; (3) broadening community impact through outreach and partnerships; and (4) restructuring internal systems to embed equity into organizational culture. While these approaches reflect significant progress toward inclusive practices, participants also identified persistent challenges including limited resources, leadership diversity gaps, political tensions, and the lingering sociocultural histories of museums.

This study offers both a conceptual model and tangible examples of DEAI strategies, providing guidance for museum professionals and researchers seeking to transform institutional culture and visitor experiences for richer science learning experiences.

Stand-Alone Paper

Strife as civic practice: Ideational expansion amid social conflict in a climate science exhibit

Lynne Zummo*, University of Utah, USA

Kaitlyn Kinshella, University of Utah, USA

Emma Gargroetzi, University of Texas at Austin, USA

Jordan Giron, University of Utah, USA

Benjamin Janney, University of Utah, USA

Ajla Auker, University of Utah, USA

ABSTRACT

In the US, there is widespread perception that divisiveness abounds. As a result, many people avoid social interactions that could involve conflict. However, the conflict that inevitably ensues within a pluralistic society is fundamental to democracy. Taking up this view, we investigate conflict-laden interactions in a museum exhibit about climate change. Drawing on a theoretical lens that integrates concepts of agonistic democracy with learning theory, we explore conflict within intimate social groups (families, friends, partners). Building from an earlier conceptualization of agonistic democracy in social interaction, we investigate the relationship between conflict and learning, as conceived of as ideational expansion. Analysis shows that learners draw upon a variety of knowledge, ideological, and identity resources within conflict, and how they do so affords and constrains ideational expansion. Further, we found that learners' use of certain identity resources was key to uptake of ideas that were once in conflict with their own. Ultimately, this study suggests that the types of conflict that are both foundational to democracy and conducive to learning are challenging but important to foster. We articulate implications for educational practice that centers conflict for both learning and strengthening democracy.

Stand-Alone Paper

Exploring exhibit development within university informal science learning centers

Hailey Bowers*, Pennsylvania State University, USA

Julia Plummer, Pennsylvania State University, USA

ABSTRACT

This study explores exhibit development in two informal science learning centers (ISLCs) within one large university in the NE United States. Utilizing spatial analysis and interviews with curatorial and educational staff members, our research team examined how the university context of ISLCs impacts the designed environment and learning objectives. Data for this study are drawn from two university-affiliated ISLCs: a nature-based ISLC and an earth science-based ISLC. Our team visited each ISLC multiple times over a semester, utilizing field notes and reflective memos, supplemented by photos, to document each center. The spatial analysis was supported by forty-five-minute semi-structured interviews with one lead staff member from each ISLC. In our study, we highlight the importance of intentional physical design elements and the role of the university museum staff members as two particularly influential elements shaping the discourses represented in university-affiliated ISLCs. These influences can be linked to the university's perspective, including the prioritization of sharing research and developing students. Our findings contribute to our understanding of the curatorial and educational positions within university-affiliated ISLCs,

highlighting the unique position they hold as both museum educators and student affairs professionals.

Preparing Preservice teachers for Inclusive Science Teaching

Strand 7: Pre-service Science Teacher Education

19-Apr-26, 14:45-16:15

Location: Columbia (L4)

Stand-Alone Paper

Translanguaging as a Path to Onto-Epistemic Heterogeneity: Preparing Preservice Teachers for Multilingual Science Classrooms

Leticia Garza*, University of Texas, USA

Maria Gonzalez-Howard*, University of Texas, USA

ABSTRACT

This multiple-case study explores how two science teacher educators (STEs) disrupt onto-epistemic supremacy in science education by enacting translanguaging as a decolonial tool in preservice teacher (PST) preparation. While translanguaging is often positioned as a scaffold for language access, we build on research that highlights its transformative potential for justice-oriented science education. Drawing on a decolonial framework, and specifically three sensibilities that support multiple ways of knowing (i.e., Multiplicity, Horizontality, Dialogicality), we examine how STE's expansive language orientations invite PSTs to reimagine what counts as language and knowledge in and for science. Our findings — illustrated through vignettes from the focal STEs' interview data — reveal how translanguaging can challenge dominant ideologies by centering multilingualism, unsettling Eurocentric language norms, and fostering critical reflection on the colonial underpinnings of scientific discourse. This study contributes to emerging research on how STEs cultivate PSTs' epistemic agency and highlights the importance of embedding translanguaging in science methods courses to expand ways of knowing and being. Framed as a joyful transgression, this work invites radical imagination in science teacher education and affirms the need for pedagogies that resist linguistic and epistemic erasure while building toward more inclusive, relational, and liberatory science learning environments.

Stand-Alone Paper

All Means All: Lesson Study for Inclusive Elementary Science Teaching

Bianor Valente*, Escola Superior de Educação de Lisboa, Portugal

Paulo Maurício, Escola Superior de Educação de Lisboa, Portugal

ABSTRACT

This qualitative study explores how a Lesson Study (LS) supported pre-service teachers, a mentor teacher, and two university-based teacher educators in developing more inclusive

science teaching practices during an Initial Teacher Education (ITE) practicum in Portugal. The LS cycle, conducted in a third-grade classroom on the topic of bones (structure and function), involved seven structured sessions across four phases: defining learning objectives, planning the research lesson, teaching the lesson, and engaging in reflective discussion. Data sources included session transcripts, interviews, observational notes, and lesson artefacts, analyzed through inductive content analysis. Findings show that LS fostered a shared understanding of inclusive education, shifting it from a principle to an enacted practice. For pre-service teachers, the research lesson was a pivotal learning moment, revealing the complexity of balancing intentional planning with adaptive decision-making in real classrooms. The mentor teacher valued the extended collaborative preparation, updated conceptual framing, and strategies to reach all learners. Teacher educators reported gains in operationalizing inclusive pedagogy and deepened collaboration with schools. The study highlights LS as a powerful structure to bridge theory and practice, enabling inclusive science teaching to be collaboratively planned, tested, and refined in authentic contexts.

Stand-Alone Paper

Exploring Preservice Elementary Science teachers' perception of Inclusive Instruction and Science Identity Formation.

Chike Elue*, University of Nevada, Las Vegas, USA

ABSTRACT

This study explores how Elementary preservice teachers make sense of inclusive instruction, belonging, and their own roles as science educators. Understanding how informal experiences shape preservice teachers' development is critical to improving teacher preparation and enhancing equity in science education. This qualitative study leverages thematic analysis to investigate how preservice elementary science teachers promote inclusive instruction and engage with science identity. The data for this study were drawn from 43 pre-service elementary science teachers. The course structure consisted of 6 weeks of online hybrid work (i.e., both synchronous and asynchronous). Findings revealed that preservice teachers overwhelmingly emphasized the importance of inclusive pedagogical practices that promote equity, inclusion, and fostering science belonging in teacher education. It also revealed that identity development is a crucial component of learning to teach science, particularly in inclusive and culturally responsive ways. However, many participants expressed uncertainty due to limited experience, content knowledge, or familiarity with scientific language. Future research should explore how professional development programs can be effectively designed to address the identity-related challenges preservice science teachers encounter. Furthermore, there is a need to explore strategic intervention that supports preservice science teachers to render inclusive and equitable science instruction.

Stand-Alone Paper

Elevating radical hope in how elementary preservice teachers position multilingual learners' multimodal resources for sensemaking

Samuel Lee*, California State University, Long Beach, USA

María González-Howard, University of Texas at Austin, USA

ABSTRACT

This study investigates how elementary preservice teachers (PSTs) envision teaching science with multilingual learners (MLs), focusing on their views of multimodal resources for sensemaking. Drawing from survey responses of 101 PSTs, we analyzed open-ended items in which PSTs described pedagogical possibilities and tensions in working with MLs. Through a disciplinary translinguaging lens, we coded responses for semiotic resources (i.e., linguistic and/or non-linguistic) and examined how multimodality was positioned, distinguishing between weak and strong versions (Grapin, 2019). Findings reveal most PSTs value MLs' linguistic varieties and multimodality as assets, regardless of their own language identity or certification program type. However, many frame multimodality as a transitional scaffold toward "the language of science" rather than as an inherent part of constructing scientific knowledge, reflecting persistent language hierarchies. These orientations have implications for equitable science teaching, as they can limit MLs' epistemic engagement and position science learning as language reproduction. We propose targeted teacher education experiences (i.e., student hat) to help PSTs critically reflect on and expand their understandings of language and multimodality use in science. This work contributes to reimagining science instruction that centers MLs' full semiotic repertoire, aligning with calls for joyful, transformative pedagogies.

Epistemic Positioning and Practices in Preservice Teachers

Strand 7: Pre-service Science Teacher Education

19-Apr-26, 14:45-16:15

Location: Jefferson B (L4)

Stand-Alone Paper

Exploring Epistemic Orientation to Develop Preservice Teachers' Engagement in Science Practices

Yetunde Adaramola*, Washington State University, USA

Patrick Ochieng, Washington State University, USA

Andy Cavagnetto, Washington State University, USA

ABSTRACT

Achieving the NGSS vision requires a change in the classroom power-dynamic influenced by the epistemic orientation (EO) of the teachers and, relatively, their pedagogical approaches.

This study was designed to support the development of preservice teachers' epistemic orientations and create opportunities to enact the acquired knowledge in authentic classroom practices. This study explored 10 preservice science teachers' (PSTs) epistemic orientations and their engagement in science practices during classroom instruction. The written artifacts collected during instruction were analyzed, and results show that most of the students possessed aligned EOs towards a knowledge-generative classroom advocated for in the NGSS vision. To better understand how the PSTs' EOs support engagement in science practices during instruction, videos of the PSTs' microteaching were analyzed using Chen and Terada's (2020) observation protocol, ICAP (Interactive-Constructive-Active-Passive) to Measure by Observation NGSS Science Practice Implementation in the Classroom (IONIC). This revealed that PSTs' EO influenced how they engaged in science practices. The findings also show a shift in the PSTs' EOs over the semester because PSTs engaged more in science practices at a higher level of engagement at the second microteaching (wrap up) compared to the first microteaching (Introduction). The results discussed the implications for teaching and teacher education.

Stand-Alone Paper

The Role of Prior Knowledge and Abductive Reasoning in Scientific Experimental Design among Pre-service Teachers

Naeun Lee*, Korea National University of Education, Korea, Republic of

Ilho Yang, Korea National University of Education, Korea, Republic of

ABSTRACT

This study explores how prior knowledge influences the cognitive processes of pre-service primary teachers during experimental design in the life sciences. The twenty-three participants (6 male, 17 female) each completed two contrasting tasks: one for which they had abundant prior knowledge, and another for which their knowledge was limited. Data from written design outputs and post-task interviews were analysed qualitatively. The findings indicate that the experimental design process comprised four stages: constructing the problem space, activating prior knowledge and devising methods, specifying conditions and producing outputs, and reviewing and refining the design. Abundant prior knowledge was associated with a linear, reproductive design process, whereas limited knowledge prompted a more exploratory and recursive approach. In situations of uncertainty arising from limited prior knowledge, participants actively employed abductive reasoning. This included creating an initial framework, borrowing from analogous knowledge to define conditions, and intuitively revising the design for validity. This study clarifies how prior knowledge is strategically activated in relation to task context and extends the discussion of abductive reasoning to the entire experimental design process. The findings have significant implications for developing instructional strategies and teacher education programmes designed to guide pre-service teachers in effective experimental design.

Stand-Alone Paper

Grasp the Grasp of Evidence: Science Teachers' Understanding and Use of Evidentiary Reasoning

Won Jung Kim*, Santa Clara University, USA

ABSTRACT

Grasp of Evidence (GoE) offers a five-dimensional evidentiary reasoning framework for laypeople—including teachers and students—to navigate epistemically unfriendly contexts marked by varying quality of evidentiary reports. This study documents how twelve secondary science teachers came to grasp the GoE as a conceptual, analytic, and instructional tool through collaborative workshop sessions offered in science methods courses. Using reflexive thematic analysis of data generated from the sessions, findings report teachers' conceptual sense-making of GoE and using it to examine science-related text sources of their choice. Regarding conceptual sense-making, teachers (1) began to grasp the complexity of evidence attending to the processes shaping it; (2) identified and addressed confusions across three dimensions: Evidence Analysis, Evaluation, Interpretation; and (3) recognized the potential of Lay Use of Evidence (LUE) dimension in fostering social consciousness. Regarding GoE usage, teachers selected text sources that featured epistemic unfriendliness in varying ways and tended to first use LUE and then move onto others, placing different emphasis across the dimensions. These findings were discussed in light of not only cognitive but also meta-cognitive and socially-conscious engagement with GoE. The study offers implications for GoE instructional design both in teacher and student learning settings.

Stand-Alone Paper

Epistemological Reflections on Using a Scientific Method Heuristic in a Preservice Teacher Module

Annemarie Hattingh, University of Cape Town, South Africa

Angela Stott*, University of the Free State, South Africa

ABSTRACT

This explanatory mixed-methods study examined the role of a Scientific Method Heuristic (SMH) template and checklist in supporting two cohorts of South African preservice non-specialist natural sciences teachers (n=48, n=51) to design and plan an experimental investigation, and its impact on their knowledge of the nature of science and scientific inquiry (KNOSSI). Data included pre/post Student Understanding of Science and Scientific Inquiry (SUSSI) questionnaires (n=32), a perception survey (n=38), experimental investigation designs (n=48), and interviews with purposively selected participants (n=4). Descriptive and inferential statistics and content analysis were used. Participants perceived the SMH as highly valuable for enabling rigorous investigation planning and, in some cases, creativity. SUSSI results showed significant improvement in the creativity/imagination dimension, but increased endorsement of the naïve view that scientists follow a single method. Findings are interpreted through a Knowledge in Pieces (KiP) lens, suggesting that such naïve

conceptions may be transitional states toward sophistication. The SMH appears to reduce cognitive load, enabling partial open inquiry and creative engagement while temporarily reinforcing simplified conceptions of scientific practice. The study argues that, in this context, avoidance of the Scientific Method is unnecessary, as structured heuristics can be productive resources in developing inquiry competence and KNOSSI.

The centrality of emotion in teacher learning

Strand 8: In-service Science Teacher Education

19-Apr-26, 14:45-16:15

Location: Cedar AB (L2)

Stand-Alone Paper

"That's why I remain a teacher": Emotion and professional learning of highly experienced STEM teachers

Michael Mauricio*, The University of Texas at San Antonio, USA

Jorge Solis, The University of Texas at San Antonio, USA

Kristen Lindahl, The University of Texas at San Antonio, USA

Bedrettin Yazan, The University of Texas at San Antonio, USA

ABSTRACT

Most research on on-going professional development (PD) programs in STEM contexts centers on early-career teachers with comparatively less attention to educators with extensive years of teaching experience. Studies that focus on STEM teachers with accumulated years of teaching experience are encouraged to further understand how this cluster of educators engage in professional learning. To expand on this research area, our study examines how three highly experienced secondary STEM teachers engage in instructional coaching focused on critical sociocultural pedagogical practices for teaching bilingual/multilingual learners (BMLs). Using thematic analysis grounded in (socio)cultural and linguistic perspectives, we analyzed qualitative data collected from STEM teachers' participation in a yearlong university-based PD program. Data included three cycles of instructional coaching, professional learning communities, semi-structured individual interviews, and artifacts. Findings showed that the STEM teachers (a) promoted partnerships through construction of knowledge and meaning, (b) established relationships through sharing of personal and professional experiences, and (c) built alliances through exchange of expertise to advocate for teaching reform. These findings demonstrate how (socio)culturally and linguistically-oriented PD programs nurture both content and pedagogical expertise of highly experienced STEM teachers while exploring more culturally and linguistically responsive teaching practices for their BMLs.

Stand-Alone Paper

Frustration as an Asset in STEM Learning: STEM Mentors' Reframing of Frustration into Productive Inquiry

Abiodun Babalola, University of Alabama, USA

Shannon Davidson, University of Alabama, USA

Joy Anogwih, University of Alabama, USA

ABSTRACT

Research Experiences for Teachers (RETs) offer in-service K–12 teachers' immersive opportunities to engage in authentic STEM research, with mentors playing a central role in shaping professional learning. While the cognitive and instructional dimensions of mentorship have been well documented, the emotional labor of mentoring, particularly the experience of frustration remains underexamined. This qualitative study investigates how STEM research mentors experience, conceptualize, and respond to frustration when mentoring in-service teachers during RET programs. Framed by Situated Learning Theory and grounded in constructivist epistemology, we conducted semi-structured interviews with five faculty mentors from diverse STEM laboratories and analyzed data using inductive thematic analysis. Findings reveal that frustration arises from institutional constraints, disciplinary complexity, and relational tensions, yet is frequently reinterpreted by mentors as a necessary and even productive component for teacher learning. Professional support, adaptive tools, and justice-oriented mentoring philosophies were pivotal to transform frustration to productivity for the teachers. This study contributes to science education by theorizing frustration as a legitimate component of the mentoring process, offering implications for the design of more supportive, reflective, and emotionally sustainable professional development.

Stand-Alone Paper

Felt Transgressions and Material Joy: Teacher Learning in Electronic Textiles Professional Development

Joanna Goode*, University of Oregon, USA

Casey Tiemann, University of Oregon, USA

Adrienne Pinsoneault, University of Oregon, USA

ABSTRACT

Persistent inequities in STEM engagement demand more than critique; they require radical reimagining of learning experiences. As interdisciplinary STEM learning expands into K-12 contexts, professional development often reinforces technocratic approaches that separate technical knowledge from relational learning, positioning teachers as recipients rather than co-constructors. Electronic textiles (e-textiles) offer a compelling alternative through “soft” materials that fuse artistic expression with scientific inquiry, creating learning experiences that transgress conventional boundaries. This ethnographic study investigates how e-textiles professional development creates “felt transgressions,” moments where joy emerges through material encounters that disrupt expertise hierarchies. Grounded in feminist new

materialist theory, we examine how materials participate as active agents in constructing pedagogical realities. During a four-day residential workshop with seven high school teachers, we documented through ethnographic observations, interviews, and project analysis how conductive thread, LEDs, sensors, circuits, microcontrollers, and fabric shaped new possibilities alongside participants. Analysis reveals how the material assemblage functioned as a “joy-generating apparatus” where teachers experienced profound shifts as boundaries between design thinking, physics, and coding became permeable. One participant's exclamation “Joy! Joy! Joy! It is Joyful!” exemplified how materials fostered affirmational engagement with difference. This investigation demonstrates attention to materiality moves beyond critique, and toward affirmation, producing joyful educational futures.

Stand-Alone Paper

Emotionally Activating Science Practices: A Study of Teacher Lesson Reflections Based on Control Value Theory

Ella Yonai*, Auburn University, USA

Julie Luft, University of Georgia, USA

Brooke Whitworth, University of South Carolina, USA

ABSTRACT

Teacher and student emotions are an important lens to describe teaching and learning in science classrooms. This study examines how science teachers talk about emotions when reflecting on lessons that implemented the Next Generation Science Standards (NGSS) science and engineering practices (SEPs). Over one school year, 46 newly hired secondary science teachers completed three Zoom interviews in which they described their lessons during a week of instruction in a specific class and reflected on how those lessons went. In the first coding stage, we identified whether teachers included SEPs in their instruction and which SEPs they referenced, using NGSS documents. After coders reached agreement on SEP classifications, we used NVivo 14 to automatically identify discrete emotions in teachers' reflections, guided by Control-Value Theory (CVT). Preliminary results show emotion codes appear most frequently for SEP 1 (asking questions) and SEP 7 (argumentation), reflecting their explicit social interaction focus. Emerging themes describe teachers' activation for developing their practice in response to emotions, alongside students' emotion activating their learning. This study grounds theories of classroom emotion in the science context and provides unique insight for teachers' implementation of SEPs and students' engagement in standards-aligned activities.

Exploring instructional relevance across the assessment system: from classroom to state assessments

Strand 10: Curriculum and Assessment

19-Apr-26, 14:45-16:15

Location: Ravenna C (L3)

Related Paper Set

Alignment Study Methodology for Curriculum-Anchored Assessments

Aneesha Badrinarayan, Education First, USA

Katie Van Horne*, Concolor Research, USA

ABSTRACT

Instructionally supportive assessments are essential for strengthening teachers' science instructional practice and ensuring the effective use of high-quality instructional materials. Traditional alignment studies focus on standards alignment and technical quality, but these measures alone do not ensure that assessment results are instructionally useful. In science education, assessments and curricula may align to the same standards yet diverge in instructional approach, limiting the assessment's capacity to inform teaching.

This paper proposes and implements an alignment methodology that incorporates curriculum–assessment coherence as a formal quality dimension. The process involves identifying unique curriculum features, defining measurable alignment criteria, inventorying both curriculum and assessment using these criteria, and describing the coherence between the curriculum and assessment. We applied this method to 130 curriculum-agnostic assessment tasks and a middle school science curriculum, using 15 coherence indicators. While standards alignment was sufficient, only one of the fifteen indicators overlapped between the assessment and the curriculum, indicating low instructional coherence.

This methodology offers one of the first replicable approaches for integrating coherence analysis into large-scale quality reviews. It extends alignment work beyond technical specifications, enabling the development and evaluation of assessments that not only meet standards but also support and enhance instructional practice.

Related Paper Set

Supporting HQIM Implementation and Science Assessment Through Instructional Relevance at the State Level

Tana Luther*, Louisiana Department of Education, USA

ABSTRACT

A state science content team aimed to support High-Quality Instructional Materials (HQIM) implementation and science assessment by prioritizing instructionally relevant assessments and professional learning. Initial observations showed educators modified curriculum, often due to perceived lack of coherence between assessment and instruction. To address this, the

team gathered data through two approaches: teacher and leader feedback, and examining successful systems. Listening sessions with educators confirmed that modifications were made to ensure student success on summative assessments, but also showed a commitment to HQIM and a desire for supporting resources. An analysis of successful systems revealed common characteristics, including strong upper-level system leaders with a long-term vision for HQIM, curriculum-specific professional learning, and content-specific coaching. These findings led the team to develop logistical support for classroom assessments, integrate local relevance into HQIM, and emphasize curriculum-based assessments in professional learning. The findings highlight the need for a systemic approach to empower teachers to use assessments in instructionally supportive ways.

Related Paper Set

Designing 3D performance assessments for instructional relevance

Jill Wertheim*, WestEd, USA

Lauren Stoll, WestEd, USA

Catherine Zozakiewicz, WestEd, USA

ABSTRACT

The use of performance assessments is growing across the country, most notably in science classrooms. Since the adoption of Framework-based science standards, teachers and students need feedback that can help them work toward these complex competencies. But the capacity performance assessments have to fulfill this role is often limited by a lack of coherence between the assessments and the curriculum and instruction surrounding them. Students face cognitive challenges transferring learning to new contexts, while teachers struggle to translate assessment outcomes into actionable instructional steps. In this study, we investigate how design elements embedded into performance assessments to increase coherence with curriculum and instruction support elementary science teaching and learning. Three design elements that attend to coherence were incorporated into 19 performance assessments for grades 3-5: transfer routines connecting prior learning to new contexts; supports for eliciting diverse evidence of student thinking; and guidance for applying outcomes to future instruction. The assessments were piloted with 23 teachers and data from student and teacher feedback, focus groups, observations, and interviews offer insights into how attending to features of instructional relevance can both improve the evidence of learning elicited from students, and how this evidence is used to support ongoing teaching and learning.

Related Paper Set

Designing Curriculum-Embedded Assessment for Instructional Relevance

Amelia Gotwals, Michigan State University, USA

ABSTRACT

When curriculum-embedded 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. The [Name] assessment system was designed to meet these needs. In this study, we examine the extent of alignment between the [Name] assessment system and [Author's] (2024) design principles. Specifically, the following question guides this work: In what ways and to what extent do teachers perceive the assessment system embedded in the [Name] curriculum to be: (1) educative; (2) developmental and asset-oriented; (3) reflective of and responsive to learners; and (4) useful for informing decisions that impact instruction? We used design-based research (Penuel et al., 2011) to iteratively design, field test, and refine assessment tools in the [Name] K-5 curriculum materials. Data include the field-tested and redesigned curriculum materials and feedback from surveys and interviews from over 280 classrooms of K-5 teachers and students. Preliminary findings suggest that teachers appreciated the ways that the assessments were designed to elicit sensemaking in multiple ways. This study offers insights into how curriculum embedded assessment systems can attend to features of instructional relevance.

Related Paper Set

Designing Curriculum-Aligned Interim Assessments for Instructional Relevance at the District Level

TJ Heck, Cognia, USA

ABSTRACT

District-level interim assessments often provide limited instructional value because they prioritize discrete content coverage and deliver generic results too late to inform teaching. This paper reports on the design and implementation of curriculum-aligned interim assessments connected to OpenSciEd in ten districts, focusing on two innovations intended to increase instructional relevance: Longitudinal Growth Tasks (LGTs) and feedforward reporting. LGTs are recurring, phenomena-based tasks that appear across multiple units and grade levels, enabling the measurement of student progress along NGSS-aligned learning progressions. Feedforward reporting was conceived as an AI-supported system to generate timely, actionable recommendations for teachers, with expert review to ensure accuracy and classroom applicability.

Findings from two years of development and piloting highlight three themes. First, LGTs supported teachers in valuing student growth over time, shifting perspectives from deficits to assets. Second, teacher feedback emphasized the urgent need for more rapid, actionable reporting, reinforcing the rationale for the AI-driven pipeline. Third, alignment of assessments with OpenSciEd materials increased teacher buy-in and integration of results into instructional planning. Together, these design features illustrate how district-level assessments can be curriculum-anchored, educative, and asset-oriented, offering a scalable, equity-driven model for strengthening coherence across curriculum, instruction, and assessment.

Community Partnerships within Science Education Research: Building Trust and Reciprocity

Strand 11: Cultural, Social, and Gender Issues

19-Apr-26, 14:45-16:15

Location: Willow A (L2)

Symposium

Community Partnerships within Science Education Research: Building Trust and Reciprocity

Julie Robinson*, University of North Dakota, USA

Sarah Voss*, Western Washington University, USA

Dimitri Smirnoff*, University of Minnesota, USA

Jadda Miller*, University of California Davis, USA

Nicole Chlebek*, Florida International University, USA

Lama Jaber*, Florida State University, USA

Peresang Sukinarhimi*, National Sun Yat-sen University, Taiwan

Lin-Chien Tung¹*, National Sun Yat-sen University, Taiwan

Josie Melton, Western Washington University, USA

ABSTRACT

Research with Indigenous communities has a troubling past of extraction, tokenization, and Westernized hegemony, resulting in harmful treatment of Indigenous peoples within research contexts. Weaving multiple ways of learning and knowing into science education can increase engagement and achievement of students historically marginalized in such settings, but effective implementation of such approaches relies on developing understandings of multiple epistemologies and cultural orientations within distinct learning environments. Despite positive intentions, when non-Indigenous researchers and educators adopt language, stories, or knowledge without equal partnership with community members, the result is a hierarchy of Western perspectives and pedagogies that excludes equal input of Indigenous voices. Approaches that center community participation and Indigenous methodologies reframe the research process and outcomes from solely benefitting the external researcher to creating conditions for shared power, reciprocity, and self-determination. These approaches are built on establishing trusting relationships that honor the community's values where partnerships are taking place. Emerging research offers frameworks and principles to guide such community-based and participatory research. The purpose of this proposed symposium is to share the many ways researchers, educators, and community members collaborate through participatory research to enhance science education and integrate Western and Indigenous knowledge systems and methodologies for improved student outcomes.

Gender, interaction, and relationality among youth in STEM

Strand 11: Cultural, Social, and Gender Issues

19-Apr-26, 14:45-16:15

Location: Willow B (L2)

Stand-Alone Paper

Epistemic Tools to Encourage Epistemic Risk Taking in Middle School Science

Kathryn Bateman*, The Pennsylvania State University, Harrisburg, USA

Brandin Conrath*, Virginia Commonwealth University, USA

ABSTRACT

Creating learning environments that support students' engagement in epistemic practices requires thinking about the inherent uncertainty and epistemic risk involved in these practices. Using case study methods, this paper illustrates how four middle school students working in a group leverage a variety of epistemic tools in concert with one another to mitigate their epistemic risk and fully engage in constructing knowledge as they engage with a digital plate tectonics curriculum. These tools included curriculum resources, the teacher as a more knowledgeable other, and the classroom's participant structures. Providing students with opportunities to explore their ideas in small groups before sharing with the whole class lessened epistemic risk, scaffolding their participation in epistemic practices of science. This study is important for educators and researchers to consider when designing classroom environments, as epistemic risk can increase existing disparities in participation in science classrooms by marginalized groups. New epistemic tools will need to be carefully and intentionally designed to mitigate epistemic risk specifically.

Stand-Alone Paper

Equal Numbers, Unequal Roles: Gendered Problem-Solving in STEM Digital Games

Xinyao Cai*, The University of Hong Kong, Hong Kong

Chen Chen, The University of Hong Kong, Hong Kong

ABSTRACT

Immersive digital serious games represent a transformative opportunity for STEM education, yet empirical studies have documented the persistence of gender stereotypes. The study employed content analysis to investigate role stratification and collaborative problem-solving (CPS) behaviors across 68 characters in 12 STEM Digital Games. Principal component analysis validates three foundational dimensions—Strategic Planning, Reassess and Response, and Scientific Inquiry—while cluster analysis delineates five distinct profiles: Protocol Followers, Strategic Leaders, Passive Spectators, Feedback Integrators, and Help Seekers. The study reveals a parity paradox: despite equal STEM role counts, males dominate strategic leadership, whereas females are systematically relegated to Adaptive Integrators and supportive roles. The findings extend prior research beyond appearance-based biases, highlighting how embedded CPS mechanics reinforce gendered roles. To foster true inclusivity, game design should promote equitable distribution of leadership and innovative problem-solving opportunities, cultivating an authentic and diverse STEM future.

Stand-Alone Paper

Infrastructuring for Climate Justice in STEM-Rich Making: The Role of Critical Relationality

Angela Calabrese Barton*, University of Michigan, USA

Wisam Sedawi, University of Michigan, USA

Edna Tan, university of north carolina, USA

ABSTRACT

While STEM-Rich Making has the potential to advance justice-oriented education for minoritized youth, limited research explores how youth are supported in developing robust STEM-rich projects addressing urgent climate challenges. This study employs critical participatory design-based research to investigate how integrating infrastructuring practices into a community-based STEM-rich maker program supports youth in responding to urgent, felt challenges of climate change through their making, while also promoting sustainable communities. Grounded in the experiences of middle school youth participating in a year-long, community-centered making program housed in a local center, our findings highlight how infrastructural resources (material, relational, social/emotional, intellectual) enabled youth to engage in meaningful, climate-focused making. These resources open up new dialogues and STEM-rich practices rooted in community perspectives and lived experiences. We first identify the infrastructural resources and how they were utilized. Then, we explore how they fostered critical relationalities through community building, generating educative, solution-oriented artifacts for climate justice and reorganizing physical spaces with maker materials (e.g., indoor planters). We argue that integrating infrastructural resources into community-based STEM-rich making supports youth-led responses to climate change and advances the field's understanding of how making can drive equity-oriented outcomes.

AI-Supported Scientific Argumentation & Reasoning

Strand 12: Technology for Teaching, Learning, and Research

19-Apr-26, 14:45-16:15

Location: Ballard (L3)

Stand-Alone Paper

From Beliefs to Better Arguments: How Trust in GenAI Shapes Student Improvement in Socio-Scientific Argumentation

Chi-Jung Sui*, National Academy for Educational Research, Taiwan

ABSTRACT

This study investigates how secondary school students' epistemic beliefs about generative AI (GenAI) and their GenAI-related self-regulated learning (SRL) influence improvement in socio-scientific argumentation. Sixty-two students in northern Taiwan engaged in three

sequential energy policy argumentation tasks, fossil fuels, nuclear energy, and renewable energy, supported by a GenAI-assisted self-regulated learning platform. The platform provided content-focused scaffolding targeting missing or weak claim–evidence–reasoning components. Students completed pretests on GenAI epistemic beliefs (certainty/source, structure, justification) and GenAI-related SRL before participating in the intervention. Repeated-measures ANOVA revealed significant gains in argumentation scores from Task 1 to Task 3. Independent-samples t-tests showed that students who improved reported significantly higher certainty/source and structure beliefs than those who did not improve, while differences in justification beliefs and SRL were nonsignificant. Findings suggest that calibrated trust in the certainty and coherence of GenAI outputs may facilitate more productive feedback uptake during short revision cycles. Implications for designing AI-supported argumentation scaffolds and integrating epistemic belief development into instruction are discussed.

Stand-Alone Paper

Designing an AI Chatbot Tool to Support Scientific Argumentation

Field Watts*, Educational Testing Service, USA

Lei Liu, Educational Testing Service, USA

Teresa Ober, Educational Testing Service, USA

Yi Song, Educational Testing Service, USA

Euvelisse Jusino-Del Valle, Educational Testing Service, USA

Xiaoming Zhai, University of Georgia, USA

ABSTRACT

Scientific argumentation involves constructing, critiquing, and refining claims based on evidence and reasoning, which is essential for science education. However, effective classroom implementation remains challenging due to students' difficulties with evidence-based reasoning and teachers' limited resources. The study explores the potential of large language models (LLMs) to provide scalable, adaptive scaffolding to support argumentation in alignment with instructional goals and learning theory. Specifically we investigate how the quality of LLM chatbot responses varies across successive refinements to a system prompt. The human-in-the-loop, iterative design process involved revising the chatbot's system prompt based on evaluation of its responses to synthetic student inputs. The chatbot was designed for integration into a performance assessment task for middle school students, and the task engages students with conducting a simulation-based investigation and using data to construct scientific arguments. The chatbot evaluation focused on the relevance, clarity, engagement, and reflective thinking prompted by the chatbot's responses. The findings indicate that theory-aligned, human-in-the-loop design can enhance the pedagogical effectiveness of AI-driven supports for scientific argumentation, providing the potential for timely, context-aware scaffolding to foster metacognitive engagement.

Environmental Identities, Hazard Literacy, and Critical Discourses

Strand 14: Environmental Education and Sustainability

19-Apr-26, 14:45-16:15

Location: Issaquah AB (L3)

Stand-Alone Paper

Assessing Hazard Literacy in adults: Science Education for Disaster Risk Reduction and preparedness

Youngjin Choi*, Hazard Literacy Center, Korea, Republic of
Mikyung Sim, Hazard Literacy Center, Korea, Republic of
Jihee Lee, Hazard Literacy Center, Korea, Republic of
Hyunju Lee, Ewha Womans University, Korea, Republic of
Donghee Shin, Ewha Womans University, Korea, Republic of

ABSTRACT

Understanding hazard literacy is essential for disaster risk reduction, yet existing studies often address fragmented dimensions, overlooking the integration of cognitive, value-oriented, emotional, and behavioral competencies. This study aimed to provide a comprehensive assessment of hazard literacy in adults using a multidimensional framework covering five domains: knowledge & understanding, reasoning & skills, values & attitudes, psychology & emotions, and behavioral & practical engagement. A nationwide survey was conducted with adults, and scores were analyzed by gender, age, and disaster education experience. Results showed stronger contextual than content knowledge, with men and younger adults generally performing better; disaster education was positively associated with both. Reasoning & skills emerged as a relative weakness, with critical thinking strong but systems and spatial thinking lowest, and significant age-related declines. Values & attitudes scored highest, with women and older adults showing stronger commitments. In psychology & emotions, resilience was strongest, while regulation of anxiety and hazard response efficacy varied by gender and age; disaster education enhanced all three subdomains. Behavioral & practical engagement was high particularly among those with disaster education. These variations across gender, age, and educational experience indicate that hazard literacy is a socially embedded, integrative competence shaped by individual characteristics, underscoring the need for tailored educational strategies.

Stand-Alone Paper

Latent profiles of Korean adults' hazard literacy: Using the Hazard Literacy Competency Test (HLCT)

Jihee Lee*, Ewha Womans University, Korea, Republic of
Mikyung Sim, Ewha Womans University, Korea, Republic of
Youngjin Choi, Ewha Womans University, Korea, Republic of
Donghee Shin, Ewha Womans University, Korea, Republic of
Su-Young Kim, Ewha Womans University, Korea, Republic of

ABSTRACT

With accelerating climate change, more frequent wildfires, earthquakes, torrential downpours, and extreme heat have heightened societal exposure to natural and human-induced hazards. Cultivating hazard literacy has become a critical priority. Latent profile analysis (LPA) has been used in disaster and risk perception studies to examine patterns of risk perception and emotional responses during the COVID-19 pandemic and post-disaster growth trajectories (Johnson et al., 2023; Amiri et al., 2022). However, few studies have applied LPA to multidimensional, performance-based assessments of hazard literacy. This study aimed to identify latent profiles of hazard literacy among adults. The Hazard Literacy Competency Test (HLCT), a performance-based instrument measuring five domains of the Hazard Literacy Framework—Knowledge and Understanding, Reasoning and Skills, Values and Attitudes, Psychological aspects, and Behavioral and Practical Engagement—was administered to 1,000 Korean adults. LPA identified five profiles: Holistic Competence Type, Knowledge–Reasoning Type, Values–to–Action Type, Knowledge–Reasoning Limited Type, and Values–to–Action Limited Type. Demographic variables, including age, marital status, religion, and disaster education, significantly predicted profile membership, showing that hazard literacy patterns vary by sociocultural backgrounds. Findings highlight the need for tailored disaster and crisis education addressing specific characteristics and vulnerabilities.

Stand-Alone Paper

Determinants of Lower Environmental Identity among Asian Communities in Hawai'i

Jhuchun yang*, Institute of Education, National Cheng Kung University, Taiwan
Paichi Pat Shein, Institute of Education, Taiwan

ABSTRACT

Many islands face urgent climate threats, with Hawai'i among the most vulnerable. Asian communities—the state's largest ethnic group—offer diverse migration histories, cultural values, and place relationships, providing a lens on how culture shapes climate attitudes. This study examines how place attachment among Asian residents influences environmental identity, and whether relationships differ across subgroups. A survey of 262 residents measured environmental identity and background variables. One-way ANOVA and post hoc tests showed Asians ($n = 93$; $M = 5.64$) scored lower than white ($M = 6.15$; $p < .001$), multiracial non-NH/PI ($M = 6.14$; $p = .028$), and Black/other ($M = 6.37$; $p = .033$). Historical immigration, economic land ties, and limited outdoor experiences may constrain Asian environmental identity, suggesting culturally grounded, place-based strategies to strengthen climate education, engagement, and resilience.

Stand-Alone Paper

Intellectual Virtues for the Capitalocene: A Critical Discourse Analysis of a Science Unit

Ajay Sharma*, University of Georgia, USA
Irem Balta, University of Georgia, USA

ABSTRACT

This study presents a critical discourse analysis of intellectual virtues as discursively embedded in 8th-grade science unit plans sanctioned by a southeastern U.S. state. Grounded in virtue epistemology—specifically a responsibilist perspective, we view intellectual virtues as deep, cultivable traits essential for excellent thinking. While Western traditions emphasize virtues like open-mindedness and intellectual humility, feminist, posthumanist, and decolonial scholarship foreground dispositions such as relationality, response-ability, pluriversal thinking, and epistemic disobedience—traits vital for a socioecologically just world in the Capitalocene. Our critical discourse analysis, informed by systemic functional linguistics, examines how virtues are constructed in curricular resources and what epistemic values and ideologies shape them. Preliminary findings indicate a privileging of virtues aligned with procedural rigor, technocratic optimization, and disciplinary compliance, while relational, critical, and ecological virtues are largely absent. Students are positioned as autonomous problem-solvers, efficient technological optimizers, and compliant participants in a narrow, anthropocentric vision of science learning. We argue that cultivating virtues highlighted in feminist, posthumanist, and decolonial perspectives is essential for preparing students to address the socioecological crises of our time, and that current curricular framings risk foreclosing such transformative possibilities.

Joyful transgressions and radical imaginations with and for Asian and Pacific Islanders through Science Teaching and Learning

19-Apr-26, 14:45-16:15

Location: Redwood AB (L2)

Administrative Session

Organizers

Rishi Krishnamoorthy¹, University of Toronto, Toronto, Canada

Edna Tan, University of North Carolina at Greensboro, Greensboro, NC, USA

Contributors

Soo-Yean Shim, Seoul National University, Korea, Republic of

Hye-eun Chu, Macquarie University, Sydney, NSW, Australia

Sarah Hajama, Macquarie University, Sydney, NSW, Australia

Johan Tabora, Northwestern University, Evanston, Illinois, USA

Jessica Chen, Stony Brook University, USA

Felicia Leammukda, St. Cloud State University, Minnesota, USA

Sarah Fankhauser, Oxford College of Emory University, Oxford, Georgia, USA

ABSTRACT

The API RIG offers a special RIG-sponsored symposium at the 2026 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, the seven poster presentations build on the 2026 NARST theme by sharing critical insights and curiosities into joyful methodologies and investigations, through exploring relationship-building and care with teachers, youth and communities in relation to science teaching and learning across contexts. The posters include researchers from Korea, Australia and the United States. Across these studies, various Asian American stakeholder perspectives will be shared, including teachers, students, student researchers and teacher educators. Dialogue across these studies focus on: 1) Where, how and when do we locate joyful instantiations with and for Asian American stakeholders in science teaching, learning and research? 2) What are some support structures that we might identify to support and sustain such joyful instantiations?

Making Science Visible: Connecting Hands-On Projects with Minds-On, Meaning-Oriented Learning

Strand 2: Science Learning: Contexts, Characteristics and Interactions

19-Apr-26, 16:30-18:00

Location: Jefferson A (L4)

Stand-Alone Paper

The Impact of STEM-PBL on Secondary School Students' Scientific Literacy

Chuan Li, Hebei Normal University, China

Qianqian Gao*, Hebei Normal University, China

Jinghua Liu, Hebei Normal University, China

ABSTRACT

Project-based learning (PBL) is recognized as a significant approach for cultivating scientific literacy among secondary school students in STEM (Science, Technology, Engineering, and Mathematics) subjects. To comprehensively examine the impact of STEM-PBL on secondary school students' scientific literacy, a systematic analysis was conducted using the meta-analysis method on 109 experimental or quasi-experimental studies from Chinese master's theses. The results showed that STEM project-based learning has a moderately large, positive and statistically significant influence on the cultivation of middle school students' scientific literacy. There are significant differences in the impact on scientific thinking among different groups. The effect size is the largest in the high school stage, information technology subject, small-scale classes, and with an experimental period of "2 to 4 months". In the practice of STEM-PBL for promoting the cultivation of middle school students' scientific literacy, attention can be focused on the cultivation of scientific thinking at the target level, strengthening information technology empowerment at the method level, emphasizing

group collaboration and embodied participation at the implementation level, and ensuring efficient use of time through task-driven methods at the management level.

Stand-Alone Paper

Science Fair and Self-Determination: The Case of One Biracial 4th Grade Girl

Scarlett Calvin*, University of Texas, USA

Emma Gargroetzi, University of Texas, USA

Leticia Garza, University of Texas, USA

ABSTRACT

Drawing on critical transdisciplinary theory (Takeuchi et al., 2020) and sociocultural learning theory (Wenger, 1998), this case study examines how a fourth-grade biracial girl resists competitive and inequitable science fair traditions and positions herself as a powerful member of STEM sharing communities. The analysis explores how she engages in and extends acts of self-determination (Davis et al., 2020) while navigating normalized science fair spaces over the course of two months. Centering one elementary student's science fair journey, this study contributes to research on STEM education for early elementary students by illuminating the role science fairs play in cultivating—or diminishing—STEM identities for young girls of color, particularly within the broader context of sociopolitical disparities in STEM participation across school and work-based settings.

Stand-Alone Paper

Integrating Hands-On, Open, and Meaning-Oriented Science to Foster Equitable Engagement in K–12 Classrooms

Olayinka Oyewole*, Florida State University, USA

Kolawole Kushimo*, University of Massachusetts Dartmouth, USA

Peter Idowu, Florida State University, USA

Oluwatosin Akande, University of Ibadan, Nigeria

ABSTRACT

This critical literature synthesis addresses the persistent challenge of fostering authentic engagement in K–12 science classrooms, where participation in genuine scientific practices remains uneven. Guided by socio-constructivist theory, the review integrates research on five intersecting domains: hands-on science, open science, student engagement, romantic understanding, and narrative thinking. Evidence highlights that hands-on inquiry promotes cognitive, affective, and behavioral gains by situating learning in authentic, tangible contexts. Open science emerges as a promising but underutilized avenue for democratizing access to data, tools, and collaboration, enabling students to view themselves as legitimate contributors to science. Romantic understanding and narrative thinking offer complementary strategies to connect scientific ideas to students' lived experiences, fostering emotional investment and persistence. The synthesis also identifies systemic barriers—including definitional ambiguity of “engagement,” limited teacher preparation, and assessment pressures—that constrain these practices. Findings are organized into five extended themes, forming a conceptual framework for designing equitable, high-

engagement science instruction that integrates cognitive, affective, and sociocultural dimensions. This work-in-progress will inform an empirical phase testing integrated pedagogical models in diverse classroom contexts, with implications for curriculum design, teacher professional development, and policy aimed at advancing equity, agency, and sustained participation in science.

Advancing Instructional Approaches in Elementary Science Education

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

19-Apr-26, 16:30-18:00

Location: Seneca (L4)

Stand-Alone Paper

Effect of 5E Learning Model Integrated With 5R on Elementary Students' Scientific Language Development

Firuze Öztaş*, Hacettepe University, Turkey

Sevgi KINGIR, Hacettepe University, Turkey

ABSTRACT

This study investigated the effects of 5E learning model integrated with 5R on the scientific language development of fourth-grade students. Using a mixed-method explanatory sequential design, the quantitative phase employed a quasi-experimental pretest-posttest control group design, while the qualitative phase involved analyzing student research reports and journals, with a particular focus on hybrid language use. The study lasted 13 weeks and involved 62 students from two different classes at a public primary school. The experimental group was taught the “Properties of Matter” and “Simple Electric Circuits” units through the 5E learning model integrated with 5R, while the control group was taught the same units using only the 5E learning model. Quantitative data from a Science Achievement Test were analyzed using an independent samples t-test, and qualitative data were examined through content analysis. Results showed that the 5E learning model integrated with 5R was more effective than the 5E learning model alone in improving both science achievement and hybrid scientific language development. Students in the experimental group expanded their science vocabulary and began to adopt an interdisciplinary perspective in understanding scientific concepts.

Stand-Alone Paper

Adaptation of the Coding Readiness Assessment for Early Childhood Children into Turkish

Nazlı ÜLKER HANÇER, Yıldız Technical University, Turkey

Mustafa TOPÇU*, Yıldız Technical University, Turkey

ABSTRACT

This study aims to adapt the coding readiness assessment developed by Relkin et al. (2025) to Turkish in order to determine the coding readiness of early childhood children. To this end, a quantitative research design was used in the study to validate the Turkish adaptation of the coding readiness assessment. The study group consists of 21 early childhood children. As a result of the analyses conducted in the study, the average item difficulty index of the coding readiness assessment adapted into Turkish was calculated as 0.64, the average item discrimination index as 0.39, and the internal consistency coefficient as $\alpha = 0.71$. Considering the current results, it is seen that the measurement tool adapted to Turkish in the study is valid and reliable in terms of assessing the readiness for coding of early childhood children and is sufficient in terms of measuring the basic coding skills of children. Another finding from the study is that the average coding readiness skill scores of the early childhood children included in the study were ($\bar{X}=13.43$).

Stand-Alone Paper

Analyzing NGSS-Aligned Science Instruction for Multilingual Learners: A Discourse Analysis Using ELPD and WIDA Frameworks

Dan Jin*, University of Georgia, USA

Emily Adah Miller, University of Georgia, USA

Ruth Harman, University of Georgia, USA

Hong H. Tran, Purdue University, USA

ABSTRACT

This study examines how an elementary science teacher enacts NGSS-aligned, phenomenon-based lessons to support multilingual learners' (MLLs) engagement in both productive and receptive language domains. Drawing on sociocultural theory and multimodality theory, it applies the English Language Proficiency Development (ELPD) framework and WIDA 2020 framework as integrated analytical tools to explore how language development and disciplinary understanding can be fostered simultaneously.

Conducted in a southeastern U.S. public school where 40% of students were MLLs, the study analyzed five lessons from a climate change hazards unit. Multimodal video records captured teacher-student interactions, modeling, and use of visual and physical materials. Four extended question sequences were transcribed and coded for NGSS practices, language domains, functions, and features.

Findings show that the teacher used multimodal supports—oral narration, visuals, gestures, written prompts, and real objects—along with strategic questioning and varied interaction formats to create multiple entry points into scientific reasoning. These practices aligned language-rich engagement with disciplinary goals.

The study offers implications for teacher preparation, curriculum design, and policy efforts that seek to advance equitable and inclusive science instruction, supporting NARST's mission to promote science literacy for all learners.

Stand-Alone Paper

Developmental Potential of Self-Generated Analogy-Based Modeling in PMM

CHEN CHEN*, Department of Science Education, National Taipei University of Education, Taiwan

Jing Lin, Department of Science Education, National Taipei University of Education, Taiwan

ABSTRACT

The particle model of matter (PMM) is a threshold concept in science education, yet difficult for upper elementary students due to its abstract and unobservable nature. Self-generated analogy-based modeling can bridge macroscopic experiences and microscopic representations, revealing learners' conceptual resources. This study involved 136 sixth graders completing paper-based modeling tasks on phase change and thermal expansion. Responses were coded for four key features—particle ontology, motion, energy source, and inter-particle forces—achieving high inter-rater reliability (Cohen's Kappa = 0.965). Eight analogy types were identified; Group Behavior and Individual Behavior were developmentally promising, Material Change, Food, and Emotional States had limited potential, while Weather Phenomena and Life Cycle were non-viable. Findings offer a framework for diagnosing and guiding the transformation of students' everyday analogies into coherent particle models, and inform the design of AI tools for real-time identification and scaffolding of analogy-based modeling in science classrooms.

Bringing NGSS to Life: Standards-Based and Place-Based Science Learning

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

19-Apr-26, 16:30-18:00

Location: Juniper (L2)

Stand-Alone Paper

Bridging Standards and Place: Place-Based PBL in Rural STEM Classrooms

Courtney Bernal*, University of South Carolina, USA

Christine Lotter*, University of South Carolina, USA

DeNae Kizys*, University of South Carolina, USA

Dodie Limberg, University of South Carolina, USA

Byndle Bottoms, University of South Carolina, USA

Joe Howell, University of South Carolina, USA

Brittany Sandonato, University of South Carolina, USA

ABSTRACT

Educators are often expected to meet the demands of standardized curricula while lacking access to high-quality science, technology, engineering, and mathematics professional

development (PD), especially in rural areas. A southeastern university partnered with rural middle schools to implement a year-long PD program for science and math teachers to foster collaboration and refine teachers' ability to practice place-based education (PBE) in project-based learning (PBL). Authentic gold standard elements and 6 A's framework provided the lens through which we examined how educators designed PBL units that embodied local relevance, drew on community assets, and engaged students in meaningful, place-connected inquiry. This mixed-methods study, using an explanatory multiple case study approach, examined five teams of educators across the implementation of two PBE-infused PBL units. Two research questions guided the study: 1) Looking at changes across two implemented PBL units, how were PBL design elements integrated into the team's units over the first year of a PD program? 2) Looking across five school teams' PBL unit implementations, what significant differences, if any, were found across students' perceptions of their teacher's frequency of implementation of PBL and PBE elements? Data included observation videos, teacher reflection journals, post-implementation educator interviews, and student surveys.

Stand-Alone Paper

From Field to Framework: Discovering NGSS Elements in Nature Journals

Jessica Farquhar*, Oklahoma State University, USA

Stephanie Hathcock*, Oklahoma State University, USA

ABSTRACT

Nature journaling is an interdisciplinary pedagogical tool that is positioned between a diary and more formal scientific data entries (Canfield, 2011; Laws & Lygren, 2020). It is a space where students are combining art, writing, and science (Laws & Lygren, 2020). There is no published evidence that students are meeting the standards' targets with their nature journaling output. This study investigated this gap in the nature journaling literature. We found many instances of NGSS SEP and CCC, indicating that both teachers and students extensively use NGSS SEPs and CCCs as they complete nature journal entries with words, pictures, and numbers. Through scientific practices and application of cross-cutting ideas, nature journaling can engage the learner in authentic and deliberate attempts to figure out how the natural world works.

Stand-Alone Paper

A Longitudinal Case Study on Writing-to-learn Strategies in Inquiry-based Middle School Science Classrooms

Raju Ahmmed*, Department of Curriculum & Instruction, University of Houston, USA

Jie Zhang, Department of Curriculum & Instruction, University of Houston, USA

Sissy Wong, Department of Curriculum & Instruction, University of Houston, USA

Laveria Hutchison, Department of Curriculum & Instruction, University of Houston, USA

Samuel Katende, Department of Curriculum & Instruction, University of Houston, USA

ABSTRACT

We examined how middle school science teachers integrated writing-to-learn (WTL) strategies into inquiry-based instruction. Guided by multimodal second language writing, multimodal interaction analysis, and disciplinary literacy frameworks, we analyzed classroom videos from three teachers who participated in an intensive three-year PD across three phases: baseline (Fall 2022), Year 2 (Fall 2023), and Year 3 (Spring 2025). We found teachers' progression from lower-order writing tasks (e.g., worksheets, fill-in-the-blanks) to more reflective, collaborative, multimodal, and evaluative writing. Our participant teachers increasingly used higher-order writing strategies such as Claim-Evidence-Reasoning writing, scenario-based analysis, and peer feedback to foster disciplinary reasoning and support emergent bilinguals. This shift reflects the positive impact of professional development through intensive coursework and lesson planning, implementation, and reflection cycles. The study contributes to the understanding of ways to support science teachers to embed WTL in inquiry-based science instruction.

Reflective and Real-World Learning in STEM

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

19-Apr-26, 16:30-18:00

Location: Aspen (L2)

Stand-Alone Paper

Knowing About to Knowing Through: First-Generation College Students' Epistemic Agency in a Field Science Camp

Priyanka Parekh*, Northern Arizona University, USA

Ron Gray*, Northern Arizona University, USA

ABSTRACT

This paper examines how a practice-based, undergraduate field science camp promotes epistemic agency (EA), the ability to author, justify, and own knowledge construction, among first-generation college students (FGCS). We used a qualitative case study approach, drawing on a month-long, hands-on research and interdisciplinary, place-based field science camp for undergraduate students at a Minority-Serving Institution in the American Southwest. Our data included detailed field notes from observations and semi-structured interviews with 16 of the 23 participants. We employed thematic analysis to explore how students engaged in their research projects. Our findings show that the field camp provided a unique environment for FGCS to enact EA, particularly through asking authentic questions, shaping inquiry through iterative problem-solving and refining methods, choosing representations to make thinking visible and communicate knowledge, and choosing sensemaking partners. The camp's design supported this by centering diverse ways of knowing and disrupting traditional hierarchies of knowledge. We conclude that the field camp enabled a transformative shift for FGCS, moving them from "knowing about" science to "knowing

through" science as a participatory practice, thereby fostering a form of belonging that was not only social but also epistemic.

Stand-Alone Paper

Exploring Joyful Transgressions in STEM: Thematic Analysis of Student Notebooks from a University Sensemaking Course

Thomas McKenna*, Boston University, USA

ABSTRACT

This qualitative study examines how undergraduate students engaged in equity-oriented sensemaking through analysis of notebook artifacts from a university-level Sensemaking in STEM course. While the NGSS position sensemaking as fundamental to three-dimensional learning, research on how students from diverse backgrounds actually engage in these practices remains limited, particularly regarding connections between scientific inquiry and social justice.

Using Braun and Clarke's reflexive thematic analysis, we analyzed notebooks from four undergraduate students, employing rightful presence, funds of knowledge, and equity-oriented sensemaking as theoretical frameworks. Four interconnected themes emerged demonstrating "joyful transgressions" in STEM education: (1) claiming epistemic space through wonder, (2) sensemaking as justice-oriented practice, (3) transgressing disciplinary boundaries with methodological creativity, and (4) evolving identity as knowledge producers.

Findings reveal how students maintained scientific rigor while transgressing traditional boundaries between personal and academic knowledge, individual and collective learning, and scientific inquiry and social justice advocacy. Students positioned their lived experiences as legitimate scientific data, explicitly connected inquiry to systemic critique, developed innovative cross-disciplinary methodologies, and transformed from knowledge consumers to active producers with epistemic agency.

This study contributes evidence that equity-oriented approaches enhance rather than compromise scientific rigor, offering concrete examples of how STEM learning environments can foster disciplinary sensemaking.

Stand-Alone Paper

Embedding Citizen Science in an Undergraduate Marine Science Class to Address Climate Change/Biodiversity Issues

Muhammad Ijaz*, University of Massachusetts, USA

Stephen Witzig, University of Massachusetts, USA

ABSTRACT

Climate change and biodiversity loss threaten marine ecosystems worldwide, necessitating innovative approaches in marine science education. This study explores how embedding a

citizen/crowd-sourced science (CS) project within an undergraduate marine science course engages students and instructors in addressing these environmental issues. Guided by a pragmatic worldview (Kitcher, 2011) and the Socioscientific Issues (SSI) instructional framework, the research focuses on the integration of NASA's NeMO-Net citizen science application, which engages students in classifying coral species and monitoring reef health. Using a qualitative single-case study design, data were collected through interviews, classroom observations, student artifacts, and instructional documents, and analyzed through iterative deductive and inductive coding. Findings reveal that student participation contributed meaningful data to ongoing biodiversity monitoring, supported understanding of climate-driven ecological changes. Importantly, instructional intentionality, course design, and technology integration were critical for enabling effective engagement. While the project did not directly solve environmental issues, it facilitated actionable contributions to scientific databases and heightened student awareness of climate and biodiversity issues. This research provides insights into how citizen/crowd-sourced science can be integrated into higher education to promote informed decision-making, problem-solving, and action-oriented engagement with complex environmental issues.

STEM Motivation, Pathways & Participation

Strand 6: Science Learning in Informal Contexts

19-Apr-26, 16:30-18:00

Location: Virginia (L4)

Stand-Alone Paper

Motivations of Students from Economically Disadvantaged Backgrounds to Complete a Seven-Month Science Internship

Pei-Ling Hsu*, University of Texas at El Paso, USA

ABSTRACT

Science internships provide students with meaningful, hands-on inquiry experiences in real-world contexts, which can significantly enhance their scientific understanding and stimulate greater interest in science. However, students from economically disadvantaged backgrounds may face considerable obstacles in fully engaging with and completing these internships, even when given the opportunity. These challenges may include ongoing financial pressures, limited academic or family support, and competing responsibilities such as work or caregiving during weekends and summer months. Guided by self-determination theory, this study analyzes student interviews and identifies seven core reasons, both intrinsic and extrinsic, that motivated them to complete a seven-month internship. Gaining insight into these motivational factors helps illuminate students' decision-making processes and highlights important considerations for better supporting those from low-income backgrounds. Suggestions for future research building on these findings are also discussed.

Stand-Alone Paper

Building Big Things for Community: Youth infrastructuring present desires into sustainable futures.

Edna Tan*, University of North Carolina at Greensboro, USA

Angela Calabrese Barton, University of Michigan, USA

Ti'Era Worsley, Northern Virginia Community College, USA

Wisam Sedawi, University of Michigan, USA

ABSTRACT

This qualitative study examines what becomes possible when minoritized youth build large-scale projects with and for their communities, through engagement in informal STEM-rich making programs, to seed and sustain desired activities. We operationalize “big things for community” as youth-created objects that: 1) youth ascertained their community needs in order to flourish; 2) requires mandatory team work in a sustained building process across months; 3) are physically and socially larger in scale than personal projects, taking the form of communal artifacts situated in shared public spaces; and, 4) manifests and sustains new socio-spatial interactions anchored in the built object.

Research questions include: 1) What are the affordances of community-based big-scale making for youth and their community a) during the making process; and b) in the new socio-spatial relationalities that unfold because of the newly built community object? 2) How do building big things for community support youth's desires for tangibly manifesting new activities with potential, built-in sustainability?

Drawing from theories in material culture, Rightful Presence and futuring, we unpack two case studies where youth built a functioning stage and a little big free STEM library with and for their communities with regards to new socio-spatial relationalities rooted in collective STEM-rich making.

Stand-Alone Paper

Transforming STEM Research Access for Third-Year and Transfer Undergraduate Students

Karina Canaba*, The University of Texas at El Paso, USA

Angelica Monarrez*, The University of Texas at El Paso, USA

Jose Banuelos, The University of Texas at El Paso, USA

ABSTRACT

In this session, we will share lessons learned from 3 years of a program aimed at accelerating degrees in science, technology, engineering, and mathematics (STEM) disciplines for transfer and third-year students at a large research Hispanic Serving Institution (HSI) located on the U.S.-Mexico border. This program has been providing monetary scholarships to students with the goal of engaging talented yet financially disadvantaged students in rigorous programming and inclusive mentorship experiences designed to promote their completion

of a STEM bachelor's degree and post-graduation involvement in research. In addition to financial assistance, the program also offered research-intensive opportunities, leadership and community engagement experiences, networking events, academic/career workshops, supplemental instruction, and social events. These activities were geared towards highlighting students' various forms of capital (i.e., social, cultural, familial) as well as enhancing research socialization, sense of belonging, research self-efficacy, and research skills, among others. Descriptive survey data from participants demonstrate measurable gains in these research-related areas. Participants also rated their mentors, program staff, and the activities very highly. Qualitative feedback reflects an appreciation for the opportunity to conduct research because of economic support and beyond the monetary aspect, such as having opportunities to network with faculty and peers and build their resumes.

Stand-Alone Paper

Place-Sustaining STEM Learning, Situated Expectancy-Value Beliefs, and Career Interests

Cuan Saw*, Claremont Graduate University, USA

Kimberly Megyesi-Brem, Claremont Graduate University, USA

Ryan Culbertson, Texas Tech University, USA

Jesus Gonzalez, The University of Texas Rio Grande Valley, USA

Eleazar Marquez, The University of Texas Rio Grande Valley, USA

ABSTRACT

This study examines how place-sustaining STEM learning associates with career interest in STEM and environmental fields among underrepresented minoritized (URM) adolescents, drawing on situated expectancy-value theory (SEVT). While prior research on place-based education links locally grounded STEM instruction to increased student engagement and career interest, little is known about the outcomes of place-sustaining education—an emerging framework that moves beyond learning about place to actively sustaining its cultural, ecological, and economic vitality. Analyzing longitudinal survey data from 361 URM middle and high school students participating in a five-week environmental STEM summer program in the U.S. South, our structural equation modeling results indicate that place-sustaining STEM learning significantly positively associated with career interest in both STEM and environmental fields. Mediation analyses reveal that STEM intrinsic and attainment values partially explained these relationships, with intrinsic value emerging as the stronger mediator. Findings suggest that place-sustaining STEM education may foster career interest in STEM and environmental fields by connecting STEM learning with sustainability of local communities and environments. This study contributes new empirical evidence at the intersection of informal STEM education, place-sustaining education, and motivation science, offering implications for curriculum design, teacher preparation, and community-based STEM initiatives.

Developing Preservice Teachers' STEM Teaching Competence

Strand 7: Pre-service Science Teacher Education

19-Apr-26, 16:30-18:00

Location: Columbia (L4)

Stand-Alone Paper

Developing Integrated STEM Teaching Self-Efficacy: Insights from U.S. and Australian Preservice Teachers

Deepika Menon*, University of Nebraska-Lincoln, USA

Sarika Kewalramani, Swinburne University of Technology, Australia

ABSTRACT

This multi-institutional case study aims to investigate preservice elementary teachers' integrated science, technology, engineering, and mathematics (iSTEM) teaching self-efficacy during their participation in science methods courses at two research contexts, one at a large Midwestern public university and another at a large public university in Australia. The United States and Australia are recognized leaders in advancing K-12 STEM education and acknowledge the critical role elementary teachers play in providing foundational STEM instruction. The following questions guided the research: (1) How and in what ways do sources of self-efficacy influence preservice elementary teachers' self-efficacy for future iSTEM teaching? (2) What course-related factors contribute to the sources of self-efficacy within the preservice science methods course in the United States and the Australian context? Data sources include written reflections on microteaching and field experiences of iSTEM implementation, researchers' field notes, lesson plans, and course artifacts. Thematic analysis revealed three major sources of self-efficacy: mastery experiences, vicarious experiences, and physiological and affective states as major contributors toward preservice elementary teachers' increased understanding and confidence in iSTEM teaching. These findings underscore the importance of strategically designed iSTEM coursework to foster iSTEM teaching self-efficacy. Implications for STEM teacher preparation programs and future research are discussed.

Stand-Alone Paper

Do Group Interaction and Engagement in STEM Activities Influence Pre-service Teachers' Acquisition STEM Teaching Competence

Hsiao-Lin Tuan*, National Changhua University of Education, Taiwan

Chi-Chin Chin, National Taichung University of Education, Taiwan

Chien-Ying Chou, National Changhua University of Education, Taiwan

Hui-Yi Peng, National Changhua University of Education, Taiwan

ABSTRACT

This study examined the influence of group interaction and engagement on high school pre-service teachers' [PSTs] acquisition of STEM teaching competence. Participants were 200 PSTs who completed the Perception of STEM Teaching Competence [PT-STEM-TC] scale at

the beginning and end of an 18-week STEM teaching methods course. The course included an introduction to STEM and lesson planning, instructor-modeled STEM teaching through two STEM activities, and the design of a STEM lesson plan as a final project. PSTs worked in groups of three to four members throughout the course and completed group interaction and engagement questionnaires after the two activities. Reflection assignments were also collected. Data were analyzed using paired t-tests, correlation analyses, and qualitative coding. Results indicated that group interaction was significantly correlated with cognitive, emotional, behavioral, and social engagement, and was also significantly associated with gains in STEM teaching preparation and expectations of STEM teaching outcomes. In addition, cognitive and behavioral engagement were both significantly correlated with gains in STEM curriculum design scores. Social engagement was significantly correlated with gains in expectation of STEM teaching outcome scores. Qualitative findings revealed that PSTs benefited from collaborative group work and were positively influenced by the instructor's modeling of STEM teaching.

Stand-Alone Paper

Early Childhood Preservice Opportunities to Learn to Teach Science and Engineering During Field Placement Experiences

Rosa Mykyta-Chomsky*, University of Delaware, USA

Jennifer Gallo-Fox, University of Delaware, USA

Maisha Mouli, University of Delaware, USA

ABSTRACT

The current study is a mixed-methods concurrent triangulation strategy design study of early childhood education majors (known in this paper as teacher candidates; TCs) experiences engaging with and learning to teach science and engineering during early and student teaching field placements, focused on undergraduate experiences within an early childhood program in the mid-Atlantic United States. This two-year study uses undergraduate surveys and interviews about their opportunities to teach science during their sophomore- through senior-year field placements.

From Identity to Instruction: Examining Preservice Teachers' Growth in Science Teaching

Strand 7: Pre-service Science Teacher Education

19-Apr-26, 16:30-18:00

Location: Jefferson B (L4)

Stand-Alone Paper

Beyond the Hook: Research on Elementary Teacher Candidates' Use of Children's Literature in Science Instruction

Alexis Markavage*, Indiana University, USA

John Mensah*, Indiana University, USA

Meredith Park Rogers, Indiana University, USA

ABSTRACT

This action research study examines how elementary teacher candidates integrate children's literature into science instruction and how modeling in a science methods course influences their instructional choices. Conducted in a Spring 2025 course at a large Midwestern university, the study involved eight consenting TCs in three teams who co-planned and taught four sequenced K–3 science lessons. Data sources included lesson plans and formative assessment reflections, analyzed thematically to identify patterns in the purposes and placement of literature within units.

Findings revealed four consistent patterns: literature was most often used as a one-time “hook” rather than revisited; opportunities to connect texts to scientific practices were frequently missed; engagement was prioritized over conceptual understanding; and TCs tended to stick to a single approach to literature integration. These patterns suggest that how literature is used matters as much as whether it is used at all.

The study underscores the need for explicit modeling of varied, purposeful uses of children's literature to foster NGSS-aligned sensemaking. Implications for teacher educators include designing structured opportunities for TCs to practice integrating literature as a flexible, recurring tool for building and revisiting science concepts.

Stand-Alone Paper

Case studies of Preservice Teacher Learning to Take Up Storyline Instruction with Critical Intentionality

Sage Andersen*, SUNY Cortland, USA

María González-Howard*, The University of Texas at Austin, USA

ABSTRACT

The current study is an exploratory, multiple case study of four groups of PSTs who participated in an elementary science methods course designed around six Core Practices (CPs) of Storyline Instruction conceptualized to center students' sensemaking and agency in their science learning and to be leverage points for more equitable and just science instruction. We examined to what extent and in what ways four groups of PSTs were able to take up the CPs and leverage them with critical intentionality (leveraging critical equity lenses) in their approximations of practice during the course. Three groups were able to design storyline units that centered students' sensemaking and agency while working toward disrupting some of the systemic injustices facing students in science education. However, the fourth group leveraged a critical equity lens but did not enact the CPs in ways that would center students' sensemaking and agency and, thus, was unable to plan truly transformative learning. These findings revealed that holding visions of equitable science instruction was not enough to create transformative learning opportunities for students if one's teaching practices do not center students' sensemaking and agency,

suggesting the need to center both teaching practice and critical praxis in teacher education.

Stand-Alone Paper

Motivation and Science Identity Changes in Pre-Service Elementary Teachers Following a Science CURE

Amandeep Kaur*, Texas State University, USA

Sunni Taylor, Texas State University, USA

Kristy Daniel, Texas State University, USA

Carrie Bucklin*, Texas State University, USA

ABSTRACT

Course-based Undergraduate Research Experiences (CUREs) offer authentic engagement with scientific practices and have shown positive outcomes for science majors, yet their impact on pre-service elementary teachers (PSETs) is not well understood. We investigated how a semester-long water-quality CURE at a high-research activity, Hispanic Serving Institution, influenced PSETs' motivation to learn science and science identity. We modified the Motivated Strategies for Learning Questionnaire and developed a Science Identity Questionnaire (both validated via Exploratory Factor Analysis). We analyzed responses from 167 PSETs using Wilcoxon signed-rank tests (non-parametric data) to determine changes before and after participating in the CURE. Overall motivation did not change significantly ($Z = -1.15$, $p = .251$). However, Self-Efficacy for Learning increased ($r = .22$), while other constructs, Intrinsic/Extrinsic Goal Orientation, Task Value, and Control of Learning Beliefs, remained stable. Item-level results showed greater confidence with challenging material, small gains in perceived utility, and modest declines in deep-understanding/value items- patterns common in required non-major courses. Science identity increased overall, with significant gains in Performance, Recognition, and Interest constructs. These findings show that while a single-semester CURE may not broadly shift motivation, it can enhance self-efficacy and science identity- key precursors for developing confident, motivated future science educators.

Stand-Alone Paper

Visualizing Dialogic Shifts in Preservice Science Teachers Using Equity Maps

Mandy Dunphy*, Baylor University, USA

Krystle Moos, Baylor University, USA

Brian Hand, University of Iowa, USA

ABSTRACT

This study examined shifts in preservice elementary teachers' beliefs and practices around language as an epistemic tool in science during a semester-long methods course paired with a year-long practicum. Drawing on surveys, Equity Maps, and reflections, we compared high-, medium-, and low-dialogic groups. Medium-dialogic teachers posted the largest survey gains, reframing equity as central to science learning. High-dialogic teachers refined strong commitments but faced pacing and curricular constraints, while some low-dialogic teachers

designed the most intentional participation structures. Across groups, growth stemmed from analyzing their own classroom discourse and linking beliefs to enactment. Findings suggest that embedding iterative cycles of participation, enactment, and analysis in Professional Development School models can foster adaptive expertise for equitable, knowledge-generating science instruction.

Developing teacher agency through transformative professional learning

Strand 8: In-service Science Teacher Education

19-Apr-26, 16:30-18:00

Location: Cedar AB (L2)

Stand-Alone Paper

Reimagining Science Teaching: Promoting teacher agency through a research-practice partnership for Bee Hunting convergent research

Isabel Delgado*, University of Puerto Rico, USA

Sara Ocasio*, University of Puerto Rico, USA

ABSTRACT

This paper discusses how a research-practice partnership (RPP) developed among in-service STEM teachers and educational and scientific researchers during a summer internship retreat supports teacher agency for the Bee Hunting convergent research project of the Arecibo C3 STEM Education Center in Puerto Rico. Funds of Knowledge (Moll et al., 1992) theoretical framework and Gold Standard PBL guided the analysis of the process of curriculum co-design. Using a qualitative case study design (Creswell, 2012) and collecting data from different sources: semi-structured interviews, observations and document analysis, the research team conducted inductive data analysis. Findings suggest that STEM teachers highly valued the RPP as it was considered a transformative learning experience that supports their teacher agency.

Stand-Alone Paper

Enacting Agency: An Ecological Perspective on Teachers' Experiences of an Integrated Curriculum

Dilara Kara-Zorluoglu*, University of Nevada, Las Vegas, USA

Ezgi Yesilyurt, Utah State University, USA

Erdogan Kaya, The University of Texas at Arlington, USA

Refika Turgut, University of South Carolina-Upstate, USA

Elif Adibelli-Sahin, Development Workshop, Turkey

Hasan Deniz, University of Nevada, Las Vegas, USA

ABSTRACT

In response to the growing emphasis on integrating computer science and computational thinking into science classrooms, teachers should adapt to the demands of the technological age. This qualitative case study examines how elementary science teachers perceive and enact agency when implementing an integrated curriculum using a scaffolded approach (from adopt to adapt). The three participants are elementary school teachers who work in the same school. Prior to classroom implementation, all of the teachers participated in professional development to experience the curricular materials. Drawing on Biesta et al.'s (2015) ecological model of teacher agency, this study emphasizes teacher voice and how agency emerges in situated contexts through interactions between individual capacities, environmental conditions, and constraints. The ecological model's dimensions conceptualize agency as individuals' past experiences, identity, values, and beliefs (iterational), actions taken in situated contexts (practical-evaluative), and future goals perceived in relation to past and current experiences (projective). The findings indicated that teachers require guidance when the integrated content is outside their area of expertise until they internalize the pedagogical approaches and practices. Therefore, this study conceptualizes an integrated curriculum as a type of scaffolding that helps teachers navigate a sequential learning path rather than a set of prescriptions.

Stand-Alone Paper

In-Service Teachers Cultivating Student Agency through Safety Science: A Year-Long Fellowship Case Study

Emmanuel Adeloju*, Arizona State University, USA

Michelle Jordan*, Arizona State University, USA

Sarah Suloff, Arizona State University, USA

Nicole Oster, Arizona State University, USA

Andrea Weinberg, Arizona State University, USA

ABSTRACT

Amid urgent climate and sustainability challenges, in-service teachers need support to turn science lessons into student-led action. One way to address this need is through a safety-science lens, as both safety science and sustainability focus on anticipating and mitigating negative outcomes for humans and the planet. This mixed-methods study examines results from the Xplorlabs Educator Fellowship, a year-long professional development program grounded in safety science and sustainability and informed by Action-Oriented Pedagogies. Pre- and post-program surveys completed by 23 US-based secondary and informal educators measured participants' awareness, understanding, confidence, and commitment to various aspects of safety science and sustainability education. There were increases in post-program averages across all constructs. Qualitative analysis of focus-group interviews, blog posts, and lesson planning artifacts explored how teachers supported students in taking safety science-related actions in their schools, homes, and communities. Findings demonstrate that safety-science-focused professional development can improve in-service teachers' capacity and, in turn, empower learners as change agents

Stand-Alone Paper

Toward Climate Justice: Developing Critical Transformative Teacher Agency

Wisam Sedawi*, University of Michigan, USA

Angela Calabrese-Barton, University of Michigan, USA

Batoul Abdalla, University of Michigan, USA

Rachel Sherwin, University of Michigan, USA

ABSTRACT

This study investigates how minoritized teachers developed critical transformative agency by working in solidarity with families to co-design and implement a climate justice education. Using participatory critical design ethnographic methods, we collaborated with one teacher, five 6th-grade classrooms of Arab American immigrant students, and their families. Our findings reveal how teacher agency evolved from defensive to transformative within figured worlds of climate justice, as she engaged in community-based epistemologies, cultivated relationality, and fostered critical consciousness. This opened new possibilities for the teacher to enact transformative agency by “writing new worlds,” and advocating for climate justice and community thriving. We argue that cultivating teachers’ critical transformative agency is essential for addressing the social and political dimensions of climate education and preparing students to navigate complex socioscientific issues.

Measurement Innovations for Assessing Science Learning, Identity, and Career Development

Strand 10: Curriculum and Assessment

19-Apr-26, 16:30-18:00

Location: Ravenna C (L3)

Stand-Alone Paper

Measuring Entrepreneurial Career Development in STEM: Validation of the STEM Entrepreneurial Career Development Measure (SECDM)

Gizem Ozyazici*, Syracuse University, USA

Qiu Wang, Syracuse University, USA

John Tillotson, Syracuse University, USA

ABSTRACT

Entrepreneurship in STEM (Science, Technology, Engineering, and Mathematics) is closely tied to real-world problem-solving, critical thinking, and innovation. Research shows that STEM students have strong potential to transform ideas into impactful technologies and businesses, driving economic and societal progress. Therefore, it is important to promote the development of entrepreneurial mindsets among STEM students and to present STEM entrepreneurship as a viable career option. However, there is a lack of measures that focus on STEM-specific entrepreneurial career development. To address this gap, a new scale was

developed based on the Theory of Planned Behavior and Social Cognitive Career Theory. Survey data from 176 undergraduate STEM students at a private research university revealed strong internal consistency ($\alpha = .91$). Results from exploratory and confirmatory factor analyses indicated strong model fit, supporting the validity and reliability of the scale in assessing STEM entrepreneurial career development. While the scale shows promising psychometric properties, further testing with larger and more diverse samples is recommended to confirm its validity and generalizability.

Stand-Alone Paper

Development and Validation of a Secondary Student Scientific Argumentation Competence Instrument in 'Biology and Environment'

Ying Zhou*, Jiujiang University, China

Jian Wang, Beijing Normal University, China

ABSTRACT

Integrating scientific argumentation into teaching enhances students' conceptual understanding and scientific literacy. To address limitations in existing assessments, this study proposes and validates a new framework for measuring secondary students' scientific argumentation competence. We developed biology-and-environment-themed multi-item tasks based on the framework and gathered validity evidence through expert review, pilot testing, interviews, and Rasch analysis with 281 students (Grades 8, 10, 11). Results confirm the framework's reliability and validity, showing that most students reached Level 3 and providing implications for developing students' competence.

Stand-Alone Paper

A multifaceted measurement approach reveals student profiles that predict intentions to persist in computing

Austin Zuckerman*, Cornell University, USA

Gena Sbeglia, San Diego State University, USA

Ashley Juavinett, University of California San Diego, USA

ABSTRACT

As computing becomes a growing competency across STEM fields and more desired in a variety of career paths, it is critical to understand which students persist into computing and why. Academic preparation and psychosocial processes are salient factors associated with persistence, yet different psychosocial constructs are typically studied in isolation from one another and apart from factors related to academic preparation. In comparison to traditional variable-centered analytical approaches, person-centered approaches are one way to examine these multidimensional patterns of student experiences in a way that is both interpretable and actionable for educators. In this study, we address existing methodological and analytical gaps in research on persistence in computing by leveraging existing instruments to simultaneously measure cognitive and affective constructs associated with persistence and then using latent profile analysis to identify subgroups based on these

constructs. We find that representation across these profiles varies by several student background variables, and the profiles predict intentions to persist comparably to indicators of academic preparation (i.e. prior coding experience). This integrated measurement and person-centered analytical approach can be adapted across disciplines to guide our understanding of factors associated with persistence and inform equity-focused interventions.

Considering Researcher-Participant Relations in How We Approach STEM Education Research

Strand 11: Cultural, Social, and Gender Issues

19-Apr-26, 16:30-18:00

Location: Redwood AB (L2)

Related Paper Set

Mapping STEM Education Co-Design Relationships with Community Organizations

Brian Gravel, Tufts University, USA

Dionne Champion, TERC, USA

Eli Tucker-Raymond, Boston University Wheelock College, USA

Amon Millner, Olin College of Engineering, USA

Christopher Wright*, Drexel University, USA

Ayanna Allen-Handy, Drexel University, USA

L. Clara Mabour, Tufts University, USA

ABSTRACT

We seek to reimagine design perspectives for culturally sustaining learning spaces that support youth of color to explore their relationships to STEM. Inspired by culturally relevant and culturally sustaining pedagogies that transform educational spaces, we share enactments of hip hop STEM-rich learning ecologies, designed in different community spaces. Co-design has become popular among STEM education researchers, yet it is used fluidly, with multiple meanings in disciplinary education research. The histories of community spaces are specific and unique, and our objective is to explore co-design perspectives focused on research with existing community spaces. What does it mean to design for people and communities, rather than disciplines? The history and nature of relations among researchers and communities varies. Some researchers are members of partner communities, others help to found new communities; we argue this complexity raises questions about designing for people and communities, over disciplines and outcomes. We present 4 design enactments of a hip hop STEM-rich program for young people, to showcase different dimensions of co-design. We present four perspectives: designing within, with, together, and to build community relations and futures. Each researcher-community partnership is a unique story, and that story and history deserve careful consideration when imagining the design possibilities.

Related Paper Set

From Participant to Partner: Empowering Students as Partners in Research and Dissemination Through Storytelling Workshops

Monica Cardella*, Florida International University, USA

Dorothy Gocol, Florida International University, USA

ABSTRACT

Administrators, faculty and staff are positioned to design and develop undergraduate experiences in university settings, and the changes that improve undergraduate education. Similarly, educational researchers have positions and expertise to be able to study experiences and systems in ways that can inform change efforts. However, too often students are positioned as the recipients of these change efforts, or the objects of study. For instance, we often interview students to understand their experiences, and then as researchers write narratives that are extracted from the interviews. In this paper we explore a process for supporting undergraduates in crafting their stories as in-tact narratives, positioning the undergraduates as partners in both research and dissemination.

Related Paper Set

Learning from Multilingual and Multidialectal Communities: The Everyday Origins of Engineering Practices

Greses Perez*, Tufts University, USA

G.R. Marvez, Tufts University, USA

Philippa Eshun, Tufts University, USA

Clara Mabour, Tufts University, USA

Taisha Pierre, Tufts University, USA

Mia Jimenez, Tufts University, USA

Pragyee Shrestha, Tufts University, USA

Luis Suarez, Tufts University, USA

ABSTRACT

Multilingual and multidialectal communities have a long history of resiliency strategies, from creating inclusive spaces to connecting people across languages and cultures to solving problems in their local context. Yet, recent political and humanitarian upheavals have led to tensions affecting these communities globally. Experiencing vilification, multilingual and multidialectal communities remained united. This paper highlights the resources of these communities in national and international contexts where people engage in socially-oriented engineering problem-solving in their local contexts. It address the need for research and methodological approaches for community-led science and engineering in multilingual and multidialectal communities.

Student belonging, identity, and rightful presence in STEM

Strand 11: Cultural, Social, and Gender Issues

19-Apr-26, 16:30-18:00

Location: Willow B (L2)

Stand-Alone Paper

A Socially Transformative Approach to Teaching Genetics Among Secondary School Biology Students

Umar Adam*, Lagos State University, Nigeria

Samuel Okenla, Lagos State University, Nigeria

Jomo Mutegi, Old Dominion University, USA

Mujibat Akorede, Old Dominion University, USA

Mary Olayanju, Federal College of Education (Technical)), Nigeria

Seth Cudjoe, Old Dominion University, USA

Steevenson Rosema, Old Dominion University, USA

ABSTRACT

Over the years, teaching approaches in Nigerian secondary schools have often mirror Western models without adaptation, disregarding students' cultural realities and lived experiences. This mismatch hinders deep understanding and contributes to inconsistent science learning outcomes. To address these gaps, this study adopted a socially transformative pedagogy that integrates learners' sociocultural contexts to promote meaningful learning. Participants were 107 Senior Secondary Two (SS2) students, consisting of an experimental group of 67 students (31 males, 36 females) and control group of 40 students (17 males, 23 females). A quasi-experimental design was employed, and data was collected using the Genetics Achievement Test (GAT), which had a reliability coefficient of 0.79. The experimental group was taught using socially transformative pedagogy, while the control group received traditional instruction. Data was analyzed using ANCOVA, as participants were not randomly assigned. Findings revealed that the experimental group (mean = 29.60) significantly outperformed the control group (mean = 24.33) [$F(1, 104) = 18.54$; $p < .05$]. Gender differences in the experimental group were not statistically significant. The study concludes that socially transformative pedagogy effectively enhances achievement in genetics, while valuing students' culture, lived experiences, and active engagement in science learning.

Stand-Alone Paper

Rightful Presence to Foster Educator Reflection and Student Belonging in STEM

Katherine King*, Georgia Institute of Technology, USA

Justina Jackson*, Georgia Institute of Technology, USA

Meltem Alemdar, Georgia Institute of Technology, USA

ABSTRACT

This study explores how the Rightful Presence (RP) framework can support educators in fostering student belonging in STEM education. Through an embedded case study design,

we examined three professional learning experiences at a large, STEM-focused university involving pre-service K-12 teachers, in-service K-12 teachers, and collegiate instructors. In each case, participants engaged in reflection on the RP framework, which emphasizes allied political struggle to reauthor student rights, making (in)justices visible, and collective disruption of guest/host relationalities. Data sources included participant reflections, observations, and focus groups. Qualitative analysis of data from each case revealed that educators used the RP framework to reimagine their roles, center student voices, and challenge unhelpful stereotypes or narratives about who belongs in STEM spaces. Across cases, educators demonstrated politicized care (McKinney de Royston et al., 2017) through simple practices, such as critical relationship building, radical hospitality, and authentic inquiry-based lessons, to validate student lived experiences and amplify student voices. This study contributes to the growing body of research on equity in STEM education and offers implications for professional development that supports educators across the K-16 spectrum in promoting belonging amongst all students in STEM spaces.

Stand-Alone Paper

A Structural Equation Model for Youths' STEM Identity Development: Impact of Contextual STEM Learning Experiences

Amdad Ahmed Awsaf*, Florida International University, USA

Remy Dou, University of Miami, USA

Susan Sunbury, Harvard University, USA

Gerhard Sonnert, Harvard University, USA

Philip Sadler, Harvard University, USA

ABSTRACT

STEM identity has predictive value for determining students' long-term persistence in STEM fields. However, the development of such identities is not incidental and often requires specific efforts by the learning authorities and stakeholders. Our current study examined how pre-college experiences influence STEM identity development among 1,134 racially and ethnically minoritized youth studying across several Minority Serving Institutions in the United States. Using the Structural Equation Modeling technique, we tested relationships among performance-competence, recognition, interest, and eight pre-college experiences that took place in both formal and informal learning environments. Results showed that STEM interest ($\beta = 0.44$) and recognition ($\beta = 0.46$) directly predicted STEM identity, with performance-competence mediating these relationships. Teacher recommendations most strongly predicted performance-competence ($\beta = 0.257$), followed by being called on to answer questions ($\beta = 0.165$). Negative out-of-school experiences decreased performance-competence ($\beta = -0.061$). Our findings suggest that fostering positive pre-college experiences continues to influence STEM identity through psychological mechanisms, and interventions focused on performance-competence can effectively support minoritized youths' STEM Identity development and their long-term persistence in the field.

Stand-Alone Paper

Between Two Worlds: Physics Students Building Belonging and Identity through Equity Work

Carolina Cruz-Vinaccia*, McGill University, Canada

ABSTRACT

Canadian institutions have implemented initiatives that centre equity, diversity, and inclusion in Physics, but the persistence of systemic barriers to belonging for marginalized students suggests the need for considerable cultural transformation. The work of cultural transformation is not equitably distributed; students emerge as primary agents of equity work despite potential professional, social, and personal impacts (Perez et al, 2022). This study investigates how equity work can operate as a counterspace for Physics students - a location of activity that counteracts dominant disciplinary narratives. We use Rivers of Life interviewing (Gonsalves et al, 2023), an arts-based method of life-story elicitation, to elucidate students' stories of equity work at a research-intensive Canadian university. Narrative data from 14 Physics students suggests that while engagement in equity work can create counterspaces that facilitate belonging in Physics for marginalized students, it can also position students in marginal ways in relation to Physics culture.

AI-Enhanced Assessment & Automated Scoring

Strand 12: Technology for Teaching, Learning, and Research

19-Apr-26, 16:30-18:00

Location: Ballard (L3)

Stand-Alone Paper

Prompted AI-Tutors to support experimental problem solving

Hendrik Maas*, Leibniz University Hannover, Germany

Gunnar Friege, Leibniz University Hannover, Germany

ABSTRACT

In recent years, the integration of artificial intelligence (AI) in educational contexts has gained significant attention. This study investigates the effectiveness of AI chatbots as tutors in comparison to traditional incremental scaffolds, focusing on their impact on learners' problem-solving outcomes and learning success. Conducted with 203 twelfth-grade students, the research employs a quasi-experimental 2x2 design to explore the effects of social form (individual vs. collaborative work) and support type (AI tutors vs. incremental scaffolds). Results indicate that AI support, particularly in collaborative settings, leads to significantly better problem-solving outcomes than traditional scaffolds. However, no substantial differences in overall learning success were observed between the two support methods. The findings suggest that while AI can enhance problem-solving processes, further investigation is needed to understand its influence on learning outcomes. This research

contributes to the growing body of literature on AI in education, highlighting both its potential benefits and the complexities of its implementation in classroom settings.

Stand-Alone Paper

Automated Scoring of Constructed Responses: BERT Performance on Near- and Far-Transfer Biochemistry Problems

Cheng-Wen He*, University of Georgia, USA

Peng He, Washington State University, USA

Tingtin Li, Washington State University, USA

Logan Fiorella, University of Georgia, USA

Paula Lemons, University of Georgia, USA

ABSTRACT

Automated scoring tools have shown promise in evaluating student reasoning at scale, yet their ability to assess transfer of learning remains underexplored. This study examines how well a BERT-based Multi-Task Classification Model reproduces human experts scoring of undergraduate students' open-ended responses in biochemistry, with a focus on noncovalent interactions. Drawing on responses from 792 students, we compared model accuracy across near-transfer and far-transfer problems using six and five rubric-aligned categories, respectively. The model achieved strong performance on near-transfer problems (accuracy = 0.97) but showed reduced accuracy in far-transfer problems (accuracy = 0.86), particularly in scoring evidence and high-quality claims. A thematic analysis of aligned and inconsistent scoring cases revealed that while the model reliably recognized discipline-specific terms and straightforward reasoning, it struggled with vague language, alternative reasoning, and non-normative ideas. Our findings highlight the potential of BERT models to support scalable, rubric-based assessment in undergraduate biology education while pointing to current limitations in assessing more complex student thinking. This study offers implications for future development of AI-supported formative assessment tools that can help instructors evaluate open-ended biology problems more efficiently and equitably.

Stand-Alone Paper

AI-Driven Analysis of Free-Response Questions regarding Pedagogical Content Knowledge in Questioning

Jianlan Wang*, Texas Tech University, USA

Ibrahim Akdilek, Texas Tech University, USA

Margarita Flores-Sicich, Texas Tech University, USA

ABSTRACT

The importance of accurately assessing Pedagogical Content Knowledge (PCK) in science teacher preparation is well established, yet conventional paper-and-pencil approaches struggle with the inherent complexity and subjectivity of classroom practice. This study investigates the use of artificial intelligence (AI) to evaluate pre-validated free-response items from the PCK in Questioning (PCK-Q) instrument, which measures teachers' ability to

identify student strengths and difficulties, select effective prompts, and justify instructional decisions. We customized ChatGPT-5 with prior PCK-Q research, explicit definitions of question types, and a detailed scoring rubric for four PCK components (Orientation, Content, Student strengths/difficulties, Instructional guidance). AI analyses of elementary science and college physics scenarios were generated on two devices, compared using a three-level similarity rubric, and assessed for inter-rater agreement with Cohen's Kappa ($\kappa = 0.85$). Expert science instructors then reviewed the AI outputs, rating their validity and providing qualitative feedback. Results showed stronger AI consistency and agreement in elementary science cases than in more complex college physics scenarios, where multiple valid prompting strategies existed. Findings indicate that theory-informed AI can generate reliable, reproducible analyses of PCK, with potential to enhance large-scale, objective assessment in teacher education. Implications for integrating AI into PCK research and professional development are discussed.

“It Doesn’t Have to Be This Way”: Confronting Epistemic Injustice in Science Education

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

19-Apr-26, 16:30-18:00

Location: Willow A (L2)

Symposium

“It Doesn’t Have to Be This Way”: Confronting Epistemic Injustice in Science Education

Ayça Fackler, The University of Missouri, USA

David Stroupe*, The University of Utah, USA

Déana Scipio, Islandwood, USA

Enrique Suárez, UMass Amherst, USA

Osnat Atias, University of Haifa, Israel

Ayelet Shavit, Israel Institute of Technology, Israel

Ayelet Baram-Tsabari, Institute of Technology, Israel

Yael Kali, University of Haifa, Israel

Christina Baze, Northern Arizona University, USA

María González-Howard, The University of Texas at Austin, USA

Chris Jadallah, UCLA, USA

Heidi Ballard, UC Davis, USA

Wisam Sedawi, University of Michigan, USA

Christina Krist, Stanford University, USA

Eve Manz, Boston University,

Angela Calabrese Barton, University of Michigan, USA

ABSTRACT

This symposium explores epistemic injustice in science education, referring to the harm done when individuals or communities are discredited or excluded as knowers. We examine how dominant systems shape whose knowledge is recognized, whose voices are heard, and who gets to belong. Across diverse contexts, including nature of science, citizen science, research and mentoring relationships, and youth engagement with socioscientific issues, presenters critically analyze how epistemic injustice manifests and how it might be disrupted. Participants will engage pressing questions, envision alternatives, and explore justice-oriented possibilities for science education that centers relational accountability and epistemic repair.

Educating for Environmental Action: Innovative Pedagogies and Learner Transformation

Strand 14: Environmental Education and Sustainability

19-Apr-26, 16:30-18:00

Location: Issaquah AB (L3)

Stand-Alone Paper

Developing competencies to action: Curriculum design and implementation in environmental education at the master's level

Shih-Yeh Chen*, Department of Science Education and Application, National Taichung University of Education, Taiwan

Han-Yu Wang, Department of Chemistry, National Taiwan Normal University, Taiwan

Shiang-Yao Liu, Graduate Institute of Science Education, National Taiwan Normal University, Taiwan

ABSTRACT

Over the past decade, the integration of socioscientific issues into science teaching has been a key focus, particularly in school settings. Engaging in argumentation enhances the understanding of the root causes of issues and helps students construct arguments from multiple perspectives, which in turn influences their action taking. This study aims to design a curriculum through an action-oriented approach in an environmental education course. Twenty-two graduate students were recruited in this research. Preliminary, students investigated issues of concern after arguing with three issues. Next, students developed strategies and took action to address the problems identified previously. Issue knowledge, argumentation skills, and action competence for problem solving were assessed as the pre/posttest. The results showed that students made significant improvements in the issue knowledge and the ability to propose arguments, counterarguments, rebuttals, and evidence excluding the qualifiers. However, the performance in each dimension of action competence for problem solving was enhanced without significance. The increase of knowledge and the use of argument elements could benefit the competence to action in the issue insight. From students' reflections, the negative outcomes in three items revealed that the construction of

ideas for future environment in collective action are crucial for developing action competence.

Stand-Alone Paper

Facilitating Ocean Sustainability Education through Immersive VR and Pre-training Strategies

Hsing-Ying Tu*, National Taiwan Normal University, Taiwan

Silvia Lee, National Taiwan Normal University, Taiwan

Tai-Sheng Hung, National Taiwan Normal University, Taiwan

ABSTRACT

This study investigated the effects of VR-based environmental education and pre-training interventions on self-efficacy and conceptual understanding of ocean sustainability. A total of 120 undergraduate and graduate students in Taiwan were randomly assigned to three VR pre-training conditions: open-route (O), attentional advice (AT), and advance organizer (AD), with 4 to 5 participants per group selected for pre- and post-intervention interviews. Self-efficacy was measured across three PISA-based dimensions—explaining human–Earth system interactions (SEE), making evidence-based decisions (SED), and considering multiple perspectives in socio-ecological problem-solving (SES). Paired t tests evaluated changes in self-efficacy and ANCOVA evaluated differences among three groups, while Epistemic Network Analysis (ENA) assessed conceptual connections. Results showed significant improvements across all self-efficacy dimensions, with the largest gains in SES, particularly in the AD group. ENA revealed a shift from abstract ideas, such as ecological balance and voluntary conservation, to concrete ocean-specific issues, including overfishing and responsible purchasing. Structured guidance (AT and AD) fostered richer conceptual interconnections, while the open-route condition produced more evenly distributed networks. Overall, these findings underscore the educational value of combining immersive VR experiences with well-designed pre-instructional strategies to enhance students' systems thinking in environmental education.

Mentor/Mentee Nexus

19-Apr-26, 18:00-19:00

Location: Willow A (L2)

Social Event

Organizers

Khadija Zogheib, Florida State University

Joi Merritt, James Madison University, USA

Contributors

Joi Merritt, James Madison University, USA

Khadija Zogheib, Florida State University

Abstract

The membership committee hosts an annual Mentor-Mentee Nexus. This 1-hour session serves as a context for first-time attendees or those relatively new to NARST to interact with more experienced NARST members. Session leaders facilitate the introduction of Mentors and Mentees by identifying and matching interested parties, creating an environment that supports communication among Mentors and Mentees, and monitors and evaluates mentor and mentee needs with respect to the NARST session. During the session, Mentors provide insight regarding topics of interest to the Mentee by either providing answers to Mentee questions or helping the Mentee identify an appropriate source of information. During the session, Mentees locate their Mentor and in a small group share questions, concerns, and insights with their Mentors and other Mentees.

President's Welcome Reception and Dance

19-Apr-26, 19:00-22:00

Location: Grand Ballroom (L2)

Social Event

Conference Day 2

20 April 2026

Mind and Sole Fun Run

20-Apr-26, 6:30-8:00

Location: Offsite

Social Event

Abstract

Mark your calendars! The 14th annual Mind and Sole 5K fun run/walk/stroll will take place in Seattle! This year we will hold the Mind & Sole on March 20, 2026 at 6:30am. We are excited to see you and to enjoy the beautiful city of Seattle together. If you are interested here is a couch to 5k (perhaps more accurate to say desk to 5k) at <https://c25k.com/>. And it's available in many languages, with versions for outdoor running/walking, treadmills, and even with your "pooch". We're currently designing a beautiful, urban route for the event, and will have maps available before the meeting.

Early Career Forum

20-Apr-26, 7:00-8:00

Location: Aspen (L2)

Social Event

Organizers

Grant Gardener, Middle Tennessee State University, Murfreesboro, TN, USA

Theila Smith, Brooklyn College (CUNY) and NYC Public Schools, Brooklyn, NY, USA

Joi Merritt, James Madison University, Harrisonburg, VA, USA

Contributors

Theila Smith, Brooklyn College (CUNY) and NYC Public Schools, Brooklyn, NY, USA

Joi Merritt, James Madison University, Harrisonburg, VA, USA

Grant Gardener, Middle Tennessee State University, Murfreesboro, TN, USA

USA. Middle Tennessee State University, Murfreesboro, TN, USA

ABSTRACT

The Early Career 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.

Research Interest Group (RIG) Meetings

20-Apr-26, 7:00-8:00

Continental and Diasporic Africa in Science Education RIG (CADASE) Meeting

20-Apr-26, 7:00-8:00

Location: Willow B (L2)

Latino/a RIG (LARIG) Meeting

20-Apr-26, 7:00-8:00

Location: Cedar AB (L2)

Contemporary Methods for Science Education Research RIG Meeting

20-Apr-26, 7:00-8:00

Location: Juniper (L2)

Engineering Education RIG (ENE-RIG) Meeting

20-Apr-26, 7:00-8:00

Location: Ravenna AB (L3)

Research in Artificial Intelligence-Involvement Science Education (RAISE) Meeting

20-Apr-26, 7:00-8:00

Location: Capitol Hill (L3)

Indigenous Science Knowledge Research Interest Group (ISK-RIG) Meeting

20-Apr-26, 7:00-8:00

Location: Ravenna C (L3)

Asian and Pacific Islander Science Education Research (APISER) Meeting

20-Apr-26, 7:00-8:00

Location: Issaquah AB (L3)

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

20-Apr-26, 7:00-8:00

Location: Greenwood (L3)

Computational Science Practices Research Interest Group (CSP-RIG) Business Meeting

20-Apr-26, 7:00-8:00

Location: Ballard (L3)

Exploring Professional Avenues in Science Education in Nontraditional Domains (EXPAND RIG) Business Meeting

20-Apr-26, 7:00-8:00

Location: Columbia (L4)

Empowering Students Through Metacognitive Strategies

Strand 1: Science Learning: Development of student understanding

20-Apr-26, 8:15-9:45

Location: Ravenna AB (L3)

Stand-Alone Paper

Promoting Self-Regulated Learning in Chemistry Education Through Transparent Learning Objectives

Nils Bergander*, TU Dortmund University, Germany

Insa Melle, TU Dortmund University, Germany

ABSTRACT

Self-regulated learning (SRL) is crucial for both lifelong learning and knowledge acquisition. In chemistry education, complex topics such as chemical equilibrium present particular challenges. To support secondary school students in dealing with these challenges, a digital learning environment on the topic of chemical equilibrium was developed, offering clearly defined learning objectives, opportunities for self-assessment, and metacognitive scaffolding.

In a pilot study involving N = 55 students, participants were assigned to one of three groups: (1) learning objectives are presented at the beginning and for self-assessment (cLO), (2) learning objectives are presented only at the beginning (pLO), or (3) no learning objectives are presented (control group). The results indicated significant learning gains across all groups, but no group differences. The cLO group showing the most pronounced improvements among students with low SRL skills and limited prior knowledge. Students with strong SRL skills benefited more in the control group. The pLO group showed the least progress overall. These findings suggest that transparent learning objectives may be particularly effective in supporting less advanced SRL learners, whereas high-performing students may benefit from an approach without learning objectives. The following study with a larger sample size will show whether this observation can be confirmed.

Stand-Alone Paper

Should we individualize the way we deal with students' conceptions?

Tim Hartelt*, University of Kassel, Germany

Joelina Henniges, University of Kassel, Germany

ABSTRACT

Alternative conceptions can be a potential obstacle to students' understanding of scientific topics. Explicitly addressing them can promote understanding. However, students' conceptions are heterogeneous, resulting in the question: Do students' individual conceptions need to be addressed, or is it sufficient to address common alternative conceptions? Further, it remains unclear how addressing students' alternative conceptions influences their self-efficacy (an important affective-motivational variable within conceptual learning). We conducted an experimental pre-post-interventional study with two groups (N = 171 secondary school students): One group received a refutation text targeting the specific alternative conception of the students, while the other group received a refutation text addressing a different, common alternative conception. Both groups used more scientific and fewer alternative conceptions and had a higher self-efficacy afterwards, with no differences between the groups. The finding suggests that the cognitive conflict induced by refutation texts does not have negative effects on students' self-efficacy and that refutation texts can enhance students' scientific understanding. The lack of differences between the groups in the posttest may be attributed to the addressed conceptions being closely related and potentially interconnected. Further research is needed to draw definitive conclusions regarding individualized approaches to addressing students' alternative conceptions.

Reimagining Power: Supporting Marginalized Participation and Resilience in Science Education

Strand 2: Science Learning: Contexts, Characteristics and Interactions

20-Apr-26, 8:15-9:45

Location: Jefferson A (L4)

Stand-Alone Paper

Distributions of Authority in Peer-to-Peer Interactions

Etta Pope*, Northwestern University, USA

Olga Vaskova, Northwestern University, USA

Jason Buell, Northwestern University, USA

Brian Resier, Northwestern University, USA

ABSTRACT

In effective science education, all students have access to participate in sensemaking. Efforts to promote equitable participation depend on how authority is distributed during group work. Drawing on existing models of influence and participation within small groups, we analyze middle school science classroom and interview data to understand how inequitable distributions of authority among students may be disrupted. The teacher's brief intervention into the participation dynamics of a collaborative small group was effective in disrupting inequitable distributions of authority, leading to more equitable interactions among students. This contributes to prior research on classroom discourse by showing how modest interventions can disrupt exclusionary dynamics to support more fluid, equitable positioning, underscoring the importance of teacher responsiveness during group collaboration.

Stand-Alone Paper

Student Norms and Power Dynamics in Small-Group Modeling: Fostering or Constraining Marginalized Students' Participation

Soo-Yean Shim*, Seoul National University, Korea, Republic of

Sunghee Kim, Seoul National University, Korea, Republic of

Hun Jeong, Seoul National University, Korea, Republic of

ABSTRACT

Collaborative knowledge-building is valued but does not guarantee equitable learning, as power dynamics shape whose ideas are heard. Yet, because such dynamics are fluid, this qualitative case study examines how students' use of epistemic norms—expectations for building and justifying knowledge—amplified or reduced inequities in small-group scientific modeling. From twelve groups of Korean 5th graders, we selected two groups of four students each that showed notable shifts in power dynamics. They engaged in collaborative modeling to explain bee disappearance during a nine-lesson ecosystem unit. We analyzed 520 minutes of video recordings of their interactions, along with artifacts and interviews. We present four cases showing how students' norms sometimes fostered meaningful contributions, while at other times reinforcing inequities. In one case, norms of justification challenged a dominant student's authority and enabled collective sensemaking; in another,

similar norms marginalized a student unable to provide reasons. Additionally, a marginalized student introduced a norm allowing all members to record their reasoning, which, despite limiting scientific discussion, provided him an important opportunity to voice his thoughts. Our findings suggest epistemic norms rooted in Western science do not always foster equitable participation. We emphasize valuing both “scientifically meaningful” and “equitable” engagement in science education.

Stand-Alone Paper

Using worlding to create spaces for joy for a more equitable and inclusive science education

Catherine Milne*, New York University, USA

ABSTRACT

Why isn't joy an underlying goal for all education and science education specifically? Taking an agential realist (Barad, 2007) approach to science education, I invite you on a journey to explore how science education could engender joy through entanglement, differentiation, and attunement with the world creating space for joy, collaborating, wondering, learning, creativity, wisdom, sensitivity and flexibility.

Stand-Alone Paper

Teacher Boundaries and Student Resilience in Nature-Based Science Learning

Amy Crowell*, University of Iowa, USA

Kay Ramey*, University of Iowa, USA

ABSTRACT

This qualitative study examines how one educator used nature-based learning (NBL) to create conditions for safe exploration that sparked the development of student resilience. Part of a larger project on scaling a collaborative program between formal and informal educators in a Midwestern state, the research follows students in grades 4–8 who engaged in four to five days of interdisciplinary, experiential outdoor learning during the school day. Findings show that students were building resiliency skills—empathy, self-care, reflection, and self-efficacy—through experiences shaped by the teacher's boundaries for safe exploration. Her authoritative approach balanced freedom with structure, allowing student-led inquiry while maintaining safety. She accomplished this through three strategies: setting concrete, nature-based limits; using natural contexts to teach morals and values; and modeling safe exploration. This case study offers science educators practical insights for leveraging nature not only as a space for learning science, but also as a catalyst for social-emotional growth, demonstrating how boundaries for safe exploration in nature can transform nature-based science learning into a pathway for student resilience.

Playful Pathways to Science Practices: Supporting Early Childhood Educators Through Professional Learning and Hybrid Spaces

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

20-Apr-26, 8:15-9:45

Location: Seneca (L4)

Related Paper Set

Professional Learning to Empower Early Childhood Educators in Science and Engineering Practices Through Play-Based Learning

Rachel Larimore*, Samara Early Learning, USA

Alison Miller*, Bowdoin College, USA

ABSTRACT

This paper describes the design and iteration of a professional learning intervention to support early childhood educators in facilitating scientific and engineering practices (SEPs) through play-based learning. We focused on developing video-based professional learning and coaching to identify and enhance nascent SEPs in play. Central to our design was the idea that helping teachers notice and extend children's natural engagement in SEPs is crucial for fostering meaningful science learning. Using a multi-method, design-based research approach, we developed professional learning for a small cohort of educators (n=7) participating in professional learning over the course of two school years. Year 1 included 12 sessions, each lasting 2 hours and held every 2-4 weeks. Year 2 included 6 sessions, each lasting 2 hours and held once every 4 weeks. During these sessions, educators were introduced to skills and strategies for identifying SEPs in children's play through video-rich exemplars. Data sources included professional learning debrief field notes from each session, professional learning exit tickets, classroom observations, and semi-structured interviews with educators. Our findings describe and analyze how educators interact with the professional learning intervention and propose further iterations on design features for future professional learning experiences.

Related Paper Set

Harnessing Hybrid Spaces: Bringing Outdoors In and Indoors Out to Support Play-Based Science and Engineering

Samantha Stevenson*, Bowdoin College, USA

ABSTRACT

Early childhood students benefit developmentally from unstructured play and learn key science and engineering practices (SEPs) when given time to explore. Unfortunately, many early childhood educators are bound by curricular and structural pressures that restrict the time they can dedicate to play, and the spaces and materials accessible to children for play, particularly nature-based play. This paper explores some of the ways teachers have circumvented systemic obstacles and blurred the lines between indoor and outdoor play in order to provide children with more opportunities to engage in play-based science and

engineering. Data sources include classroom observations and teacher interviews. We offer two illustrative case studies in which teachers brought natural materials inside to support and extend children's science investigations, and a third case in which the teacher brought materials from an indoor, child-led exploration into the outdoors, allowing children to continue deepening their play-based exploration.

Related Paper Set

From Direction to Facilitation: How Professional Learning Transforms Early Childhood Educators' Conceptions of Science & Play

Lauren Poniatowski, Bowdoin College, USA

Hildah Makori*, Bowdoin College, USA

ABSTRACT

This paper presents preliminary findings from two instrumental case studies examining the impact of the SciEPlay professional learning (PL) program on early childhood educators' conceptions of and pedagogy around play-based science learning. SciEPlay is a two-year, video-based PL intervention designed to support teachers' ability to notice, interpret, and extend young children's engagement with science and engineering practices during play. Cohort 1 participants (n=6) engaged in 17 PL sessions combining collaborative video analysis, peer coaching, and strategy-focused workshops. Using a sequential explanatory mixed methods design, we collected pre- and post-surveys, semi-structured interviews, and professional learning exit tickets.

We report on two teachers, selected as instrumental cases to illuminate representative yet distinctive patterns of change. Analysis of Year 1 and Year 2 interviews, triangulated with survey trends and exit ticket reflections, indicates shifts from viewing science as discrete, planned activities toward recognizing its presence in spontaneous, child-led play. Both teachers restructured their classroom environments to include more open-ended materials and adopted more facilitative, less directive instructional moves. Persistent challenges included balancing curricular requirements with extended play and determining optimal timing for adult intervention. Findings highlight the potential of iterative, video-rich PL to foster equitable, inquiry-rich science learning in early childhood settings.

Designing Science Learning for Future-Ready Students

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

20-Apr-26, 8:15-9:45

Location: Ravenna C (L3)

Stand-Alone Paper

A Comparative Study of Knowledge Maps and Ontological Scaffolding in Complex Systems Thinking

Yi-Chen Lin*, Graduate Institute of Science Education, National Taiwan Normal University, Taiwan

Ting-Kuang Yeh, Department of Earth Sciences, National Taiwan Normal, Taiwan

ABSTRACT

Complex systems thinking is essential for science education, yet students struggle to understand how macro-level phenomena emerge from micro-level interactions. Existing ontological scaffolding (OT) uses text-based explanations and authentic examples to help students recognize complex systems ontologies, such as decentralized order and emergence. However, students often fail to understand underlying mechanisms behind these ontologies. Knowledge maps scaffolding (KM) offers an alternative using node-link diagrams with signaling features and sequential guidance. This visual approach supports students in exploring system relationships and their hierarchical nature. We compared KM and OT effectiveness in a three-week course with 175 eleventh-grade students. Linear mixed models and follow-up interviews were employed to analyze learning outcomes. Results suggested that KM students significantly identified more system elements and interactions, and better grasped feedback loops and decentralized order. OT students, on the other hand, showed advantages in identifying complex systems ontologies but struggled to explain their emergence. Our study contributes to complex systems education by showing how KM moves students beyond superficial identification toward understanding multilevel mechanisms.

Stand-Alone Paper

Science Classroom Goals and Defaults: Powerful Levers for Building Alternative Futures

Christopher Irwin*, Florida International University, USA

Nicholas Oehm, Florida International University, USA

Joshua Ellis, Louisiana State University, USA

Darryl Dickerson, University of New Mexico, USA

ABSTRACT

Contemporary science education faces a fundamental tension: while STEM engagement for human and planetary well-being has never been more critical, teaching conditions often constrain educators to narrow, test-oriented instruction. We present an instrumental case study that examines how Mr. V., a secondary science teacher in Florida, navigates accountability demands while cultivating transformative STEM engagement. Drawing on goal congruity theory, masculine defaults research, and affirmative critique, we investigate how classroom practices can serve as levers for systemic transformation. Using interviews, classroom observations, and professional development documentation, our relational materialist analysis revealed that Mr. V. systematically redirects agentic elements—individual performance and technical mastery—toward communal purposes while disrupting masculine defaults that privilege speed, independence, and competition. Through a consistent four-part pedagogical pattern, he positions high-stakes testing as punctuation rather than domination, creating space for community-building and civic engagement. Our

findings suggest two pathways for transformation: making student STEM experience synonymous with communal practice may influence career perceptions and participation patterns, while disrupting unnecessary agentic defaults creates more inclusive environments. Rather than working around accountability constraints, Mr. V. demonstrates how strategic classroom practices can simultaneously address testing demands and cultivate students as potential transformers of STEM's social purposes.

Stand-Alone Paper

Designing and Assessing a Science Unit for Improving Media Literacy

Mitchell Klocke*, Drake University, USA

Jerrid Kruse*, Drake University, USA

Lucas Menke, Drake University, USA

Sarah Borzo, Drake University, USA

Sarah Hunt, Drake University, USA

Maddie Kampf, Drake University, USA

ABSTRACT

Science media literacy (SML) is essential for navigating the growing volume of science information online and through social media, yet explicit instruction in SML is uncommon in middle school classrooms. This study investigates the impact of a science unit designed to integrate SML with science content related to the water cycle, farm runoff, and water quality. Seventh-grade students from a mid-sized midwestern district were assigned to either a control group, which completed science activities, or an experimental group, which engaged in the same activities with added explicit and reflective SML instruction. We will report on changes in students' confidence distinguishing real from fake news, understanding of how news is made, and beliefs about media using statistical analyses of a pre/post survey. Findings include that explicit SML instruction significantly improved students' confidence in evaluating news credibility and was positively correlated with reported understanding of news production. While no significant changes were found in some belief-based measures (e.g., overcoming personal bias), findings suggest that targeted, explicit SML instruction embedded in science content can enhance students' ability to critically engage with media. Implications and next steps will be discussed.

Stand-Alone Paper

Examination of Changes in Students' Epistemological Beliefs, Critical Thinking Skills, and Science Process Skills

Feral Ogan-Bekiroglu*, Marmara University, Turkey

Erol Suzuk, Marmara University, Turkey

Cansu Sivgin, Marmara University, Turkey

ABSTRACT

This study aimed to investigate the development of high school students' epistemological beliefs, critical thinking dispositions, and science process skills from 9th to 12th grade. Using a

cross-sectional design, data were collected from 1174 high school students. The findings revealed that all three constructs showed growth between 9th and 11th grades, followed by a slight decline in 12th grade. Engagement and Innovativeness improved significantly over time, while Cognitive Maturity remained relatively stable. Students' epistemological understanding became more sophisticated and their science process skills increased through 11th grade but dipped slightly in the final year. These results highlight the importance of sustained cognitive and inquiry-based challenges and underscore a potential stagnation in students' intellectual development during final year of high school.

Measuring and Tracking STEM Identity and Beliefs

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

20-Apr-26, 8:15-9:45

Location: Aspen (L2)

Stand-Alone Paper

The Student Science Identity (SSI) Questionnaire: A Multi-Group Validation Study Among US College Students

Ava Breitbeck*, Syracuse University, USA

Gizem Ozyazici, Syracuse University, USA

John Tillotson, Syracuse University, USA

Qiu Wang, Syracuse University, USA

ABSTRACT

Students' level of science identity – their belief that they are a science person – is a critical predictor of their engagement and success in STEM programs. The Student Science Identity (SSI) Questionnaire is a new tool used to assess students' science identity, but it has so far only been validated among high school students in China. We used a multi-group confirmatory factor analysis (CFA) approach to test the scale's psychometric properties among a diverse group of U.S. college students. CFA results showed an almost excellent fit with four factor models with residual correlations ($CFI = .93$, $TLI = .92$, $RMSEA = .072$ (90% CI = [.068, .077])), which indicates that the SSI Questionnaire is a valid instrument to assess U.S. college students' science identity. In addition, results showed that STEM major students have significantly higher levels of science identity than their non-STEM major peers. The model produces acceptable fit for both underrepresented minority (URM) students and non-URM students in STEM fields. This study facilitates further use of the scale by validating its psychometric properties in English and testing its suitability for college students, thus extending the scope of the instrument to higher education and cross-cultural contexts.

Stand-Alone Paper

Measurement Invariance of the Community of Inquiry Survey Framework Across Diverse In-person College Chemistry Environments

Regis Komperda*, San Diego State University, USA

Jungwon Kim, San Diego State University, USA

ABSTRACT

The Community of Inquiry (CoI) survey has been used to evaluate students' perceptions of constructive learning environments in online educational programs. Given the popularity of constructivist approaches in STEM education, modifications were made to the original CoI measurement to better suit in-person contexts. This study tests the generalizability of the modified CoI measurement with four samples from chemistry courses at three universities across the United States, with unique institutional culture and demographics. Various factor models suggested in the literature are tested; a four-factor model emerged as the most concise and effective for comparing observed or latent scores across diverse groups. Importantly, this model acknowledges the significance of the cognitive-affective dimension in constructive learning, serving as a catalyst for nurturing students' curiosity, interests, and intrinsic motivation. Overall, this study underscores the wide-ranging adaptability of the CoI framework and its measurement across diverse educational settings that prioritize constructive learning and teaching.

Stand-Alone Paper

Disciplinary Beliefs, Perceptions, and Performance: A Within-Student Comparison of Introductory Chemistry and Physics

Lindsay Wheeler*, University of Virginia, USA

Lynn Mandeltort, University of Virginia, USA

Eric Bredder, University of Virginia, USA

Josipa Roksa, University of Virginia, USA

ABSTRACT

Introductory STEM courses can function as curricular and intellectual “gateways” with long and short term effects on students’ experiences and outcomes. While prior research has examined factors such as students’ self-efficacy, mindset, and belonging in performance, most studies analyze these relationships within a single discipline or aggregate across STEM. Guided by Social Cognitive Theory and our conceptual framework, this exploratory quantitative study examines within-student similarities and differences in beliefs, perceptions, and performance across introductory chemistry and physics. Undergraduates (n=365) completed pre/post surveys for both courses between Fall 2023 and Spring 2025, measuring self-efficacy, disciplinary mindset, and belonging, along with perceptions of instructor and peer support. Institutional data provided demographics and grades. Pearson correlations and hierarchical linear regressions assessed discipline-specific relationships and predictors of course performance. Results revealed stronger relationships between instructor support and both growth mindset and belonging in physics than in chemistry. Regression models explained more variance in physics grades ($R^2=.312$) than in chemistry ($R^2=.202$), with post-survey disciplinary beliefs contributing more strongly to physics performance. Findings suggest predictors of performance differ meaningfully across STEM disciplines, challenging

the assumption of a unified STEM learning model. Understanding these differences is essential for designing inclusive, discipline-specific interventions.

Visitor Experience, Emotion & Engagement

Strand 6: Science Learning in Informal Contexts

20-Apr-26, 8:15-9:45

Location: Virginia (L4)

Stand-Alone Paper

What Engages Us in the Museum? Revisiting Science Museum Education through the Lens of Engagement

Yael Eshed silver*, Technion Israel Institute of Technology, Israel

Tali Tal, Technion Israel Institute of Technology, Israel

ABSTRACT

We examined how science museums can foster meaningful engagement with underrepresented youth through participatory, justice-oriented educational practices. Drawing on an ethnographic case study of the “Personal Involvement” program within the Citizen Lab initiative: a partnership between a university-affiliated science museum and a diverse urban community, we explore how sustained youth involvement can disrupt exclusionary norms. Guided by the question, “Which educational practices effectively foster the engagement of underrepresented youth in science museums?”, the study highlights the pedagogical principles and institutional commitments that enabled transformative participation.

We demonstrate that when youth are treated as equals: given real responsibilities, public-facing roles, and access to institutional structures, they develop a stronger sense of belonging, agency, and scientific competence. The program emphasized relational inclusion, dialogue, and cultural responsiveness, enabling students from diverse backgrounds to serve as science communicators. Through reflective thematic analysis, we show how the museum became a site of epistemic justice, where youth contributed to shaping public engagement with science.

This study offers a practical model for academia–community partnerships that move beyond symbolic inclusion toward authentic collaboration. It contributes to the broader discourse on equity in informal science learning and underscores the importance of dialogic, co-constructed, and culturally embedded engagement.

Stand-Alone Paper

AI and Human Thematic Mapping of Volunteer Motivation and Sustained Engagement in Citizen Science Program.

Meena Kharatmal, Texas State University, USA

Kristy Daniel*, Texas State University, USA

Kristi Becker*, Texas State University, USA

Jill Zipperer*, Texas State University, USA

ABSTRACT

The study proposes a meta-methodological analysis of comparing AI and human generated themes in a qualitative study for exploring volunteer motivation and sustained engagement in citizen science program. We used a sample of 178 open-ended responses, 9 focus group interviews, 66 graffiti-wall responses and 231 token voting responses for reflexive thematic analysis to create code, categories, and human generate analytical themes. Further, we have input the same data sources into AI using Claude 4.0 Sonnet LLM, with set of prompts to an output of AI generated themes. The findings suggest both the AI and human generated themes depicted convergent themes, with some AI unique and human unique themes, mapped to the conceptual frameworks. The AI unique generated themes indicated the organizational support and challenges often seen as obstacles in the program. The human generated themes added the contextual richness, deeper insights and highlighted the program serving for emotional well-being. This meta-methodological study demonstrates that while both approaches capture core motivational themes effectively, they offer distinct and valuable contributions that offers hybrid qualitative analysis in citizen science research. We present the implications and recommendations of practice for using AI in qualitative research in informal science contexts.

Stand-Alone Paper

Emotional Experiences of Visitors in a Science Centre

Neta Shaby*, University of Southampton, United Kingdom

Nancy Staus*, Oregon State University, USA

ABSTRACT

Emotions play a vital role in learning, yet they remain under-researched, especially in informal settings like science centres. As interest grows in the emotional dimensions of learning, this study aims to explore the emotional experiences of families during their visit to a science centre, focusing on the types of emotions expressed, how these vary across exhibits, and whether science-related conversations is linked to emotional expression. Fifteen families were video-recorded during their visits, and emotional expressions were analysed using the EMOTool framework. Emotions were identified through both verbal and behavioural cues, with attention to specific family members, exhibit contexts, and science-related discussions. Across the dataset, 13 distinct emotions were expressed, predominantly positive ones such as excitement. Emotional responses varied widely between families and across exhibits, with more expressions observed in exhibits involving challenge, competition, or open-ended interaction. Science conversations were relatively infrequent and rarely tied to emotional expression. This research contributes to informal science education by highlighting how specific exhibit features elicit emotional engagement. These findings have

implications for exhibit design and learning facilitation, supporting a more holistic approach that integrates emotional and cognitive dimensions of visitor experience.

Stand-Alone Paper

Relational Methodologies in Natural History Museum Evaluation: Visitor Learning through Embodiment and Cultural Storytelling

Rachel Chaffee*, American Museum of Natural History, USA

Gladys Rowe*, Indigenous Insights Collective, USA

Albeliza Perez*, American Museum of Natural History, USA

Ida Ayu Sakira Hermawan, American Museum of Natural History, USA

ABSTRACT

One of the most profound challenges educators face in helping people learn is the difficulty of overcoming long-standing societal beliefs, assumptions, and cultural messages that impede deep understanding. This study explores how a decolonial relational methodology focused on embodiment and cultural storytelling can expand the ways in which visitors learn about contemporary Indigenous and First Nation cultures in the context of a natural history museum. Grounded in decolonizing and Indigenous methodologies that incorporate a collaborative and relational approach as a means to sustain and deepen relationships and connections, we present the ways in which our study of visitor experience in a cultural hall design intentionally centers stories, experiences, and knowledges of Indigenous peoples and communities, and disrupts and decenters colonial research and evaluation paradigms of extraction. Findings from this study suggests that visitors desire to engage in informal learning spaces in ways that foster connection with the communities natural history museums represent in their cultural halls.

Preparing Culturally Responsive, Socioscientific Decision-Makers in Science Teacher Education

Strand 7: Pre-service Science Teacher Education

20-Apr-26, 8:15-9:45

Location: Columbia (L4)

Stand-Alone Paper

Exploring Preservice Science Teachers' Decision-Making Processes and Influencing Factors regarding Socioscientific and Sociotechnical Scenarios

Mustafa Topcu*, Yildiz Technical University, Turkey

Nejla Atabey, Mus Alparslan University, Turkey

ABSTRACT

Using controversial issues such as socioscientific and sociotechnical issues/problems can provide learning contexts for advancing STEM education. While there is a substantial body of

research on students' and teachers' decision-making processes and influencing factors regarding socioscientific issues (SSI), limited research exists on their decision making and influencing factors concerning sociotechnical problems. Therefore, three research questions guided the present study: (1) Can the SEE-STEP analytical framework be used to analyze decision making on the sociotechnical scenario in the context of science education research? (2) How do Preservice Science Teachers' (PST) decisions differ between socioscientific and sociotechnical scenarios? (3) What subject areas/factors influence PST's decision making on socioscientific and sociotechnical scenarios? This qualitative study involved 48 PST enrolled in a science education undergraduate program at a public university in western Türkiye. Data were collected through socioscientific and sociotechnical scenarios. The findings indicated that the SEE-STEP analytical framework can be used to analyze decision-making in sociotechnical scenarios. While PST exhibited greater diversity in their decisions on the SSI, their decisions regarding the sociotechnical scenario showed less variation. PST's SSI decisions were shaped by science and risk analysis, whereas sociotechnical decisions were influenced by technology and security analysis.

Stand-Alone Paper

Growth of Personal Pedagogical Content Knowledge in Elementary Preservice Teachers Engaged with Socioscientific Issues Instruction

Melanie Kinskey*, Texas A&M University, USA

Crista Banks*, University of Alabama, USA

Jeff Papa*, Kent State University, USA

ABSTRACT

This study explores how elementary preservice teachers develop personal pedagogical content knowledge (pPCK) for socioscientific issue (SSI)-based instruction by connecting science to students' lived experiences. Guided by the Dynamic Systems Model of Role Identity (DSMRI), we analyzed reflections from a semester-long science methods course with integrated fieldwork and SSI instruction. Findings show that as preservice teachers engaged in field experiences, participated in modeled SSI lessons, and planned their own SSI lessons, they shifted from idealized views of teaching to more nuanced understandings grounded in real classroom contexts. They increasingly emphasized inquiry, inclusivity, and relevance, which are hallmarks of meaningful science knowledge-making. In this presentation, we will share key themes from their reflections, illustrative examples of identity shifts, and implications for leveraging teachers' unique identities to develop their pPCK for SSI instruction.

Stand-Alone Paper

Reviewing Design Principles to Develop Culture-Based Socio-Scientific Issues Training Programme for Indonesian Pre-service Science Teachers

Aprillyana Utami*, University of Southampton, United Kingdom

Andri Christodoulou, University of Southampton, United Kingdom

Marcus Grace, University of Southampton, United Kingdom

ABSTRACT

Socio-scientific issues (SSIs) have been employed over the last two decades to promote scientific literacy. In teaching SSIs, teachers need to consider students' socio-cultural background as their initial knowledge and decision-making can be influenced by their cultural beliefs. To deliver SSI lessons, competent teachers are required. Prior studies have attempted to introduce SSIs to Pre-service Science Teachers (PSTs). However, teacher trainers have not yet anchored their work in students' socio-cultural backgrounds, despite the critical role of providing culturally relevant science teaching. Considering the importance of including students' socio-cultural backgrounds in teaching SSIs, this study aims to address how science educators can prepare PSTs by exploring design principles that can be used to develop a CBSSIs training programme for Indonesian PSTs. A literature review and semi-structured interviews were conducted to explore the design principles, involving PSTs, lecturers, and experts. The results extracted five design principles, which are a) Understanding SSIs/CBSSIs, (b) Experiential Learning, (c) Collaboration and Reflection, (d) Accommodating Third Space, and (e) Practical Implementation. This study offers a theoretical contribution for educators on the principles to apply when teaching CBSSIs to PSTs.

Stand-Alone Paper

"I Am a Researcher": Authentic Research Shaping Pre-Service Teachers' Researcher Identity and NOS/NOSI Understanding

Heidi Turcotte*, Georgia State University, USA

Renee Schwartz, Georgia State University, USA

ABSTRACT

This study examines how participation in an authentic research experience influences Pre-service teachers (PSTs) science researcher identity and understanding of Nature of Science (NOS) and Nature of Scientific Inquiry (NOSI). Data were collected through a variety of surveys, lab observations and weekly reflections that were analyzed through emerging and thematic coding to identify patterns and create a profile and explore how authentic research experience shaped participant NOS/NOSI understandings and science researcher identity. Findings from this case study revealed that Davis initially viewed math and science separately, identifying more as a "numbers guy" than a science researcher. Over the program, he began integrating math into scientific reasoning, shifting from a passive science consumer to an active researcher, designing lab protocols and applying inquiry-based approaches to his future teaching. By the end, Davis conceptualized teaching as a form of research, uniting his researcher and teacher identities through intentional experimentation and data-driven instructional adjustments. Overall this study suggests that engagement with scientific practices shape PSTs science researcher identity and NOS/NOSI understandings and highlights the shift to move beyond a compartmentalized view of disciplines. The study further suggests the need for teacher preparation programs to include more opportunities for authentic research experiences.

Resources and challenges for emerging STEM teachers

Strand 8: In-service Science Teacher Education

20-Apr-26, 8:15-9:45

Location: Cedar AB (L2)

Stand-Alone Paper

Challenges or Assets: Early Career STEM Teachers' Perception of Students as Resources

Adepeju Prince*, Kent State University, USA

Shannon Navy, Kent State University, USA

ABSTRACT

Early career science, technology, engineering, and mathematics (STEM) teachers (ECSTs) often begin their careers with full professional responsibilities but limited classroom experience, navigating different teaching contexts. While research frequently frames students through challenges to manage, this study explores how ECSTs perceive and utilize students as resources during their first five years. Guided by an asset-based framework and sociocultural theory, we conducted a qualitative analysis of longitudinal data from ten ECSTs in high-needs middle and high schools. Data sources included post-observation and end-of-year interviews across three academic years, analyzed inductively using NVivo 14. Findings show that ECSTs recognized students as feedback providers, instructional collaborators, and sources of motivation. Drawing upon student needs, performance data, and identities, findings from three academic years of lesson planning, science instruction, and reflection show that ECSTs shifted from structured, teacher-directed approaches to co-constructed learning environments, incorporating student agency and leadership. These evolving perceptions illustrate how student presence and participation contribute to ECST professional growth and identity development. The study extends knowledge on teacher induction by positioning students as active contributors to ECST's professional development, with implications for pre-service preparation and ECST retention.

Stand-Alone Paper

Teacher Movers: Longitudinal Study of Early Career Science and Math Teachers' Migration Decisions

Lisa Borgerding*, Kent State University, USA

Shannon Navy, Kent State University, USA

Adepeju Prince*, Kent State University, USA

Paulo Loureiro*, University of Georgia, USA

ABSTRACT

Science and math teacher shortages are partially caused by teachers leaving their schools and leaving the profession. Teacher migration to different schools has negative impacts for

hard-to-staff schools. Previous literature has documented the rates of teacher leavers and movers, reasons for moving, and features of the departure and arrival schools. The present study extends this literature by following teacher movers into their new schools and capturing teacher movers' perspectives on their moves in a longitudinal study. This multiple case study follows 10 early career science and math teachers teaching in high-needs contexts and changed schools within a three-year period in order to better understand teachers' migration experiences. Data sources included three years of beginning-of-year interviews, end-of-year interviews, and career intentions surveys. Findings from this study can help science teacher educators and administrators better understand how early career teachers achieve a "fit" within their school positions and may yield implications for job preparation, placement, and supports for retention.

Stand-Alone Paper

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 qualitative methods approach was used to analyze interview data. The interviews focused on teachers' perceptions of the quality of social resources and their reasons for using or not using resources. 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. Teachers' perception of social resources influenced their use, which emphasized the importance of individualized teacher support. 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.

Stand-Alone Paper

Mapping resilience: How summer break activities influence resilience trajectories of newly hired STEM teachers

Jose Pavez*, Western Illinois University, USA

Ella Yonai, Auburn University, USA

Shanon Navy, Kent State University, USA

ABSTRACT

Teacher turnover remains a persistent challenge in U.S. schools, particularly in high-need contexts where mathematics and science teachers are at heightened risk of leaving the

profession within their first five years. While resilience has been identified as a critical factor in teacher persistence, little attention has been paid to how non-instructional periods, such as summer break, shape resilience trajectories. This mixed-methods study investigates how summer activity patterns, categorized as All Work, All Leisure, or Some Work–Some Leisure, influence the resilience of 25 newly hired STEM teachers in high-need schools over a two-year period. Quantitative analyses of survey data revealed modest but consistent increases in resilience between summer-adjacent time points, particularly in the emotional dimension. Qualitative interviews illuminated distinct pathways: All Work teachers emphasized preparedness but risked depletion, All Leisure teachers prioritized recovery but sometimes lagged in readiness, and Mixed teachers demonstrated a balance of professional growth and emotional restoration. Findings underscore summer as a strategic window for sustaining resilience, with implications for school leaders, teacher preparation programs, and policymakers. By identifying how teachers' summer choices contribute to resilience, this study extends theoretical understandings of resilience as dynamic and multidimensional and provides practical recommendations for improving STEM teacher retention.

Reimagining Science Education with Global and Societal Challenges at the Center

Strand 10: Curriculum and Assessment

20-Apr-26, 8:15-9:45

Location: Greenwood (L3)

Stand-Alone Paper

Exploratory Content Analysis: Food-Energy-Water Nexus in Chinese High School Biology Textbooks for Systems Thinking

Rudan Wang*, Purdue University, USA

Hui Hui Wang, Purdue University, USA

Hezhe Li*, Purdue University, USA

Shuangting Li, Purdue University, USA

ABSTRACT

Systems thinking in science education thrives on meaningful, contextual learning. Well-curated textbook content that connects to students' everyday life provides a crucial foundation for developing systems thinking skills. This study qualitatively analyzes the presence of Food-Energy-Water (FEW) Nexus concepts in Chinese high school biology textbooks using a modified FEW Nexus framework. Findings show that food, energy, food-energy, and food-water are the most frequent concepts, while the full FEW Nexus is less represented, particularly in the new edition compared to the old. The new edition contains fewer codes on other life sciences but more on food systems and human health, indicating stronger real-world connections. Prominent examples include a biogas project and vertical agriculture, with the latter serving as an implication of the mini-unit integrated STEM lesson designed to cultivate students' system thinking skills. The study underscores the need to

expand FEW Nexus content to strengthen systems thinking and offers practical insights for educators seeking to use the FEW Nexus as a context for integrated STEM instruction.

Stand-Alone Paper

Astro-sociology Curriculum to Promote Science Identity and Global Citizenship

Chen Chen*, The University of Hong Kong, Hong Kong

Zeyu Han, The University of Hong Kong, Hong Kong

Kejian Qiu, Warwick University, United Kingdom

Gerhard Sonnert, Harvard University, USA

ABSTRACT

This study explores the integration of astronomy with socio-scientific issues (SSI) to advance scientific literacy and civic engagement among middle school students. By embedding astrosociology—a field examining interactions between space activities and human societies—into curricula, this approach connects STEM content with ethical and governance considerations. Neutral hypothetical space scenarios (e.g., Mars immigration, planetary defense) provide contexts for inquiry-based learning. A randomized controlled trial (N=59) evaluated the impact of this curriculum compared to a traditional astronomy course. Results from growth model analysis indicated a significant positive impact on the growth trajectory of Global Citizenship in the treatment group. While both groups showed significant growth in Science Identity over time, the intervention did not significantly alter this trajectory compared to the control. The findings suggest that astrosociology serves as an effective venue for delivering both science content and fostering the global awareness necessary for navigating complex, transnational challenges.

Stand-Alone Paper

Dialogic Argumentation about Health Equity in a Text-Based NGSS Biology Seminar

Jeanne Chowning*, Fred Hutchinson Cancer Center, USA

Regina Wu, Fred Hutchinson Cancer Center, USA

Kristen Bergsman, Fred Hutchinson Cancer Center, USA

Kristin Bass, Rockman et al Cooperative Inc., USA

Maggie Deagon, Rockman et al Cooperative Inc., USA

Shelley Stromholt, Aspect Research + Evaluation, USA

ABSTRACT

Although the Next Generation Science Standards (NGSS) foreground disciplinary core ideas, science and engineering practices, and crosscutting concepts, they offer little explicit guidance for addressing justice issues in science and society. This study examines how high school biology students engaged with an NGSS quality-rated biology unit that integrated a cancer storyline and opportunities to explore the historical, social, and personal dimensions of science. We examined argumentation in a text-based health equity seminar enacted by five teachers across five schools. Using a sociocultural lens, we analyzed data from 150

students. Data sources included surveys, interviews, classroom audio, teacher logs, and student work. Findings show that the seminar promoted relevance by connecting science to students' lives and societal contexts. Students engaged in dialogic argumentation while reflecting on systemic health inequities and their capacity to address them. Some reported increased awareness of health care justice; others felt validated when discussions acknowledged lived experiences tied to inequity. Overall, the study underscores the value of justice-focused, text-centered argumentation within NGSS-aligned units and the need to embed equity-focused dialogic approaches that prepare students to engage critically with societal challenges and contribute to a more just world.

Stand-Alone Paper

Reimagining school science: Harnessing scientific thinking and socio-scientific issues for student engagement and empowerment

Crystal Menzies*, University of California Berkeley, USA

Kelly Grindstaff*, University of California Berkeley, USA

Eric Greenwald*, University of California Berkeley, USA

Janet Bellantoni*, University of California Berkeley, USA

Ben Koo*, University of California Berkeley, USA

ABSTRACT

This position paper presents a framework for extending socio-scientific issues (SSI) approaches through Scientific Thinking for All: A Toolkit, a secondary curriculum adapted from a university course course [Blinded]. We propose two key theoretical advances: first, providing students with an explicit “toolkit” of transferable scientific thinking strategies applicable across diverse contexts; and second, embedding “scientific optimism,” a solutions-oriented approach positioning students as active agents rather than passive observers. Implementation across 20 diverse classrooms, from elite private schools to schools that serve high proportions of low-income students, revealed consistent positive impacts on students' understanding of science as a process, reasoning about uncertainty, and ability to distinguish facts from values. Qualitative findings demonstrate transformative impacts on scientific identity, with students developing sophisticated understanding of science while seeing themselves as capable scientific thinkers. Teachers reported the curriculum's accessibility for all learners, particularly noting its effectiveness in inclusive classrooms and with students lacking prior science knowledge. The curriculum's success challenges deficit-models of science education, demonstrating that intellectually rigorous content becomes universally accessible when grounded in students' lived experiences. This toolkit approach offers a path for reimagining science education that empowers all learners with agency to address complex real-world challenges.

Justice-Centered and Arts-based Science Teaching and Learning Across Spaces & Places

Strand 11: Cultural, Social, and Gender Issues

20-Apr-26, 8:15-9:45

Location: Willow A (L2)

Symposium

Justice-Centered and Arts-based Science Teaching and Learning Across Spaces & Places

Mindy Chappell*, University of Illinois Urbana Champaign, USA

Jonathan McCausland, Iona University, USA

Maria Varelas, University of Illinois Chicago, USA

Argyris Nipyrakis, University of Groningen, Netherlands

Betzabe Torres-Olave, University of Groningen, Netherlands

Stephanie Batres Spezza, University of Illinois Chicago, USA

ABSTRACT

In urgent times that call for radical imagination and responsive pedagogies, this symposium explores the integration of justice-centered and arts-based practices in science education as a form of joyful transgression. These approaches challenge canonical boundaries, re-envision learning spaces, and position science education as a vehicle for collective liberation. Responding to NARST's theme, Joyful Transgressions and Radical Imagination in Science Education, we convene scholars working in solidarity with students, teachers, and communities. We interrogate how arts-based methodologies rooted in care and creativity can serve as transformative tools for deepening engagement with justice-centered science. Drawing on pluriversal conceptions of justice in science education (Kayumova & Dou, 2022) and understandings of art as a powerful mode of inquiry and expression (Leander & Boldt, 2012), we frame context as an active terrain for radical world-building. We explore how justice and art together support expressing lived experiences, engage multiple ways of knowing, and foster spaces where science learning is inclusive, liberatory, and responsive to sociocultural realities. This symposium showcases how arts-integrated practices can embody justice and transform both the content and culture of science education. These contributions offer radical possibilities for reconfiguring what science education looks like, who it serves, and how it can be co-created.

Beyond Survival: Joyful Transgressions and Radical Imagination of Black Girls and Black Women Science Teachers

Strand 11: Cultural, Social, and Gender Issues

20-Apr-26, 8:15-9:45

Location: Willow B (L2)

Related Paper Set

Centering Spirit and Science: Black Women Teachers Resisting Anti-Blackness in the Curriculum

Karin Mason*, Georgia State University, USA

Renee Schwartz, Georgia State University, USA

Natalie King, Georgia State University, USA

Patrick Enderle, Georgia State University, USA

ABSTRACT

This case study examines how Black women secondary science teachers resist anti-Blackness through intentional curricular and pedagogical decisions. Framed by womanist pedagogy and anti-Blackness, teachers in this study reject colorblindness, uplift their students' identities, and critique the racialized absences in traditional science curricula. Their teaching fosters critical consciousness, connection, and care. In doing so, they enact joyful transgressions reshaping science learning into a liberatory experience for Black youth, grounded in cultural relevance and humanization.

Related Paper Set

I Should Know, I Once Was Her: Black Women Science Teachers Engaging Black Girls

Teresa Massey*, Georgia State University, USA

Renée Schwartz*, Georgia State University, USA

Natalie King*, Georgia State University, USA

Patrick Enderle*, Georgia State University, USA

ABSTRACT

What happens when Black girl brilliance and the humanity of Black women educators are centered as the foundation of science teaching and learning? This related paper set explores the radical possibilities that emerge when joy, identity, and care become non-negotiables in science education. These four studies offer counternarratives to deficit discourse and position resistance, relationality, and wellness as transformative forces toward liberation. Paper 1, a phenomenological study, illuminates the experiences of Black girls navigating AP and IB biology courses, revealing how supportive networks and dreams for the future open pathways to reimagine science education. Paper 2, grounded in anti-Blackness and Womanist Pedagogy, examines Black women secondary science teachers' critical engagement with curricula to disrupt sociopolitical inequities. Paper 3, using sista circle methodology, highlights how shared lived experiences and cultural connection allow Black women science teachers to cultivate STEM belonging and affirm Black girls' identities. Paper

4, an embedded case study, reframes Black women teachers' self-care as radical resistance, showing that wellness is essential to sustaining equity work. Anchored by a presider and discussant whose scholarship centers Black girls and Black women teachers, this session invites the NARST community to imagine and enact science education as a joyful and liberatory space.

Related Paper Set

Sustainable Self-Care as Radical Resistance for Early Career Black Women Science Teachers

Jelissa Wright, Georgia State University, USA

Meagan Naraine, Georgia State University, USA

Natalie King, Georgia State University, USA

Andrea Dziengue, Georgia State University, USA

ABSTRACT

Together, these four papers illuminate the radical possibilities of science education when Black girls and Black women early-career and veteran educators center joy, identity, and humanity. Each study offers a counternarrative to the dominant deficit discourse by highlighting resistance, care, and relationality as transformative forces. From affirming Black girls in advanced science courses to prioritizing teacher wellness as resistance, this session explores how joyful transgressions and radical imagination can reshape science education for liberation.

Related Paper Set

Dreaming Beyond the Lab Coat: Black Girls' Experiences in Advanced Science Courses

Jessica Snead*, Georgia State University, USA

Natalie King*, Georgia State University, USA

Renée Schwartz*, Georgia State University, USA

Patrick Enderle*, Georgia State University, USA

ABSTRACT

What happens when Black girl brilliance and the humanity of Black women educators are centered as the foundation of science teaching and learning? This related paper set explores the radical possibilities that emerge when joy, identity, and care become non-negotiables in science education. These four studies offer counternarratives to deWcitt discourse and position resistance, relationality, and wellness as transformative forces toward liberation. Paper 1, a phenomenological study, illuminates the experiences of Black girls navigating AP and IB biology courses, revealing how supportive networks and dreams for the future open pathways to reimagine science education. Paper 2, grounded in anti-Blackness and Womanist Pedagogy, examines Black women secondary science teachers' critical engagement with curricula to disrupt sociopolitical inequities. Paper 3, using sista circle methodology, highlights how shared lived experiences and cultural connection allow Black

women science teachers to cultivate STEM belonging and affirm Black girls' identities. Paper 4, an embedded case study, reframes Black women teachers' self-care as radical resistance, showing that wellness is essential to sustaining equity work. Anchored by a presider and discussant whose scholarship centers Black girls and Black women teachers, this session invites the NARST community to imagine and enact science education as a joyful and liberatory space.

Learning Progression and GenAI for Supporting Teacher Instructional Adaptations and Student Three-Dimensional Learning

Strand 12: Technology for Teaching, Learning, and Research

20-Apr-26, 8:15-9:45

Location: Ballard (L3)

Related Paper Set

Toward Development: From Customizing Classroom Assessments with ADAPT-AI to Further Supporting 3D Learning Progression

Lalith Midde, Washington State University, USA

Hyeonji Lee, Washington State University, USA

Zeyuan Wang, Washington State University, USA

Tingting Li*, Washington State University, USA

ABSTRACT

This study explores how generative AI can support teachers in designing equitable, NGSS-aligned three-dimensional (3D) science assessments. While the NGSS vision emphasizes knowledge-in-use, teachers often face barriers such as limited time, insufficient expertise, and lack of professional learning. To address these challenges, we developed ADAPT-AI, a generative AI-empowered assessment design platform grounded in evidence-centered design. Using a design-based research approach, Phase I examined how teachers used ADAPT-AI to design customized 3D assessments. Findings show that ADAPT-AI reduced technical burdens and scaffolded attention to disciplinary practices, encouraging richer, multidimensional tasks. However, teachers also highlighted needs for equity—simplifying language for multilingual learners, contextualizing tasks within curricula, and refining rubrics to capture growth across 3D learning progressions (3DLP). Phase II, currently underway, embeds ADAPT-AI into professional learning workshops to investigate its potential for supporting personalized, longitudinal trajectories of 3DLP. This work advances human-AI collaborative design and outlines a developmental trajectory from task customization toward sustained support for student learning progression.

Related Paper Set

Teachers Use of 3D Learning Progression to Adapt Local Instructional Materials: A Multiple Case Study

Zeyuan Wang*, Washington State University, USA

Peng He, Washington State University, USA

Timothy Fiser, Washington State University, USA

Yu Xue, Washington State University, USA

Namsoo Shin, Michigan State University, USA

Joseph Krajcik, Michigan State University, USA

ABSTRACT

Translating the vision of the Next Generation Science Standards (NGSS) into responsive classroom practice is challenging, as teachers must balance coherence, developmental sequencing, and local relevance. Three-Dimensional Learning Progressions (3DLPs) offer a framework for tracing how student understanding develops across disciplinary ideas, practices, and crosscutting concepts, but little is known about how teachers use them to adapt instruction. This multiple case study explored how six middle school science teachers across diverse contexts engaged with a 3DLP for Matter and Its Interactions. Data included interviews, lesson plans, and student interviews, analyzed through thematic and cross-case approaches. Findings show that teachers used 3DLPs to (1) reorganize curriculum sequences, (2) embed assessments as scaffolds, and (3) interpret student ideas developmentally to guide instructional decisions. Adaptations varied by local contexts, reflecting differences in resources and student needs. This study demonstrates the promise of 3DLPs as tools for supporting NGSS-aligned, context-sensitive instruction.

Related Paper Set

2. Supporting Student 3D Learning Development with Learning Progression-based Classroom Assessments

Timothy Fiser*, Washington State University, USA

Peng He, Washington State University, USA

Zeyuan Wang, Washington State University, USA

Yu Wue, Michigan State University, USA

Joseph Krajcik, Michigan State University, USA

ABSTRACT

Three-Dimensional Learning Progressions (3DLPs) offer a powerful framework for supporting students' knowledge-in-use by integrating disciplinary core ideas (DCIs), science and engineering practices (SEPs), and crosscutting concepts (CCCs). Yet few studies link teachers' adaptive use of 3DLP-based assessments to measurable student learning gains. This mixed-method study investigated 290 middle school students across six classrooms where teachers implemented a validated 3DLP on Matter and Its Interactions. Students completed seven embedded assessments aligned with analytic rubrics, and 25 students participated in post-unit interviews. Quantitative analyses revealed significant growth across all three dimensions—DCI, SEP, and CCC—particularly in classrooms where teachers sequenced tasks progressively, embedded formative prompts, and allowed revisions. Qualitative findings highlighted supports such as real-time feedback and cross-task connections, while challenges included applying CCCs and articulating models without scaffolds. This study

demonstrates how 3DLP-based assessments, when intentionally adapted, can advance students' integrated science learning and inform equity-responsive instructional practices.

Related Paper Set

Leveraging GenAI to Generate Actionable Feedback on Student 3D Learning: A Human-Centered Design Approach

Peng He*, Washington State University, USA

Kaiqi Yang, Michigan State University, USA

Honglu Liu, Washington State University, USA

Hang Li, Michigan State University, USA

Yucheng Chu, Michigan State University, USA

Jiliang Tang, Michigan State University, USA

Tingting Li, Washington State University, USA

ABSTRACT

Generative AI (GenAI) offers new possibilities for supporting science teachers in providing timely, individualized, and progression-aligned feedback on students' 3D learning. This study designed and tested a GenAI-powered feedback system using middle school students' written responses to 3DLP-based classroom assessments. We developed structured prompts that embedded validated 3D rubrics and formative feedback principles, then compared outputs under zero-shot and few-shot prompting conditions. Quantitative analyses showed that GenAI reliably generated essential feedback—explicit, goal-oriented, and actionable guidance—with accuracy improving under few-shot prompting. However, variable feedback dimensions, such as adaptivity and timeliness, were largely absent. Qualitative analyses confirmed that while many outputs mirrored human-created structures, others were generic or formulaic. These findings demonstrate both the promise and current limitations of GenAI in supporting progression-aligned science feedback, positioning it as a complementary partner to teacher expertise.

New approaches and methods to NOS and scientific literacy

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

20-Apr-26, 8:15-9:45

Location: Jefferson B (L4)

Stand-Alone Paper

Comparing Approaches of Analyzing Nature of Science Understandings Collected Using Open-Ended Measures

Jeanne Brunner*, University of Massachusetts Amherst, USA

Ryan Summers*, University of North Dakota, USA

Fouad Abd-El-Khalick, University of Massachusetts Amherst, USA

ABSTRACT

This study compares the analysis of 36 Views of Nature of Science – Form C (VNOS-C) questionnaires using the traditional holistic approach and the newly-developed two-part VNOS Analysis and Scoring Rubric (VAScoR). We also explored how NOS aspects are distributed across VNOS-C items, as well as how the quantity of references to a specific aspect relates to the quality of its rating. We found that every question in the VNOS-C provided an opportunity to address multiple NOS aspects, although some questions targeted specific aspects more directly. Additionally, there was no relation between quantity of responses for an aspect and its qualitative rating. Finally, we found that the two-phase approach of the VAScoR provided additional information about participants' views than the qualitative ratings produced by the traditional approach because Phase II considers the targeted aspect and its related aspect. The additional steps in the VAScoR analysis provide important nuances about participants' beliefs about NOS and is likely to be of interest to researchers and teacher educators who use the VNOS in their practice. We also argue that because of the holistic nature of analysis, the VAScoR can likely be used with other NOS instruments or items, which broadens its impact.

Stand-Alone Paper

A Case Study of Mentorship in a High School STEMM Research 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 research internship in a medical school research group, part of an NSF grant. Informed by cascading mentorship and nature of scientist, I consider the assigned faculty mentor as well as the broader research group's mentorship 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, and intern monthly blog posts and final presentations. Findings include that relevant situational expertise in mentorship, science, and the research group, along with a dynamic engine of support and independence and broader interactions and connections, supported interns' seat at the physical table and supportive communication. Open, vulnerable communication and belonging/trust supported a shift from interns' seat at the physical to metaphorical table. This shift was associated with legitimate peripheral and more central participation and learning of the interns within the research group. This work has implications for acculturation and nature of scientist, supporting high school internships and related teaching/learning, as well as higher education STEMM research group functioning.

Graduate Student Research Symposium

20-Apr-26, 8:15-9:45

Location: Redwood AB (L2)

Administrative Session

Organizers

Georgie Schafer, Drexel University, Philadelphia, Pennsylvania, USA

Stephanie Tracey, Clemson University, Clemson, South Carolina, USA

Arya Karumanthra, Indiana University Bloomington, Indiana, USA

Presenters

Aakriti Bisht, University of California, Irvine.

Aidyn Intykbekov, University of Massachusetts Dartmouth.

Chelsea Mateu, Florida International University

Cheyenne Woods, California State University, Fresno

Dana Haine, NC State University

Dimitri Smirnoff, University of Minnesota Twin Cities

Elizabeth Andrew Thiel, Purdue University

Emmanuel Dwamena, University of Connecticut

Glory Saidu, University of Minnesota

Hun Jeong, Seoul National University

João Pedro Santos Coutinho, University of São Paulo

Khadija Zogheib, Florida State University

Lisa Archuleta, Stanford University

London Williams, UCLA

Lorena Caballero, Northern Arizona University

Maria A. Moreno Vera, Boston College

Myeongji Kim, The Ohio State University

Natália Machado Carvalho, University of São Paulo

Paige Prescott, New Mexico State University

Peter Oyewole, Kent State University

Sarah Hajama, Macquarie University

Sarah Lu, University of Toronto

Savvy Demers, University of Massachusetts Boston

Seth Cudjoe, Old Dominion University

Sevde Nur Yeerisenoglu, Bogazici University

Shuochian Joe Shiu, National Sun Yat-sen University

Téa Pusey, UC Davis

Yaa Dankwa, Ohio State University

Yaxin Luo, Beijing Normal University

Yong Xie, Beijing Normal University

Writing, Publishing, and Reviewing for Science Education Journals

20-Apr-26, 8:15-9:45

Location: Issaquah AB (L3)

Administrative Session

Organizers

Edna Tan, UNC Greensboro, Greensboro, NC, USA

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

Matthew Kloser, University of Notre Dame, Notre Dame, IN, USA

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Ron Gray, Northern Arizona University, USA

Scott McDonald, Pennsylvania State University, USA

M. Gail Jones, North Carolina State University, USA

Abstract

This session explores insights into publishing, reviewing, and writing from the editors-in-chief of three major science education journals: *Journal of Research in Science Teaching*, *Science Education*, and *International Journal of Science Education*. The session will provide a vision for successfully contributing manuscripts to these journals, highlight the review process, and raise questions about issues related to academic publishing in science education and current challenges and opportunities that impact the communication of academic research. This session will include a panel discussion with time for participants to raise questions about the academic publishing process.

Technology-Supported Learning for Engagement and Interdisciplinary Sensemaking

Strand 2: Science Learning: Contexts, Characteristics and Interactions

20-Apr-26, 10:00-11:30

Location: Jefferson A (L4)

Stand-Alone Paper

Interdisciplinary sensemaking with ChatGPT - Evidence for extended cognition

Ada Abes*, Technion, Israel

Asnat Zohar, Tehcnion, Israel

Yam Arieli, Hebrew University, Israel

Shulamit Kapon, Technion, Israel

ABSTRACT

The rapid adoption of generative AI (GAI) in education raises questions about its ability to genuinely augment human cognition, particularly in interdisciplinary contexts where differing epistemic cultures create barriers to integration. While GAI can provide scaffolds, analogies, and rapid access to information, little is known about the fine-grained mechanisms by which human–GAI interaction supports productive boundary crossing. This study examines whether a human–GAI conversation can function as a coupled cognitive system that meaningfully advances interdisciplinary sensemaking.

We analysed a 12,203-word conversation between a graduate student, who is transitioning from computer science to computational biology, and ChatGPT. Using discourse analysis and an epistemic collaboration framework, we operationalized three philosophical criteria for extended cognition (Nyholm, 2024): mutual reliance, shared regulation, and interdependence of behavioural capacities.

The findings show that both the student and ChatGPT made essential, complementary contributions: the student provided direction, contextual framing, and novel connections; ChatGPT offered elaborated explanations, examples, simulations, and conceptual connections beyond the student's prior knowledge. This interplay met all three extended cognition criteria and enabled progress unlikely for either agent alone. The methodology offers a foundation for analysing the quality of human-AI collaborations and designing educational interventions and GAI-mediated tools to foster interdisciplinary discovery.

Stand-Alone Paper

When Context Is Constructed: Positioning Virtual Learning Environments on the Contextualization Spectrum

Michael Giamellaro*, Oregon State University, USA

ABSTRACT

Virtual learning environments (VLEs) offer immersive, interactive contexts for science learning, yet their role in contextualizing science phenomena remains uncertain. Drawing on two systematic reviews, we examined how VLEs are represented in science education research. A bibliometric analysis identified two clusters: Augmented and Virtual Reality, and Embodied Cognition and Virtual Field Settings. A meta-analysis comparing virtual, primary (in context), and secondary (with context) contextualization found no significant differences in cognitive outcomes, suggesting that VLEs can be as effective for knowledge gains as real-world contexts. However, the nature and quality of learner experiences in virtual spaces remain underexplored.

In this conceptual paper, we present a framework positioning VLEs as potentially hybrid contexts integrating epistemic, spatial, social, instrumental, and temporal elements. We highlight both risks (e.g., over-contextualization, seductive details) and opportunities (e.g., culturally responsive design, adaptive learning pathways). Guided by driving questions, we

invite discussion on how design, learner characteristics, and instructional mediation influence contextualization in VLEs, and how these environments might be intentionally crafted to optimize engagement, transfer, and inclusivity.

Stand-Alone Paper

The Impact of Gamification on Student Motivation in Science Education: A Meta-Analysis

Kübra BAĞRIYANIK*, Artvin Coruh University, Turkey

Ulaş ÜSTÜN, Middle East Technical University, Turkey

Meral HAKVERDİ CAN, Hacettepe University, Turkey

ABSTRACT

Gamification integrates game elements into learning to enhance motivation. This meta-analysis synthesizes findings from 44 empirical studies published in Turkish and English up to January 2025 to investigate the overall effect of gamification on motivation in science education. From these studies, 89 effect sizes were calculated. The results indicate that gamification has a moderate and statistically significant effect on motivation ($g = 0.716$, 95% CI [0.516, 0.917], $p < .001$). Subgroup analyses reveal that the strongest effect is observed on intrinsic motivation ($g = 0.988$). Furthermore, moderator analyses were conducted to explore the effect of variables such as motivation type and learning environment. This study offers insights for educators and instructional designers seeking to employ gamification in science education.

Making Thinking Visible: Reasoning, Representation, and Classroom Discourse **Strand 4: Science Teaching — Middle and High School (Grades 5-12): Characteristics and Strategies**

20-Apr-26, 10:00-11:30

Location: Ravenna C (L3)

Stand-Alone Paper

Students' Epistemic Modelling through Multimodal Representations

Kason Ka Ching Cheung*, The Education University of Hong Kong, China

Lan Yang, The Education University of Hong Kong, China

ABSTRACT

During modelling, classroom instruction needs to scaffold students into epistemic practices, where students construct, negotiate and peer review scientific models as a community of scientists. However, seldom do studies on scientific modelling focus on how students integrate different modalities in construction, negotiation and peer review of scientific models. A multiple case study design was adopted. To fill in this gap, we co-planned lesson with teachers to facilitate two groups of Hong Kong seventh graders' epistemic modelling,

where structural scaffolds are provided for students to understand the consequential, interactional and intertextual nature of modelling. For each group of seventh graders, we used a camera capturing the whole group setting and another camera capturing what they did on the worksheet. Our findings indicate that each stage of epistemic modelling was characterized by different multimodal semiotic resources. Students' orchestration of multimodal semiotic resources is entangled with their epistemic emotions. To realize further contribution of this research, based on the findings, we create a conceptual framework that delineates the specific modal resources in each stage of modelling (construction, negotiation, peer review).

Stand-Alone Paper

Making Students' Reasoning Visible through a Novel Assessment Format: Claim-REASON TEST (CREATE)

Thineshan Puspanathan*, National Institute of Education, Nanyang Technological University, Singapore

Yann Shiou Ong*, National Institute of Education, Nanyang Technological University, Singapore

Huifen Xu, National Institute of Education, Nanyang Technological University, Singapore

Yew Jin Lee, National Institute of Education, Nanyang Technological University, Singapore

ABSTRACT

This paper introduces the Claim REASON TEST (CREATE), a novel assessment format adapted from the assertion–reason question (ARQ) to make students' reasoning visible. Each CREATE item consists of two parts. In Part a, a multiple-choice question requires students to evaluate the truth of a statement (X) and a statement (Y) and decide whether Y is the reason for X. In Part b, students provide an open-ended response based on their choice in Part a: they may improve the claim–reason pair (if both are true and causally linked), give a correct reason (if both are true but not causally linked), or explain what is wrong (if either is false).

Answering CREATE items engages students in critiquing the scientific accuracy of claims and reasons, as well as judging causal validity. In this study, we developed and trialled CREATE items for primary and secondary science, refining a set of design heuristics to guide item construction. These heuristics offer practical support for science educators to design tasks that assess and foster students' reasoning and argumentation. By embedding structured critique and causal evaluation into assessment, CREATE serves as a targeted formative tool for diagnosing and advancing scientific reasoning in classrooms.

Stand-Alone Paper

Examining Science Teachers' Questioning Patterns for Learning Support : A Computational Grounded Theory Approach

Tongtong Guan*, Research Institute of Science Education, Faculty of Education, China

Jie Yang*, Research Institute of Science Education, Faculty of Education, China

Yonghe Zheng, Research Institute of Science Education, Faculty of Education, China

ABSTRACT

This study investigates how science teachers' questioning patterns support students' learning in high school physics classrooms. Using classroom observation data from 32 lessons comprising 1,274 teacher questions, we applied a computational grounded theory approach integrating large language model-assisted clustering and lag sequential analysis to examine the types, sequences, and instructional functions of teacher questioning. The analysis identified 19 distinct question types, categorized across behavioral, cognitive, and metacognitive levels. Sequential analysis revealed significant transition patterns, including self-reinforcing cycles, chain-like progressions, and cross-level scaffolding sequences, indicating how teachers dynamically structure discourse to guide conceptual construction, foster reasoning, and facilitate knowledge application. Findings highlight that higher-order cognitive and metacognitive questions are strategically embedded within sequences of lower-order prompts to sustain engagement and progressively deepen thinking. This study contributes to both methodological and theoretical discussions by demonstrating the potential of integrating artificial intelligence with discourse analysis to capture fine-grained dynamics of classroom interaction. Implications for teacher professional development include designing questioning strategies that leverage structured sequences to promote multi-level learning support. These insights advance our understanding of questioning as an orchestrated pedagogical practice in science education.

Stand-Alone Paper

Visible and Invisible Self-Regulation: Observational Scenarios from Science Classrooms

Katrin Saks, University of Tartu, Estonia

Kõue Heintalu*, University of Tartu, Estonia

ABSTRACT

To effectively foster students' self-regulated learning (SRL) skills, educators must understand how SRL manifests across various learning activities. Such insight enables teachers to evaluate how instructional design supports SRL development and informs potential adjustments to learning tasks and teaching strategies. This study examined the components and scenario patterns of SRL as they appeared during three distinct learning activities—student-teacher discussion, individual work, and group work—within sixth-grade science classrooms. Data was collected through observational microanalysis across fifteen classroom sessions. Findings revealed that the majority of SRL components emerged during the forethought, planning, and activation phase, with significantly fewer manifestations in the monitoring phase. Among the analyzed learning formats, group work elicited the most SRL components, while discussion activities reflected the fewest. Scenario models constructed from patterned contingencies demonstrated more elaborate SRL sequences in interaction-rich environments, such as group work and guided discussions. This methodological approach provides a deeper understanding of how SRL processes unfold within naturalistic settings and highlights areas where instructional practices can be enhanced to better support students' self-regulatory behavior.

Science Identity Development Across Undergraduate Pathways

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

20-Apr-26, 10:00-11:30

Location: Aspen (L2)

Stand-Alone Paper

External Validation of Undergraduate Research Leads to Gains in Science Identity, Value, and Self-Efficacy

Mary Whitfield*, Edmonds College, USA

J. Shlichta*, Edmonds College, USA

Julia Smith*, University of Washington, USA

ABSTRACT

Course-based undergraduate research experiences (CUREs) are a recognized high-impact practice with documented positive impacts on students' acculturation into science. They provide a scalable mechanism for students at two-year colleges to gain early experiences in research, but unlike students in a university-level URE, there is rarely an opportunity to formally present the work and have it evaluated and validated by an external audience. In this study we explore whether adding an element of external validation to a CURE curriculum leads to gains in measures of STEM identity when compared with students in CURE-only courses. We identified 81 students in CURE courses both with ($n = 41$) and without ($n = 40$) an external validation component, which in this study was the presentation of research results at a public symposium. We used a validated pre and post Likert-style instrument (TIMSI) to measure changes in Science Identity, Values, Self-Efficacy, and career intention. Bayesian regression models were used to test for the impact of the symposium experience. Results show positive effects of external validation on all dimensions with the exception of career intention. Results are preliminary and are limited by a low sample size and the lack of qualitative data, which is forthcoming.

Stand-Alone Paper

High Stress, High Support: Scientific Conferences, Interactions and Identity Development for Undergraduate Women in Science

Stacy Olitsky*, Saint Joseph's University, USA

ABSTRACT

Students from historically marginalized groups remain underrepresented in many areas of science and continue to face barriers to participation and retention. Scientific conferences, as communities of practice beyond the university, can serve as important sites for fostering science identity. However, conferences can also reproduce exclusionary dynamics that disproportionately affect minoritized students. This qualitative study draws on interaction

ritual theory and explores perspectives on scientific conferences of two undergraduate women from minoritized groups who experienced them as pivotal in their trajectories. The findings highlight the importance of inclusive conference structures such as social events, facilitated practice, mentorship, communication across levels of experience, and financial support for attendance. Under these conditions, high stress moments such as presenting research may be emotionally charged but are not necessarily alienating, competitive or individualistic. Instead, they can become highly anticipated interaction rituals that lead to emotional entrainment with colleagues and engagement with shared symbols, thereby forging strong connections to scientific communities. Through chains of successful interaction rituals, students may experience high-stress/high-support validation events as enabling competence, performance, and recognition. Overall, this research offers insights into how conference design and mentoring can be more inclusive in ways that support the retention of minoritized students in science.

Stand-Alone Paper

Development of Science Identity through Student-Work

Gabriel LeBlanc*, The University of Tulsa, USA

Maivi Nguyen, The University of Tulsa, USA

Kathryn Hosbein, Middle Tennessee State University, USA

ABSTRACT

High impact practices, such as undergraduate research, provide a number of benefits for undergraduate students in STEM fields, including the development of a student's sense of science identity. While traditional undergraduate research opportunities provide a fertile ground for students to develop this kind of science identity, they have significant barriers to participation including selectivity, time-constraints, and financial barriers. An additional high-impact practice that is already common on most campuses is internships in the form of student-work. In this work, we explored the possibility that student-work in a chemistry-specific setting can provide an opportunity to develop a student's science identity in similar and difference ways compared with traditional undergraduate research experiences. This was accomplished through a qualitative study in which semi-structured interviews were conducted with student-workers. Using the science identity framework described by Hosbein and Barbera (2020), the interviews were coded and analyzed for themes. Findings from this study support the idea that discipline-based student-work can foster the development of science identity. When considering existing opportunities for students to participate in high-impact practices, this study illustrates how student-work can provide unique opportunities for students to develop science identity without sacrificing income opportunities.

Stand-Alone Paper

Justice-Centered STEM Pedagogy and STEM Identity: Exploring Links Across Intersectional Identities in Higher Education

Juan Garibay, University of Virginia, USA

Lindsay Wheeler, University of Virginia, USA

ABSTRACT

STEM identity, defined as the extent to which individuals see themselves and are recognized as STEM members, plays a critical role in student persistence and performance. While extensive research has examined factors shaping STEM identity, little work has explored its relationship to students' experiences in justice-centered, equity-focused STEM courses. This exploratory, cross-institutional study surveyed 196 students enrolled in 18 social justice-focused STEM courses across 11 U.S. R1/R2 institutions. Grounded in Carlone and Johnson's (2007) science identity framework and QuantCrit methodology, we examined how competence, performance, and recognition intersect with perceptions of justice-oriented course design, practices, and learning. Hierarchical linear regression revealed that students' perceptions of classroom community and preparedness to engage in social justice through STEM significantly predicted STEM identity, beyond demographic and disciplinary factors. Notably, minoritized cis-female students reported significantly lower STEM identity scores, even when accounting for course-based experiences. This study contributes newly developed, theoretically grounded scales for measuring justice-centered STEM pedagogy and highlights the potential of such pedagogies to strengthen STEM identities, particularly through fostering inclusive communities. Findings inform both research and practice by connecting critical pedagogical approaches to identity development and by identifying persistent inequities in STEM.

Beyond the Tenure Track: A Workshop Exploring Career Opportunities in Non-Traditional and Informal Settings

Strand 6: Science Learning in Informal Contexts

20-Apr-26, 10:00-11:30

Location: Willow A (L2)

Symposium

Beyond the Tenure Track: A Workshop Exploring Career Opportunities in Non-Traditional and Informal Settings

Christa Haverly*, Chicago Public Schools, USA

Karen Hammerness*, American Museum of Natural History, USA

Ti'Era Worsley*, NOVA SySTEMic, USA

Jennifer Richards*, Northwestern University, USA

Déana Scipio*, IslandWood, USA

ABSTRACT

More than half of Ph.D's pursue or obtain positions beyond academia. However, doctoral programs often focus on preparing graduating candidates for tenure-line positions, with less guidance for such pathways and access to professional networks outside of academia. Designed for graduate students and early career researchers, this workshop responds to the

growing need to support learning about more diverse professional trajectories, including the kinds of careers available, the range of settings, and the kinds of research made possible in contexts beyond the traditional academy. The session begins with a panel discussion with researchers working in a range of non-traditional settings; and an artifact-based discussion that illuminates the types of research and investigations that take place in these settings. Next, participants explore a range of current job descriptions, collectively investigating the affordances and challenges of these roles as well as how they might position their own skills, expertise and experiences in relationship to pathways that they find especially generative and appealing. The workshop ends with a vision-statement activity to prepare participants to advocate for themselves as they translate their skillsets and experiences to jobs that will greatly benefit from them but may not be designed with a Ph.D. in mind.

Preparing Future STEM Teachers for Deeper, Justice-Oriented Learning

Strand 7: Pre-service Science Teacher Education

20-Apr-26, 10:00-11:30

Location: Columbia (L4)

Stand-Alone Paper

Influence of Teacher Education on Science Teaching: The Role of High-Leverage Practices, Equity, and Sensemaking

Amber Bismack*, Oakland University, USA

Patricia Bills, Oakland University, USA

Boyun Kim, Oakland University, USA

ABSTRACT

Supporting novice teachers' centering the brilliance and joy of marginalized students in science is critical for disrupting inequities in schools. And while the use of teaching practices within practice-based teacher education (PBTE) has been shown to support novice teachers' practice, it is still unclear how PBTE can support equitable teaching for scientific sensemaking. For this reason, we investigated how a PBTE program influenced novice elementary teachers' use of high-leverage practices (HLPs), attention to equity, and teaching for scientific sensemaking compared to influences from a traditional teacher education (TE) program. Using a longitudinal comparative case study, we analyzed a) course syllabi (PBTE and traditional TE programs), and b) novice teachers' science teaching videos and interviews for evidence of all three strands over time. Overall, the PBTE program, compared with the traditional TE program, provided more opportunities supporting all three strands, yet equity was broadly evident in both programs. Similar patterns were noticed in the novice teachers' science teaching with the PBTE teachers demonstrating more expansive use of HLPs and sensemaking repertoires, yet equity was superficially evident in practice for all teachers. This highlights the continued need to deeply integrate HLPs, sensemaking, and equity within learning opportunities in teacher education programs.

Stand-Alone Paper

Prospective Teachers Learning to Teach About Climate Justice: A Case Study

Julie Bianchini*, University of California, Santa Barbara, USA

Devon Azzam, University of California, Santa Barbara, USA

Kaylee Laub*, University of California, Santa Barbara, USA

Danielle Harlow, University of California, Santa Barbara, USA

Karin Lohwasser, University of California, Santa Barbara, USA

ABSTRACT

Given the urgency of the climate crisis, the purpose of our study was to investigate an undergraduate course focused on helping prospective K-12 teachers learn to teach youth about climate justice. We defined climate justice as recognizing and working to repair the differential impacts of climate change on those with the fewest resources and the lowest contributions to greenhouse gas emissions. We used a climate justice education framework with 12 intersecting dimensions to organize both the undergraduate course and our case study of it. We foregrounded three framework dimensions: ecological caring with humility, place-based and outdoor learning, and solution- and action-focused learning. Data collected included the instructor's syllabus, lesson plans, and written reflections; prospective teachers' assignments, group action plans, and focus group interview; and course observation field notes and video records. From our qualitative analysis of these data, we found that both the teacher educator and prospective teachers learned about the importance of making connections to nature, identifying solutions to local climate issues, and attending to the complexities of climate justice in intersection with local actions. In our discussion, we offer suggestions to teacher educators and teachers on how to teach climate justice in locally based, solution-focused, and action-oriented ways.

Stand-Alone Paper

Preservice Science and Math Teachers Conceptions of and Teaching Practices for Deeper Learning

Matthew Bennett*, UC Santa Barbara, USA

Jing Su, UC Santa Barbara, USA

Yvette Doss, UC Santa Barbara, USA

Ying Gao, UC Santa Barbara, USA

Oishee Mujtaba, UC Santa Barbara, USA

Daniel Santana, UC Santa Barbara, USA

Mian Wang, UC Santa Barbara, USA

Danielle Harlow, UC Santa Barbara, USA

ABSTRACT

This qualitative study examines how preservice science and math teachers (PSTs) across 5 U.S. teacher education programs conceive of and implement teaching practices for deeper learning. This study consists of a subset of data from a larger study which aims to explore how teacher education programs engage with a set of Deeper Learning Modules in a focus

on preparing teachers for deeper learning. This study is grounded in an understanding of deeper learning drawn from the National Research Council (2012, 2018) and Mayer (2011) and an understanding of teaching for deeper learning characterized by the five dimensions of teaching for deeper learning proposed by Darling-Hammond and Oakes (2019). We analyzed 9 semistructured interviews, 3 focus groups, and a number of teaching artifacts to identify how science and math PSTs in these programs conceived of deeper learning, how they implemented relevant teaching practices in their K-12 classrooms, and how those conceptions and practices were aligned. This study provides insight into how the connections between conceptions of deeper learning and teaching practices for deeper learning are important for understanding beginning teacher practice and ultimately for supporting preservice teachers as they engage in the process of learning how to teach for deeper learning.

Science teachers' approaches to climate, energy, and justice

Strand 8: In-service Science Teacher Education

20-Apr-26, 10:00-11:30

Location: Cedar AB (L2)

Stand-Alone Paper

Science Teachers' Uptake of Multispecies Justice in Designing Phenology Lessons on Climate Change Impacts

Asli Sezen-Barrie*, University of California, USA

Mary Stapleton, Towson University, USA

Emily Cohen, University of Maryland Center for Environmental Science, USA

ABSTRACT

This study investigates how secondary science teachers integrate multispecies justice into the design of phenology lessons on climate change impacts using participatory science data. Multispecies justice extends climate justice to consider the rights, needs, and vulnerabilities of nonhuman species, challenging anthropocentric approaches and emphasizing interdependence in shared ecosystems. Conducted within a year-long Professional Learning Experience (PLE) in the mid-Atlantic USA, the study engaged nine diverse secondary science teachers in developing justice-centered phenology lessons. Data sources included pre- and post-lesson interviews, lesson plans, and researcher field notes from professional learning sessions. Using cross-case qualitative analysis, we examined how teachers named and framed multispecies justice, connected ecological change to justice concerns, incorporated non-Western and Indigenous knowledge systems, and navigated community-specific barriers. Findings reveal that conceptual naming empowered teachers to explicitly integrate justice language into curricula, phenology data facilitated connections between ecological shifts and equity issues, and engagement with Indigenous perspectives supported a relational view of human–nonhuman interdependence. However, uptake was mediated by local cultural, political, and racialized contexts. This work contributes to climate change

education scholarship by illuminating design-stage strategies for embedding multispecies justice in science instruction, offering an empirically grounded framework for bridging scientific rigor with ecological ethics.

Stand-Alone Paper

Discursive Roles in Climate Science+Data Professional Learning: An Analysis of Learner Hat

Kimberly Jones*, University of Tennessee - Knoxville, USA

Kerri Wingert, Good Question Research, USA

Kristin Hunter-Thomson, Dataspire, USA

Anne Gold, CIRES CEEE - University of Colorado Boulder, USA

Karla Citlali Lemus Gordillo, CIRES CEEE - University of Colorado Boulder, USA

Jonathan Griffith, CIRES CEEE - University of Colorado Boulder, USA

Annette Brickley, Dataspire, USA

Joshua Rosenberg, University of Tennessee - Knoxville, USA

Jessica Bean, University of California Berkeley, USA

ABSTRACT

This mixed-methods study explores the value of the “adult learner hat” in professional learning (PL) for science teachers engaging with climate science and data sensemaking. As science education shifts towards “figuring out” versus “learning about,” teachers must learn new content, high-quality materials, and effective pedagogies. While “teacher hat” and “student hat” discursive roles have been shown to be valuable, teachers often “break” from these roles. This study focuses on the “adult learner hat,” where teachers leverage their existing knowledge to deeply engage with complex scientific concepts and data.

Through pre- and post-surveys and video-based analyses of a 3-day PL workshop, we found teachers' confidence in climate science, data sensemaking, and the instructional framework significantly increased. Qualitative data revealed “adult learner hat” activities, particularly working directly with data, were identified as the primary source of this growth. We present a thematic account of PL design choices that supported this role, including surfacing teacher “teacher hat” concerns, withholding instructional documents, and purposefully redirecting teachers back to the learner role. This study highlights how the “adult learner hat” provides a productive space for teachers to grapple with uncertainty, critique visualizations, and collaborate in meaning-making, ultimately building intellectual resources for ambitious, data-rich science instruction.

Stand-Alone Paper

Water as a Conduit for Exploring Environmental Justice in K-12 Classrooms

Kathryn Ribay*, San Jose State University, USA

ABSTRACT

In the face of increasing environmental disasters linked to the climate crisis, environmental justice offers a critical lens for helping students understand both ecological systems and the human impacts of environmental change. Water, a recurring topic across grade levels, is deeply connected to histories of place, access, and inequity, making it a powerful conduit for interdisciplinary learning. This paper investigates outcomes from a week-long professional development program for K-12 educators, designed to integrate local water issues, sustainability, and environmental justice with pedagogical strategies. Through analysis of pre- and post-surveys, final reflections, and lesson plan products, the author identified key themes in how participants incorporated environmental justice into their teaching plans. Findings identify both explicit and implicit references to environmental justice within the lesson plans. Sustainability and local issues provided accessible entry points across grade levels as well as cross-curricular applications. However, some participants focused primarily on scientific content and careers without meaningfully addressing justice or sustainability themes, highlighting challenges in authentically weaving these perspectives into established pedagogies. The results suggest that cross-disciplinary, locally grounded professional development can help educators meaningfully address environmental justice, while also revealing the need for sustained support to bridge intentions and implementation.

Restructuring the Science Curriculum around Grand Challenges

Strand 10: Curriculum and Assessment

20-Apr-26, 10:00-11:30

Location: Greenwood (L3)

Related Paper Set

Teachers' Implementation of the Grand Challenge Curriculum

Rebecca Lesnefsky*, SUNY Cortland, USA

Natasha Segal*, Weizmann Institute, Israel

ABSTRACT

This study examines how middle school science teachers in two international contexts interpret and implement the Grand Challenges curriculum within their local instructional

and institutional settings. Drawing on the Interconnected Model of Professional Growth (IMPG), we analyzed interviews, classroom observations, and instructional artifacts from ten teachers with varied experiences. Our findings revealed three instructional profiles: Content-Focused Teachers, who prioritized content mastery and control; Developing Reflective Teachers, who sought to integrate GC goals but struggled to balance them with systemic demands; and Integrated and Transformative Teachers, who embedded values, emotions, and civic engagement into science learning despite structural constraints. These profiles illuminate the varied ways teachers respond to curricular innovation and highlight how institutional contexts shape what is possible in practice. Findings inform the design of professional learning and curricular supports that align with teachers' current orientations and move implementation toward more meaningful, ambitious science instruction.

Related Paper Set

Centering Student Voices on Grand Challenges: A Cross-National Study

Heewoo Lee*, University of North Carolina at Chapel Hill, USA

Shira Passentin*, Weizmann Institute, Israel

ABSTRACT

This paper explores how students perceive Grand Challenge (GC) curricula and how they respond to its design principles. We examine commonalities and differences between students from two countries located on different continents, each with distinct cultural and linguistic backgrounds. This cross-contextual approach allows us to identify unique and transferable aspects of the GC program. Our goal is to determine whether the program effectively conveys its core messages regardless of national context, and to assess which of its intended objectives are being realized. The findings collectively illustrate how GC experiences not only shaped students' engagement and positive perceptions of scientific practices but also fostered meaningful dialogues that extended into their personal lives.

Related Paper Set

Theoretical Foundations and Design Principles for a Grand Challenge Curriculum

David Fortus*, Weizmann Institute, Israel

Troy Sadler*, University of North Carolina at Chapel Hill, USA

Keren Dalyot, Weizmann Institute, Israel

ABSTRACT

This paper provides foundational information for the empirical studies described in the remaining papers of the paper-set. In order to advance the Grand Challenge (GC) agenda, we used foundational research, theory, and practice to develop a set of five design principles that help to define core aspects of GC-based learning experiences. These principles, each of which have multiple dimensions, include the following: 1) Contextualized in a global issue with local connections, 2) Culturally responsive, 3) Practice oriented, 4) Attentive to student voice, and 5) Coherent within and across units. The process of conceptualizing a GC curriculum and developing design principles was conducted in conjunction with development and

implementation of a new middle school science curriculum that highlights GCs. We operationalized this work in terms of curricular units; that is, modules or units of instruction that can be implemented in formal middle school science education environments. The development of design principles was a critical first step in establishing a common vision for the essential features of GC units.

Related Paper Set

Assessing Modeling Competencies in the Grand Challenges Curriculum

Nannan Fan*, University of North Carolina at Chapel Hill, USA

David Fortus, Weizmann Institute, Israel

Adi Moskovits, Weizmann Institute, Israel

ABSTRACT

Engaging students in modeling practices, particularly those contextualized in Grand Challenges (GCs), allows and prepares students to navigate complex issues and make informed decisions in daily lives. Although significant effort has been devoted to advancing modeling-based instruction in science classrooms, fewer studies have developed instructionally aligned modeling assessments to capture progress in students' modeling competencies. This paper introduces the development of three GC-aligned modeling assessments and their corresponding rubric features along with analyses of student responses. To assess the progress in students' modeling competencies, we created similarly structured modeling assessments for each unit, addressing the same modeling dimensions. We began coding student responses to the modeling items by identifying distinct types of errors and engaging in open coding in order to characterize them, believing this characterization of error types would provide insights for refining modeling instruction and providing more targeted feedback to the students. Our initial coding of students' responses surfaced three distinct error categories including (a) component errors-incorrectly identifying or locating key components in the model; (b) relational errors-misrepresenting directional interactions through incorrect arrows or non-directional lines or connecting wrong components; and (c) relationship annotation errors-inaccurately describing the interactions between components.

Black youth, faculty, and curricular considerations

Strand II: Cultural, Social, and Gender Issues

20-Apr-26, 10:00-11:30

Location: Juniper (L2)

Stand-Alone Paper

Centering Black Girls in STEM: A Culturally Relevant and BlackCrit Approach

Raketa Thomas*, University of North Carolina at Charlotte, USA

Uchenna Emenaha Miles*, University of Texas San Antonio, USA

ABSTRACT

This study explains how anti-Blackness operates in secondary STEM classrooms through teacher bias and instructional practices that limit Black girls' access and belonging. Drawing on semi-biographical vignettes and our lived experiences as Black women in STEM education, we apply Culturally Relevant Pedagogy (CRP) and Black Critical Theory (BlackCrit) as guiding frameworks. The vignettes show how Black girls are framed by deficit narratives that limit their participation in advanced STEM coursework. Even equity efforts reinforce exclusion without accompanying ideological change. Our analysis reveals missed opportunities to affirm the brilliance and aspirations of Black girls. We argue that CRP must be enacted through relational practice and that BlackCrit is essential to naming and disrupting the structural nature of anti-Blackness in education.

Stand-Alone Paper

Understanding impostor phenomenon among Black faculty members in STEM: A US-based exploratory study

Devasmita Chakraverty*, Indian Institute of Management Ahmedabad, India

ABSTRACT

Impostor phenomenon is experienced when some people consider their success as fake, feel fraudulent, and disregard their achievements, secretly believing that they will be found out. It is common in science, technology, engineering, and mathematics (STEM) and can cause considerable psychological distress. Using Crenshaw's (1991) theory of intersectionality and identity-based othering, this study examined the research question: How do US-based Black faculty in STEM describe their impostor phenomenon? One-on-one, semi-structured phone interviews (40-45-minutes) were conducted in 2017-2018 with 15 Black faculty members in STEM, identified through convenience and snowball sampling. Using qualitative inquiry, interviewees were coded using constant comparison and analytic induction to construct themes. Preliminary findings (in-progress) reveal that the assumed Black identity as monolithic, the pressure of being the only one, and being mistaken as some other than a faculty member are ways in which participants experienced impostor phenomenon, lack of tailored mentorship, isolation, and anxiety. Institutional awareness about challenges faced by minoritized groups including everyday racism and micro-aggression is needed. This study argues that impostor phenomenon is more than an individual trait and can be perpetuated by systemic inequalities and environmental stressors.

Stand-Alone Paper

Curious about Black Hair: A Study of the STEM Curriculum Interest of African Americans

Jomo Mutegi*, Old Dominion University, USA

ABSTRACT

The aim of this study is to survey members of the African American community to determine what interest (if any) people of African descent have in the scientific study of Black hair. Data were collected from 92 respondents all of whom self-identify as African American.

Respondents included males and females from a broad range of ages, socioeconomic statuses, educational levels, and geographic locations. Respondents were asked to respond to two open ended questions: “What influences you to wear your hair the way you do?” and “What would you like to learn about the science of Black hair?” In addition to these open-ended questions, respondents completed the Multidimensional Inventory of Black Identity (MIBI) (Sellers, Rowley, Chavous, Shelton, & Smith, 1997). Data were analyzed to (a) determine patterns in responses to the open-ended questions, and (b) assess any correspondence between those responses and respondents’ identities as measured by the MIBI. The insight gleaned from this study is used to support the development of science curricula for learners of African descent.

Stand-Alone Paper

Synthesizing the Synthesis: A Review of Researcher Positionality in STEM Education Research about Black girls

Olayinka Mohorn-Mintah*, University of Memphis, USA

Monica Miles*, University at Buffalo, USA

Demetrice Smith-Mutegi*, Old Dominion University, USA

Alexis Riley*, New York University, USA

Catherine Quinlan, North Carolina Central University, USA

Joi Merritt, James Madison University, USA

Crystal Morton, Indiana University Indianapolis, USA

ABSTRACT

This systematic literature study examines how researchers’ positionalities influence the ways Black girls are represented in STEM education literature. Building on a prior systematic review, we analyzed 32 peer-reviewed articles published between 2013 and 2023 that focus on Black girls in STEM. Using Positionality Theory and Positioning Theory as analytical lenses, we explored (1) how Black girls are positioned in the research and (2) how authors position themselves in relation to the work. Our findings reveal that Black women scholars- who authored 74% of the reviewed studies play a leading role in affirming the identities, agency, and lived experiences of Black girls in STEM. In contrast, research teams led by non-Black scholars were more likely to adopt deficit-based framings. Notably, 90% of manuscripts that explicitly addressed systemic barriers and exclusionary practices were authored by Black scholars. These patterns highlight the critical role of researcher identity in shaping educational narratives and underscore the importance of reflexive, justice-oriented scholarship that centers Black girls’ brilliance, challenges dominant narratives, and reimagines STEM education through an equity lens.

Cultural Considerations to Radically (Re)-Imagine STEM Education and Research

Strand 11: Cultural, Social, and Gender Issues

20-Apr-26, 10:00-11:30

Location: Willow B (L2)

Related Paper Set

Maintaining communalistic values to support the STEM matriculation of Black Diasporic men

Takeshia Pierre*, Tufts University, USA

ABSTRACT

Black Diasporic Men are not retained in the STEM field preparation at rates comparable to their peers. To add, if and once Black Men enter STEM careers, the same holds true regarding their retention. This study was conducted to answer the research question: What supports Black Diasporic Men's matriculation and retention in STEM and Health professions? 50 Black Diasporic Men STEM professionals participated in Brotherhood Circles, where it was revealed that Afrocentric values of communalism are evidenced in Black Diasporic Men's abilities to matriculate through their respective studies and enter STEM careers. Black Men in this study naturally gravitated to communities that held similar beliefs, cultures, and customs, whether or not these communities were STEM-specific. This study also introduces Brotherhood Circles as a methodology, where Black Males congregate and discuss important topics relative to their positioning in STEM spaces, their devotion to community and community building, and leadership across STEM fields and beyond.

Related Paper Set

Cross-Cultural Interactions in Community-Based Engineering Projects: Financial and Reputational Borders in Engineering Study Abroad Programs

Trevion Henderson*, Tufts University, USA

Collette Higgins, Tufts University, USA

ABSTRACT

Community-based projects are thought to foster students' sociotechnical repertoires (McGowan & Bell, 2020; Reynante, 2022). However, such projects can be harmful, particularly when they encounter financial, knowledge, epistemic, and reputational borders that reinforce and exacerbate power dynamics between students, faculty, administrators, and community members (Costanza-Chock, 2020; Pineda et al., 2012). The purpose of this paper was to examine those borders and their implications for project outcomes and student learning. We draw on a multi-year ethnographic study of engineering students engaged in a study abroad program in Cartagena, Colombia. Data sources include recordings of course activities, virtual meetings with community members, students' interactions with community members in Cartagena, debrief sessions following workdays abroad, and reflective interviews with community members. We find that participants recognized financial and reputational borders during the project, as well as the implications of these

borders for project outcomes. However, participants noted how maintaining such borders could preserve community leadership and autonomy. These findings challenge the assumption that borders between stakeholder groups require dismantling. Instead, drawing on community member knowledge, it became clear that maintaining some borders might support project outcomes. Thus, educators implementing community-based projects must reconsider assumptions about the manifestations of power dynamics between stakeholder groups.

Related Paper Set

Rooted in Resistance: Cultivating Critical Consciousness Through Pláticas in Engineering

Joel Mejia*, University of Cincinnati, USA

ABSTRACT

This study explores how culturally grounded pedagogical practices rooted in Chicana/o/x epistemologies can challenge deficit-based narratives in engineering education and cultivate critical consciousness among students at a Hispanic-Serving Institution (HSI). Drawing on Chicana Feminist Epistemologies and Freire's concept of conscientização, the research centers pláticas (i.e., dialogic, relational, culturally-grounded conversations) as tools for knowledge-making, resistance, and reflection on sociopolitical contexts that shape students' experiences in engineering. Over the course of a four-year ethnographic study, 11 undergraduate engineering students participated in a series of pláticas that focused on the sociopolitical history of engineering and its influence on their own educational trajectories. Through iterative coding and analysis, the study found that while students often entered their programs with internalized meritocratic beliefs, pláticas helped them recognize the broader systemic forces, including racism, colonialism, and class stratification, that shape who is seen as an engineer and what knowledge is valued. As students reflected on their lived experiences, moments of resistance emerged, including questioning dominant narratives and reimagining engineering in ways aligned with justice, community, and cultural affirmation. These findings highlight pláticas as powerful pedagogies of resistance and underscore the importance of integrating culturally rooted epistemologies into engineering education, particularly within HSIs.

Related Paper Set

Climate Tech Journalism: Engineering Climate Futures through the Voices of Multilingual and Multidialectal Youth

Clara Mabour, Tufts University, USA

Greses Perez, Tufts University, USA

Kristen Wendell, Tufts University, USA

Fatima Rahman, Tufts University, USA

Chelsea Andrews, Tufts University, USA

ABSTRACT

Learners often experience science and engineering in monolingual contexts. This reality demands approaches where the voices and lived realities of students and their communities are centered. Drawing on translanguaging scholarship and situated learning, our work amplifies the strengths of youth to analyze and communicate the role of engineering in developing climate technologies while enhancing their capacity to participate in engineering design practices in the community. We developed a hyper-localized curriculum with translanguaging supports that engages sixth-grade students in learning about engineering design, climate technology, and engineering communication. The data includes two years of video recordings, artifacts and interviews of sixth grade students from four schools in a large school district in the Northeast. The findings suggest that while students bring in aspects of their community experiences during class discussions, many are hesitant to draw on the multilingual and multidialectal resources of their communities in their public-facing artifacts. Learners perceived their repertoires as valuable for communicating with others and connecting with their peers. As scholars, we acknowledge that participants offer their experiences as gifts to research and it is our responsibility to ensure that they are supported in bridging their multilingual and multidialectal backgrounds together with their technical and scientific understandings.

Hybrid/AI-Enhanced Investigations & Model-Based Learning

Strand 12: Technology for Teaching, Learning, and Research

20-Apr-26, 10:00-11:30

Location: Ballard (L3)

Stand-Alone Paper

Exploring the implementation of GenAI in STEM education through the co-creation of learning activities

Federico Valeri*, Halmstad University, Sweden

Pernilla Nilsson, Halmstad University, Sweden

Anne-Marie Cederqvist, Halmstad University, Sweden

ABSTRACT

As STEM education continues to gain global importance, there is a growing need to explore how to support students in navigating the difficulties of these subjects. GenAI has recently emerged as a tool to support students in learning STEM content, offering opportunities but also introducing several challenges. Current research on the topic often lacks contextualisation, addressing these challenges and opportunities generally, rather than within STEM content. To address this gap, the present study explores in-service teachers' reflections while co-creating and test-running educational activities. These activities are contextualised within STEM subjects and planned as classroom implementations. The findings indicate that although both subject- and content-specific opportunities could be identified, challenges such as miscommunications and unexpected outputs must be

carefully addressed. The absence of PCK components, such as curricular knowledge and knowledge of students' learning in GenAI's outputs, further stresses the importance of teachers' PCK to promote careful use. Finally, test-running the activities showed promising results in supporting the development of teachers' TPACK, promoting careful assessments of potential risks and reflections about instructional integration strategies.

Stand-Alone Paper

Understanding Generative AI through the SOLO Taxonomy: An Example from Nanotechnology Education

Yael Feldman-Maggor*, Ben Gurion University of the Negev, Israel

ABSTRACT

The emergence of generative AI (GenAI) necessitates rethinking assessment design to ensure that evaluations reflect student learning. As learners increasingly rely on GenAI tools to complete educational tasks, there is a growing need for frameworks to evaluate these tools' capabilities within science education, as this identification can help to design learning tasks that promote deep understanding. This study contributes to this effort by applying the Structure of the Observed Learning Outcome (SOLO) taxonomy, a framework for categorizing learning outcomes by complexity, to analyze assignments completed by ChatGPT-4o. Specifically, tasks from an introductory materials science and nanotechnology course. Findings indicate that ChatGPT-4o achieved the relational level when linking nanoscale science and technology (NST) concepts to high school chemistry. However, when applying NST concepts to explain real-world nanotechnology applications, the responses often included inaccuracies or unsupported reasoning. Although structurally similar to relational responses, these were more accurately categorized at the pre-structural level. Furthermore, ChatGPT-4o did not demonstrate extended abstract-level understanding. The implication of this study is that frameworks such as the SOLO taxonomy may be used to evaluate GenAI outputs and to inform the redesign of learning tasks that foster higher-order thinking, even in contexts of widespread GenAI accessibility.

Stand-Alone Paper

Challenging the advantage of hybrid investigations in the context of electric circuits

Elon Langbeheim*, Ben-Gurion University of the Negev, Israel

David Krein, Ben-Gurion University of the Negev, Israel

ABSTRACT

Recent research suggests hybrid investigations that combine virtual labs (VLs) and physical experiments (PEs) often outperform single-mode investigations. This advantage is attributed either to increased epistemic authenticity or to enhanced conceptual salience through contrasting representations. We examined whether replacing the physical component in a VL+PE hybrid with an augmented reality (AR) lab yields comparable conceptual and collaborative benefits. Forty-six 9th-grade students participated in a four-lesson unit on Ohm's law using either (1) VL + PE, or (2) VL + AR card-based lab. Pre- and posttests assessed

conceptual knowledge, along with surveys on group work preferences, attitudes toward science, and epistemic beliefs. The VL+PE group showed greater pre-post gains, but no significant differences in normalized gains emerged between groups. Learning gains were unrelated to collaboration preferences or epistemic beliefs. These findings, though limited by sample size and timing, suggest AR-based labs may substitute for PEs in hybrid settings without reducing conceptual learning. A larger follow-up study will further test whether hybrid benefits derive from conceptual salience rather than epistemic authenticity.

Stand-Alone Paper

Integrating biomimicry into middle school STEM: Using structure-function analysis and modeling to inspire engineering design

Debra Bernstein*, TERC, USA

Kathryn Hobbs, TERC, USA

Michael Cassidy, TERC, USA

Kristen Wendell, Tufts University, USA

Gillian Puttick, TERC, USA

Ethan Danahy, Tufts University, USA

Geling Xu, Tufts University, USA

Tyrine Pangan, Tufts University, USA

William Church, CRCS, USA

ABSTRACT

While many middle schools teach science, engineering, and technology in separate classes, educators and policymakers recognize the benefits of integrated STEM learning. Biomimicry is a natural umbrella for integrating STEM disciplines, as it involves the application of a structure-function relationship from an organism or ecosystem (science) to the design of a human-created system (engineering). In integrated STEM contexts like biomimicry design challenges, students engage in modeling across two disciplines - engineering and biology. Our research investigates how two middle school STEM teachers supported their students' modeling efforts during biomimicry design challenges. Teacher post-implementation interview data was synthesized into a curriculum map, which was triangulated using teacher, student, and classroom artifacts. The paper presents data from a final teacher interview (plus the curriculum map) to explicate the materials and instructional supports teachers used during biomimicry design challenges, and highlights three methods for supporting student modeling in an integrated STEM learning environment: identifying goals for student learning and growth, designing an instructional sequence to support design complexity, and encouraging and supporting students to identify and justify design decisions.

Teacher learning in nature of science

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

20-Apr-26, 10:00-11:30

Location: Jefferson B (L4)

Stand-Alone Paper

Nonformal Learning, Worlding, and the Future of Science Education for Preservice Childhood Educators

Leah Master*, New York University, USA

ABSTRACT

Abstract: Preservice childhood teachers of science often replicate the teacher-led ways of doing science that they experienced as children. Reimagining science curriculum for preservice teachers, this study of a field trip to a natural history museum and a local park with PSTs explored how nonformal, experiential learning can provide authentic, relational, and joyful intra-actions with phenomena. Using a starting-with-the-earth-first framework based in posthumanist, feminist materialist, experiential, nonformal, and Indigenous perspectives, this study offers the concepts of worlding, diffraction, and reciprocal respect for the earth to address historical hierarchical approaches to science education. Through this field trip, PSTs reconnected to the earth, learned to value their entanglements with the nonhuman and more-than-human, and collectively rethought possibilities for designing meaningful science learning experiences for their own students.

Stand-Alone Paper

Science Teachers' Incorporation of NOS-based Activities into Their Lesson Planning

Büşra Aksöz*, Bogazici University, Turkey

Ebru Kaya, Bogazici University, Turkey

ABSTRACT

This study is part of a teacher professional development (PD) project grounded in Erduran and Dagher's (2014) Family Resemblance Approach (FRA) to the Nature of Science (NOS), later redefined as the Reconceptualized FRA-to-NOS (RFN) by Kaya and Erduran (2016). The RFN framework addresses the cognitive, epistemic, and social-institutional dimensions of science, offering practical and pedagogical guidance for science education. The aim of this research is to explore the impact of an online, reflective, and collaborative PD program on science teachers' incorporation of NOS-based activities into their group-designed lesson plans. It also examines the strengths and weaknesses of their approaches, as well as the strategies they employed. The seven-week program involved six science teachers. Data were collected through group-developed lesson plans, teacher journals, and recordings of group discussions during the workshops. Lesson plans were evaluated using the Lesson Plan Assessment rubric, while qualitative analysis was applied to the remaining data. Findings indicated that teachers had more difficulty in integrating the scientific knowledge and methods categories into their instructional designs compared to other categories. Moreover, example lesson plans shown during the PD program, including RFN objectives, activities,

visuals, discussion questions, and assessment tools, played a key role in guiding teachers' instructional design.

Stand-Alone Paper

Pre-service science teachers' perceptions of epistemic knowledge when using experiments in chemistry lessons

Janne-Marie Bothor*, University of Kassel, Germany

David-Samuel Di Fuccia, University of Kassel, Germany

ABSTRACT

In chemistry lessons, experiments are often used to teach both declarative and procedural knowledge. To give learners an authentic understanding of science, experiments can explicitly focus on epistemic knowledge. With this in mind, experiments were designed in a university learning environment with seven pre-service science teachers. These experiments were intended to convey epistemic knowledge using selected NOS aspects, employing a scientific inquiry or history of science approach. Three interviews were conducted to collect the participants' perceptions of their experiences with the objectives of the experiments, and the criteria that the experiments should meet were also collected at three test points during the intervention.

The results showed that the participants' experience of chemistry lessons was that the main aim of experiments was to convey content knowledge and visualise it. Furthermore, reflection on knowledge was formulated as a criterion for experiments after the intervention. However, only two participants reached this conclusion. Other criteria, such as increasing motivation or imparting content knowledge on visualisation, were mentioned significantly more often.

Stand-Alone Paper

Exploring the Nature of Science through AI-Based Experiments: A Look into Pre-Service Teachers' Learning

Jua Lee, Korea National University of Education, Korea, Republic of

Suna Ryu*, Korea National University of Education, Korea, Republic of

ABSTRACT

This study examines how pre-service chemistry teachers conceptualize the role of AI in scientific inquiry by participating in AI-integrated experiments. Based on the Family Resemblance Approach to the Nature of Science (NOS), we created the AI_NOS instrument and conducted interviews to identify changes in epistemic understanding. Students engaged in hands-on, sensor-based experiments supported by ChatGPT and Python programming. The findings reveal diverse views on the role of AI in modeling, generating hypotheses, and justifying knowledge. Participants emphasized the importance of empirical validation, interpretability, and recognizing AI's sociocultural context. The results suggest that

authentic engagement with AI-driven practices deepens students' understanding of science as an evolving, evidence-based, socially situated endeavor.

Environmental Identities, Cultural Contexts, and Education for Sustainability

Strand 14: Environmental Education and Sustainability

20-Apr-26, 10:00-11:30

Location: Issaquah AB (L3)

Stand-Alone Paper

'Civilized Behavior' Signs versus Nature-Friendly Education: A Cross-Cultural Analysis from a Science Education Perspective

Haoxuan Du*, UCL Institute of Education, United Kingdom

Michael Reiss, UCL Institute of Education, United Kingdom

Joanne Nicholl, UCL Institute of Education, United Kingdom

Kate Greer, UCL Institute of Education, United Kingdom

ABSTRACT

This study explores how environmental signage and cultural messaging in educational settings influence children's relationship with nature. In Chinese educational contexts, common signs such as "Please do not step on the grass, the grass is suffering" reflect a moral discourse of environmental care. While such messages may foster a sense of ecological responsibility and civic virtue, they can also constrain opportunities for embodied, sensory-based science learning. Drawing on Critical Discourse Analysis and Foucault's concept of disciplinary power, this study analyzes signage texts collected from primary schools in China and compares them with the nature-promoting discourse in the UK. Supplementary interview data with science teachers in China reveal a cultural tension: efforts to instill environmental values frequently translate into behavioral constraints that distance children from the natural world. The study frames this phenomenon as a form of ecological discipline, where language both protects and restricts. Findings suggest the need to critically re-examine environmental messaging in school science education and to develop culturally responsive language that supports participatory, place-based engagement with nature.

Stand-Alone Paper

Political Ecology of Environmental Education: Moral Narratives of Living in a Protected Indonesian Forest

Patricia Patrick*, Columbus State University, USA

ABSTRACT

This study examines how residents living in a protected Indonesian forest make sense of land, wildlife, and conservation. Guided by the Political Ecology of Environmental Education (PEEE), I analyzed moral narratives as place-based knowledge shaped by power, livelihood,

and belonging. Using narrative inquiry and critical ethnography, I applied Saldaña's first-cycle coding (descriptive, process, values, and emotion) to interviews to develop themes. Findings illuminate five intertwined themes: Human-Wildlife Coexistence; Land Rights and Boundaries; Agricultural Practices in Protected Areas; Government Relations and Compliance; and Community and Environmental Stewardship. Residents describe living with tigers while feeding families; asserting inherited rights and confusing boundaries; continuing smallholder agriculture in restricted zones; negotiating surveillance, permission, and fear with officials; and organizing to protect resources. These narratives reveal plural ecologies and ethical reasoning that complicate deficit views of "illegal" use. The study advances environmental education by centering local ontologies and the politics of place and offer evidence for culturally responsive, justice-oriented teaching and collaboration in contested conservation landscapes. For NARST audiences, the work demonstrates how PEEE clarifies learning and agency in human-wildlife settings and informs research-practice partnerships with communities and conservation agencies.

Stand-Alone Paper

Ecological Presence in Education: Using Technology to Support Student Identity and Connection with Nature

Tyler Hansen*, Washington State University, USA

Colby Tofel-Grehl, Teachers College, USA

ABSTRACT

This paper examines how educational technologies can be leveraged to cultivate a sense of identity, belonging, and connection to the natural world for middle school students. We demonstrate how using codable sensors in a community-driven science course can situate scientific learning within students' lived experiences and community practices. We use ecological presence as a framework for understanding how students position themselves within ecological and social relationships, and how technology can allow students to make these connections. We applied epistemic network analysis to map relationships across their discourse and reflections about nature, culture, and technology, both at the beginning of the course and at the end. Findings highlight the potential of curricula to support student identity development, bridge cultural practices with scientific understanding, and encourage relational forms of environmental stewardship.

Equity, Identity, and Policy in Science Education

Strand 15: Policy, Reform, and Program Evaluation

20-Apr-26, 10:00-11:30

Location: Capitol Hill (L3)

Stand-Alone Paper

Surface Learning by Design: An Analysis of Texas Science Standards

Allison Esparza*, South Dakota State University, USA

Joanne Olson, Texas A&M University, USA

ABSTRACT

Nationally developed science frameworks aim to establish coherent learning progressions to enhance student comprehension over time. However, state standards are often shaped by elected officials who may or may not adhere to these frameworks as intended. This proposal addressed two key issues: first, whether state-developed science standards exhibit horizontal coherence, meaning they can be conceptually connected to build learning progressions and facilitate coherent instruction; and second, whether the standards are developmentally appropriate. To investigate these issues, we conducted a comparative content analysis of state standards against the national framework, The Atlas for Science Literacy. Our study revealed that more than half of the second-grade science standards examined either lacked developmental appropriateness or were missing from research-based learning progressions. Additionally, the standards displayed fragmented coherence within grade levels and had excessive breadth, requiring teachers to cover too many disconnected topics. This analysis demonstrates that merely using or referencing national frameworks does not ensure that the standards developed by states are developmentally appropriate or coherent.

Stand-Alone Paper

Does Research Count in Shaping Science Education Policy? Evidence from England

Wonyong Park*, University of Southampton, United Kingdom

Carys Hughes, University of Southampton, United Kingdom

Chris Downey, University of Southampton, United Kingdom

ABSTRACT

Science education research and policy both play vital roles in shaping the quality and direction of science education. However, a persistent disconnect between researchers and policymakers often undermines the potential of both domains to create meaningful change. When these communities work in silos, opportunities for collaboration, mutual learning, and informed decision-making are lost, resulting in fragmented efforts and limited uptake of research evidence in policy processes. This study examines the research-policy interface in science education through a case study of England. Drawing on semi-structured interviews with 17 key stakeholders including academic researchers and policy officers from learned societies and subject associations, the study identifies key institutional pressures and brokerage mechanisms that shape interactions across these communities. The analysis is

further informed by discussions held during a one-day symposium bringing together stakeholders from research, policy, and practice. Based on the findings, we reflect on implications for strengthening research-policy linkages and rebuilding a more robust science education ecosystem in England and beyond.

Stand-Alone Paper

Bridging Boundaries: How State Computer Science Leader Networks Advance Equity

Stefanie Marshall*, Michigan State University, USA

Ain Grooms*, University of Wisconsin-Madison, USA

Joshua Childs*, University of Texas-Austin, USA

Grace Tukurah*, Michigan State University, USA

SJ Hemmerich, University of Wisconsin-Madison, USA

ABSTRACT

State leaders play a pivotal role in implementing equitable K–12 Computer Science Education (CSEd), yet little research explores their intra- and interstate networks. This study examines how CSEd leaders build infrastructure to support equity-focused policy implementation. We ask: How are state CSEd infrastructures designed? Who are the key actors, and how do their roles and relationships influence equity? Findings reveal how social networks shape CSEd policy adoption, highlighting implications for leadership, collaboration, and systemic reform.

Stand-Alone Paper

Investigating Science Identity Development in a STEM Summer Program

Manal Almalki*, Walter Reed Army Institute of Research, USA

Debra Yourick, Walter Reed Army Institute of Research, USA

ABSTRACT

This study explores how participation in a 2024 STEM summer program influenced middle and high school students' science identity. Conducted across four sites, a federal research institution, two Historically Black Colleges and Universities (HBCUs), and a large public research university, 695 students engaged in one-week, inquiry-based STEM sessions led by trained undergraduate mentors. Using a validated Science Identity (SciID) scale, 520 participants completed a post-program survey assessing two core dimensions: exploration and commitment to science. Results showed that older students and those with multiple years of participation reported significantly higher science identity scores. Site-level differences also emerged, with participants at the federal research institution showing the highest commitment levels. These findings highlight the role of informal STEM programs in strengthening students' science identity, a critical factor in long-term STEM persistence.

Stand-Alone Paper

Toward an Organizational, Professional, and Community Theory of Science Teacher Retention

Douglas Larkin*, Montclair State University, USA

Suzanne Patzelt*, Touro University, USA

Liz Carletta, Montclair State University, USA

Khadija Ahmed, Montclair State University, USA

Mayra Muñoz, Montclair State University, USA

ABSTRACT

In this paper, we present teacher embeddedness as an organizational, professional, and community model of teacher retention. Our research team developed this theory from an empirical qualitative study of school districts in the United States with high rates of science teacher retention. The research our team conducted over six years—which we summarize in the paper—aimed to understand the determinants of science teacher retention. This paper builds on earlier theoretical work on science teacher retention by presenting a revised theory of teacher embeddedness, which is constructed in organizational, professional, and community domains—each with components of fit, links, and assets. Fit refers to the comfort and compatibility of an individual, and includes the degree to which the goals, values, and worldviews of the employee are aligned with each of these domains. Links are formal and informal social connections and relationships, including family, religious, and other social affiliations. Assets refer to material or psychological benefits. Teacher embeddedness theory promises to provide specific and detailed guidance to strengthen each of the embeddedness domains for science teachers, increasing the likelihood of staying to improve their practice over time for the benefit of the science learners in their classrooms.

“A Case for Joyful Transgressions and Radical Imagination in Science Education Within the African Diaspora”

20-Apr-26, 10:00-11:30

Location: Redwood AB (L2)

Administrative Session

A Case for Joyful Transgressions and Radical Imagination in Science Education Within the African Diaspora

Organizers

Rona Robinson-Hill, Ball State University, Muncie, IN, USA

Jonathan Hall, California State University, San Bernardino, CA, USA

Contributors

Malcolm Butler, University of North Carolina at Charlotte, 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) includes a 45-minute plenary presentation with our Dr. Mary Atwater Distinguished Lecturer, Dr. Malcolm Butler. In recognition of a demonstrated commitment to advancing diversity, equity, and inclusion in Science, Technology, Engineering, and Mathematics (STEM)—as well as a history of inspiring leadership, including during a term as Association of Science Teacher Education (ASTE) President—the keynote speaker is well-positioned to guide, uplift, and challenge the field toward a more inclusive and imaginative future. After the plenary speaker's presentation, a question-and-answer period will be held, followed by poster presentations from approximately 6 - 10 presenters. We will need one poster board for each individual poster presenter. The rationale for our session is: 1) to hear strategies around staying the course in these challenging times where we can all flourish; and 2) share how CADASE members are impacting their communities to create spaces of hope, imagination, and joy with their research and engagement with STEM students, faculty, and teachers. The Dr. Mary Atwater Distinguished Lecturer and invited poster presenters will be asked to reflect on the challenges and opportunities within science education that either constrain or enable joyful transgression in the lives of learners.

NARST Connects

20-Apr-26, 10:00-11:30

Location: Kirkland (L3)

Discussion Session

Abstract

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 (see <https://narst.org/conferences/2026-annual-conference>).

Sample discussion topics include: What recent challenges are you facing? How might NARST be able to help? Easels with flipchart pads and markers will be available for folks to record information or messages that they wish to share with the NARST Board of Directors.

Advancing Literacy and Innovation in Science Ed

20-Apr-26, 10:00-11:30

Location: Virginia (L4)

Administrative Session

Advancing Literacy and Innovation in Science Ed

Organizers

John Pecore, University of West Florida, USA

Contributors

Laura Jacobs, Towson University, USA

Katherine Sharp, Missouri University of Science and Technology, USA

Carly Carron, Missouri University of Science and Technology, USA

Keira Walker, Missouri University of Science and Technology, USA

Carson Dudley, Missouri University of Science and Technology, USA

Awards Ceremony

20-Apr-26, 12:30-13:30

Location: Grand Ballroom (L2)

Joy as Method, Community as Praxis: Reimagining Science Education as Collective Flourishing

20-Apr-26, 13:30-14:30

Location: Grand Ballroom (L2)

Keynote Speakers

Abstract

Grounded in the conference theme, *“Joyful Transgressions and Radical Imagination in Science Education,”* this keynote will be a fireside chat spotlighting community-centered work in Seattle - from Education, Community, and STEM Education. The panelists have coalesced their energies to bring a praxis of their work of justice in Academia and in the Community. Estelitas Library is the centerpiece of our conversation, serving as a radical gathering space where community members raise their voices, share knowledge, and learn together. Through programs and resources that center youth empowerment and community education, Estelitas offers a compelling model for reimagining science education as something that emerges from culture, lived experience, and collective flourishing. As we reflect on expanded notions of research impact, this fireside chat invites us to radically

reimagine science research, teaching, and service through practices grounded in care, trust, relationships, and joy.

Speakers:

Prof. Edwin Lindo

Dr. Kaleb Germinaro

Dr. Estell Williams

Co-Moderated by:

Dr. Terrell Morton

Dr. Daniel Morales-Doyle

Advancing Systems Thinking and Climate Literacy in K-12

Strand 1: Science Learning: Development of student understanding

20-Apr-26, 14:45-16:15

Location: Ravenna AB (L3)

Stand-Alone Paper

High School Students' Knowledge-in-Use of Energy Through the Systems-Transfer Approach

Weiwei He*, CREATE for STEM Institute, Michigan State University, USA

Steve Bennett, CREATE for STEM Institute, Michigan State University, USA

Jeffrey Nordine, Department of Teaching and Learning, University of Iowa, USA

David Fortus, Weizmann Institute of Science, Israel

Joseph Krajcik, CREATE for STEM Institute, Michigan State University, USA

ABSTRACT

This study examines how high school students interpret energy-related phenomena when engaged in physics instruction grounded in the systems-transfer approach (STA). STA frames energy as a unitary quantity transferred between interacting systems, emphasizing fields and avoiding form-based representations. We conducted a single case study at a rural high school in the upper Midwest, involving two physics classes (N=52) taught with three units on mechanics, electromagnetism, and waves. Primary data came from interviews with eight purposively selected students, supported by classroom observations, artifacts, and video. Iterative qualitative analysis focused on five areas: depth of energy transfer discussion, use of representation tool, references to fields, use of form-based language, and systems thinking. Findings show students blended systems-transfer and form-based language, often indicating a transitional conceptual stage. While some integrated particle and field ideas to connect macroscopic and microscopic mechanisms, others conflated particle motion with energy transfer. Systems thinking ranged from object-focused to multi-component models incorporating fields. The results highlight STA's potential to support multi-scale reasoning

and the need for scaffolds that strengthen connections between representations, mechanisms, and systems thinking.

Advancing Systems Thinking and Climate Literacy in K-12

Strand 1: Science Learning: Development of student understanding

20-Apr-26, 14:45-16:15

Location: Ravenna AB (L3)

Stand-Alone Paper

Three-Dimensional Learning about Water as a Limited and Threatened Resource

Kristin Gunckel*, University of Arizona, USA

Linda Morell, University of California Berkeley, USA

Mingfeng Xue, University of North Carolina Greensboro, USA

Paulchell-Lehan Alexander, University of Arizona, USA

Malissa Hubbard, University of Arizona, USA

Anna MacPherson, American Museum of Natural History, USA

Dozier Sara, California State University Long Beach, USA

Mark Wilson, University of California Berkeley, USA

ABSTRACT

Freshwater scarcity threatens over half of the global population, yet little is known about how students learn about water as a limited and threatened resource. This study investigated middle school students' learning about water scarcity across three dimensions—disciplinary core ideas about natural resources and human impacts (DCI:NRHI), the crosscutting concept of patterns (CCC:PAT), and the science and engineering practice of argumentation (SEP:ARG)—using a learning progressions approach. We used a construct modeling system to develop and refine construct maps and assessment items for each dimension. We analyzed responses from 1,115 middle school students from two urban U.S. school districts. Wright Maps produced by a multidimensional Rasch model confirmed construct validity and revealed differential difficulty across dimensions. CCC:PAT was the easiest and provided entry into learning about the topic, supporting advancement in DCI:NRHI. SEP:ARG was the most difficult, suggesting that proficiency in patterns and disciplinary content is necessary for students to make progress in argumentation about water. This work advances understanding of how students integrate dimensions in learning about water scarcity, provides validated construct maps and assessments, and offers implications for three-dimensional measurement, curriculum design, formative assessment, and environmental science literacy.

JuST in the World- Expanding Justice-Centered Ambitious Science Teaching and Learning across contexts

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

20-Apr-26, 14:45-16:15

Location: Redwood AB (L2)

Symposium

JuST in the World- Expanding Justice-Centered Ambitious Science Teaching and Learning across contexts

Déana Scipio*, IslandWood, USA

April Luehmann*, University of Rochester, USA

Priya Pugh*, IslandWood, USA

Chris Jadallah*, University of California Los Angeles, USA

Hannah Cooke*, University of Connecticut, USA

Scott McDonald*, Pennsylvania State University, USA

Elizabeth Starks, University of Washington, Bothell, USA

Veronica McGowan*, University of Washington, Bothell, USA

Symone Gyles, University of California, Irvine, USA

Molly Wilson, University of Rochester, USA

ABSTRACT

This session explores the potential for Justice-centered science teaching to create opportunities for joyful and transgressive opportunities for learning for teachers and students. As organizations more broadly and universities more specifically face political pressures to shudder anti-racist, justice-focused, and DEI efforts, science educators are increasingly constrained in promoting justice within their teaching. We see an opportunity to explore these ideas in response to the 2026 conference theme of Joyful Transgressions and Radical Imagination in Science Education. The contributors to this session aim to highlight a variety of efforts and strategies by science teachers and science teacher educators across the country who seek to elevate justice-centered science teaching aims at the intersection of radical, joyful, and transgressive science teaching and learning. Specifically, this session seeks to explore the ways in which collaborative networks, prefigurative discourse, and local curricular innovations can play a role in strengthening justice-centered science teaching and learning and resisting efforts to silence justice-centered educational aims.

Cultivating Joyful Transgression in Elementary Science Methods: A Collaborative Self-Study of AI Integration & Radical Imagination

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

20-Apr-26, 14:45-16:15

Location: Willow A (L2)

Symposium

Cultivating Joyful Transgression in Elementary Science Methods: A Collaborative Self-Study of AI Integration & Radical Imagination

Thomas McKenna*, Boston University, USA

Deepika Menon*, University of Nebraska-Lincoln, USA

Badri Adhikari*, University of Missouri-St. Louis, USA

Carolyn Colley*, Sartori Elementary, USA

Meenakshi Sharma*, Mercer, USA

Christina Schwarz*, Michigan State University, USA

Emily Adah, University of Georgia, USA

Tingting Li*, Washington State University, USA

Melissa Luna, West Virginia University, USA

Min Sun, University of Washington, USA

ABSTRACT

As AI tools rapidly enter teacher education, this symposium examines how elementary science teacher educators can create what bell hooks calls “locations of possibility” where preservice teachers learn to harness AI while cultivating radical imagination in science learning. Using collaborative self-study and critical participatory action research methodology, we investigate how teacher educators across diverse institutional contexts leverage AI technologies to enhance rather than constrain emergent, creative, and justice-oriented practices.

Our central inquiry explores: How do we cultivate spaces for joyful transgression and radical imagination in elementary science teacher education while thoughtfully integrating AI tools? Four brief presentations share empowering approaches from action research cycles: developing pedagogical agency in AI integration, supporting collaborative lesson planning processes, building educator and student critical evaluation skills, and redesigning assignments with AI as creative partner.

The symposium's collaborative structure maximizes learning: Following presentations, attendees choose from themed discussion tables led by elementary science teacher educators representing diverse geographic regions and institutional contexts. Participants co-construct innovative possibilities for AI integration that amplify radical imagination in science education, moving between tables as interests evolve. A synthesis by an expert in AI/ML educational research and policy integration concludes the session, identifying actionable insights for transformative practice.

Complexity in Science Education: Perspectives from Systems Thinking and Modeling

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

20-Apr-26, 14:45-16:15

Location: Ravenna C (L3)

Related Paper Set

Connecting Classrooms to Climate Change: Teaching Building Energy Systems Through Systems Thinking and Modeling

Laura Zangori*, University of Missouri, USA

Jessica Justice, University of Missouri, USA

Delaney O'Brien, Colorado State University, USA

Jong Kim, University of Missouri, USA

Aysegul Akturk, Gebze Technical University, Turkey

Laura Cole, Colorado State University, USA

ABSTRACT

Buildings account for nearly half of U.S. carbon emissions and 70% of electricity use, yet learning about how buildings are part of socio-ecological energy systems remain underrepresented in science education. This study, part of an NSF-funded model-based curriculum project, investigated how a place-based middle school unit supported students' systems thinking (ST) about a school building energy systems. Students took a pre and post-system modeling assessment, (n = 162) and 25 of the students were interviewed about their systems models. Analysis focused on the distinctions (D) and relationships (R) students' included within their models. D and R frequency changes were analyzed using Chi-square tests. Results showed statistically significant growth in distinctions of natural resources, energy production sites, and building elements influencing thermal energy transfer (e.g., windows, doors, insulation). Students also increased knowledge of relationships between energy sources, transfer processes, and environmental impacts from energy sourcing. Students progressed from depicting isolated electricity delivery to modeling multi-stage energy flows and design features affecting efficiency. Findings suggest that modeling within familiar contexts can bridge climate and energy education, strengthening students' capacity to reason about how buildings both consume and conserve energy. This work advances understanding of how modeling fosters ST in climate-related science learning.

Related Paper Set

Systems Thinking and Modeling in Climate Education: A System Dynamics Approach for Middle School Students

Melda Demirtas, Inonu University, Turkey

Gaye Ceyhan*, Bogazici University, Turkey

Ibrahim Unal, Inonu University, Turkey

ABSTRACT

Understanding climate change requires students to comprehend complex, interconnected systems with multiple feedback loops and dynamic relationships over time. Climate education traditionally emphasizes isolated facts and simple cause-and-effect relationships, limiting students' understanding of complex climate system interactions. This study examines what levels of systems thinking skills middle school students demonstrate when learning climate change concepts using system dynamics tools. Using a one-group case study design, 120 eighth-grade students (ages 13-14) from four classes participated in a four-week climate curriculum incorporating behavior-over-time graphs, stock-flow diagrams, and causal loop diagrams. Student performance was assessed using a four-level rubric measuring dynamic, stock-flow, and causal thinking skills. Results revealed varying proficiency levels across skills. Stock-flow thinking showed the strongest performance, with nearly half of students achieving the highest level, successfully creating complex diagrams illustrating multifaceted factors influencing atmospheric CO₂. Dynamic thinking displayed a bimodal distribution, with students demonstrating either basic descriptions or advanced explanations but struggling with intermediate connections between patterns and mechanisms. Causal thinking proved most challenging, with performance clustering at middle levels and few students mastering complex feedback loops. Findings show how students engage with different system dynamics tools and offer practical guidance for incorporating systems approaches into middle school climate curricula.

Related Paper Set

Scaffolding for Systems Thinking: Challenges and Mitigations

Ram Tamir, Ben Gurion University of the Negev, Israel

Tom Bielik*, Radboud University, Netherlands

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

ABSTRACT

Complex natural systems present fundamental challenges in science education due to their hierarchical nature, dynamic interactions, and emergent properties. This study investigates challenges students encounter in systems thinking (ST) when modeling complex systems. We developed a 15-hour instructional unit using Yellowstone's wolf reintroduction as an exemplary complex system, engaging approximately 60 eleventh-grade biology students in modeling activities. Through qualitative micro-analysis of screen recordings, audiovisual documentation, and student artifacts analysis, we identified several main challenge categories.

Key findings revealed students struggled with feedback loop conceptualization, conflating them with simple effects and defaulting to linear cause-and-effect reasoning. They demonstrated difficulties understanding indirect relationships and network propagation. Additionally, students viewed models primarily as representational rather than predictive/exploratory tools, treating initial models as final products. When evaluating

models, students focused on internal consistency while neglecting representational accuracy—consistency with real world data. Several effective scaffolding strategies were found to mitigate these challenges, including using multiple everyday examples and explicit instruction on considering both top-down and bottom-up effects. Our findings underline the importance of explicit instruction of metacognitive modeling knowledge and epistemological foundations of the modeling process. This research identifies persistent cognitive barriers and offers concrete pedagogical strategies for developing systems thinking capabilities.

Related Paper Set

Relationships between pre-service science teachers' modeling metaknowledge and modeling practices

Kim Lobner*, IPN, Germany

Tom Bielik, Radboud University, Netherlands

Moritz Krell, IPN, Germany

ABSTRACT

The development of modeling competence is a goal of science education. In addition to metaknowledge about models and the modeling process (i.e., metamodeling knowledge), science teachers are expected to develop their modeling practices. Previous studies found different results regarding the relationship between pre-service science teachers' (PSTs) metamodeling knowledge and their modeling practices. To gain new insights and corroborate previous findings, this study surveys PSTs' modeling competence.

A questionnaire measures PSTs' metamodeling knowledge, while their modeling practices are analysed using a task in which they explore an unknown phenomenon and create a digital model. Based on a sample of 158 PSTs, results indicate limited metamodeling knowledge. PSTs predominantly understand and use models as representations rather than as tools for prediction. Initial analyses of ten PSTs' modeling practices show most activities in the modeling process focus on exploring the phenomenon and constructing a model, with few activities focusing on applying the model for prediction. PSTs who integrated model application activities demonstrated varying levels of metamodeling knowledge, indicating different understandings of models and the modeling process. So far, no clear relationship between metamodeling knowledge and engagement in modeling practices is evident. Data based on a larger sample will be presented at the conference.

Context Matters: Using a Resources Perspective to Model Learner Reasoning

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

20-Apr-26, 14:45-16:15

Location: Aspen (L2)

Related Paper Set

Shifting into Sensemaking: Fluidity in biology students' epistemic cognition

Julia Svoboda*, Tufts University, USA

Sugat Dabholkar, Tufts University, USA

Scott Benjamin, Bunker Hill Community College, USA

Yiru Wang, Mount Holyoke College, USA

ABSTRACT

A goal of science education is to help students develop sophisticated ideas about knowledge and learning. Research in postsecondary biology education has identified a correlation between students' ideas about knowledge and approaches to learning: ideas about knowledge as coming from authority correlate with rote approaches to learning, whereas ideas about knowledge as constructed correlate with approaches that support understanding. In this case study, we examine shifts in how one student engages with knowledge in a single interview. At the start of the interview the student is focused on getting her answers checked and is hesitant to offer her own ideas. Later, she shifts, identifying gaps in her understanding and constructing and evaluating explanations that make sense to her. This shift aligns with prior work that students are likely to bring a variety of epistemological resources and framings to learning environments. It specifically disrupts characterizations of biology students as stably oriented towards memorizing facts and showcases that when socially positioned as capable of having ideas, they can activate a productive set of resources for engaging in knowledge construction that can support learning for understanding.

Related Paper Set

How Metacognition and Principle-based Reasoning Co-develop: A Case Study of Learning Flux in Biology

Alexander Waugh, Michigan State University, USA

Aeryn VanDerSlik, Michigan State University, USA

Safana Ismeal, University of Wisconsin Madison, USA

Hana Zhou, Michigan State University, USA

Sheela Vemu, Waubensee Community College, USA

Mary Pat Wenderoth, University of Washington, USA

Janet Branchaw, University of Wisconsin Madison, USA

Jennifer Doherty, Michigan State University, USA

ABSTRACT

Many students rely on memorization instead of using broadly applicable principles to reason mechanistically during problem solving. We investigated how students' metacognition and knowledge of the physiological principle of Flux (gradient-driven flow) interact during mechanistic reasoning. Drawing on coordination class theory and metacognition theory, we conducted a qualitative, longitudinal study in an active-learning introductory biology course. Two groups of four students were video-recorded across a semester as they solved mechanistic reasoning problems. We used microgenetic learning analysis of group work, along with in-class artifacts, homework, and exams, to characterize the development of

students' Flux coordination class, their metacognitive actions (planning, monitoring, evaluating), and their interaction.

Case studies of two student groups revealed distinct trajectories. Group A displayed limited metacognitive engagement, a fragmented understanding of Flux, and an epistemic frame of "knowledge as acquired," which constrained their reasoning. Group B exhibited robust metacognitive actions, a deepening Flux coordination class, and a "knowledge as constructed" frame that supported integration of knowledge resources.

Findings suggest that metacognition and disciplinary concept development can reinforce one another, and that principles like Flux can guide metacognitive actions. Effective instruction may also require scaffolding both metacognitive skills and epistemic frames that prioritize reasoning over authoritative sources.

Related Paper Set

Students' Knowledge Resources in a Problem-Solving-First Lesson

Paula Lemons*, University of Georgia, USA

Cheng-Wen He, University of Georgia, USA

ABSTRACT

This study uses the resource framework to explore how students engage and coordinate knowledge resources during a problem-solving-followed-by-instruction (PS-I) lesson on noncovalent interactions. Four students completed a PS-I lesson involving problem solving, explicit instruction, and transfer tasks. Narrative coding and resource graphs were used to analyze students' reasoning and resource use. Findings revealed three key patterns: continuity and coherence in resource application across lesson phases; reorganization of resources prompted by instruction and transfer tasks; and context-dependent resource activation shaped by individual learner experiences and instructional materials. These insights highlight the importance of accessing and scaffolding students' prior knowledge, and demonstrate how instructional contexts can reshape and refine students' conceptual understanding.

Related Paper Set

More than meets the eye: The impact of context in scientific observation

Adrian Adams*, University of Utah, USA

Lauren Barth-Cohen, University of Utah, USA

ABSTRACT

Scientific observation in field geology involves extracting relevant features from the environment and making inferences grounded in domain knowledge. Using Coordination Class Theory and a situative perspective, this study examines how social and instructional contexts influence one teacher's reasoning during a five-day geology field course. Data consist of video recordings throughout the course and the teacher's fieldbook. Analysis

qualitatively coded the teacher's and her peers' observations and inferences made during free observation time and tracked how observations were used to form larger explanations. Results suggest that the instructional context (open-ended vs. goal-oriented) and social context (group size) impacted how the focal teacher engaged. In larger groups, she primarily listened, incorporating peers' ideas into her notes and later using them in whole-class discussions; in smaller groups, she engaged in more dialog and occasionally challenged conflicting inferences. The goal-oriented instructional tasks elicited more synthesis of her and her peer's ideas. Results highlight the role of peer contributions in supporting complex reasoning. Implications include designing field experiences that leverage group interactions and varied tasks to foster collaborative knowledge building.

Roundtables Session 1

20-Apr-26, 14:45-16:15

Location: Grand Ballroom (L2)

Strand 1: Science Learning: Development of student understanding

WIP Roundtable

Hearing the Stars, Seeing Our Words: A Science-SEL Journey Through Sonification

Shanel Lightfoot*, The University of Alabama College of Engineering, USA

ABSTRACT

This work-in-progress action research study examines how astronomy, coding, and social-emotional learning (SEL) can be meaningfully integrated through the art of sonification. High school students engage in a five-day sequence beginning with the life cycle of stars and light spectroscopy, progressing to the sonification of stellar spectra, and culminating in voice-to-light analysis of spoken phrases. Using coding tools, students map both stellar and human voice frequencies to color gradients, creating visualizations inspired by the Hertzsprung–Russell diagram. Positive and negative phrases are compared to reveal patterns in communication tone, fostering self-awareness and active listening.

The roundtable will invite discussion on strategies for introducing coding to beginners, assessing SEL outcomes in science-based projects, and expanding sonification activities across STEM disciplines. By linking the frequencies of the cosmos to the frequencies of human interaction, this project highlights the power of interdisciplinary science education to cultivate both technical skills and empathy.

Strand 2: Science Learning: Contexts, Characteristics and Interactions

WIP Roundtable

Laughing to learn: Humor as a gateway to epistemic safety in high school chemistry

Elizabeth Harris*, Stanford University, USA

Tracy Poulsen*, Brigham Young University, USA

Erin Whiting*, Brigham Young University, USA

ABSTRACT

This study explores how humor and laughter can operate as tools for learning in a high school chemistry classroom. While prior research in science education has examined student emotions through surveys, few studies investigate how emotion is experienced during the act of learning. Drawing from sociopolitical perspectives on emotion, this study examines one teacher's conceptualization of humor in supporting relational, sociopolitical, and epistemic safety—key conditions for meaningful participation in science. Using a phenomenological approach, three semi-structured interviews were conducted with “Cathy,” a high school chemistry teacher in the Mountain West region of the United States. Findings reveal that Cathy intentionally uses humor to foster a safe, humanizing learning environment—creating space for epistemic vulnerability and engagement. Practices like “nerdy” jokes and classroom roles like “the scapegoat” invite students to participate without fear of failure. However, the study also finds that humor can at times inhibit learning, depending on group dynamics prompting further research. This work contributes to scholarship on science education by highlighting humor as a pedagogical tool for cultivating epistemic safety, an essential foundation for engaging students in the science and engineering practices outlined in Next Generation Science Standards.

Strand 2: Science Learning: Contexts, Characteristics and Interactions

WIP Roundtable

Connecting Creativity with PCK: Creating a Framework for Science Teacher Education

William Veal*, University of Charleston, USA

Vanessa Kind, University of Leeds, United Kingdom

ABSTRACT

High quality teachers are essential to high-performing education systems. These teachers are responsible for implementing their governments' vision of workforce preparedness in the 21st Century. How does a country, university, and society prepare effective and highly qualified teachers? In this paper, we explore qualities of effective teaching with specific focus on two constructs: creativity and pedagogical content knowledge (PCK). Creativity is an attribute that all teachers should have and be able to use while teaching, yet difficulties exist in identifying creativity in teaching science content. Scientific creativity offers a way to view how a teacher of science content can use creativity in the classroom. Likewise, PCK is challenging to define and describe. Researchers disagree about the knowledge bases comprising PCK and how teachers acquire them. An exemplary science teacher should be

creative and have PCK that ensures content is represented appropriately and students learn accordingly. These diverse, yet similar constructs share theoretical and methodological qualities. We propose examining how unification of creativity and PCK can help define and elaborate an exemplary science teacher's actions, thus pointing to strategies for ensuring how high quality teachers can be trained and developed.

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

Research on the influencing factors of scientific critical thinking of junior high school students

Chaochao Jia*, China Research Institute for Science Popularization, China

Xiuju Li, China Research Institute for Science Popularization, China

Ren Lei, China Research Institute for Science Popularization, China

Yuele Huang, China Research Institute for Science Popularization, China

Mengqian Wang, China Research Institute for Science Popularization, China

Tao Yang, Beijing Normal University, China

ABSTRACT

Scientific critical thinking is one of the core components of scientific literacy, which can enable individuals to maintain an open attitude, and have the courage to question and explore. It's found that the effect of cultivating critical thinking for students in the basic education stage is better than that in the college stage, so it is very important to study the influencing factors of students' scientific critical thinking in the basic education stage. Based on "ternary interaction" of social cognitive theory, this study chooses both personal and environmental level factors, and designed questionnaires. Carrying out multi-level analysis using 927 students and 27 science teachers' data, the important factors of scientific critical thinking are explored, which would provide local empirical evidence for the effective fostering of scientific critical thinking of junior high school students. The results show that the variation of scientific critical thinking knowledge and skills comes mainly from school-level, while the variation of the tendency and practice comes more from student-level. The direction of influence of different influencing factors is the same. The impact on scientific critical thinking include motivation, interest, thinking patterns, value recognition and learning methods from student-level; scientific experiments, inquiry teaching and scientific activities from school-level.

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

Leveraging Science Communication in Fostering Science Literacy and Science Identity Among Biology Graduate Students.

Meena Kharatmal, Texas State University, USA

Tyler Harper-Gampp, Texas State University, USA

Tiara Thompson, Texas State University, USA

Carolyn Jess, Texas State University, USA

Jill Zipperer, Texas State University, USA

Kristy Daniel*, Texas State University, USA

ABSTRACT

In this preliminary study, we explore the development of Science Literacy and Science Identity through graduate students' perceptions of their engagement in Science Communication course. We followed a qualitative method and applied the constructs of Science Literacy and Science Identity to deductively code students' open ended responses of pre and post course reflections. The preliminary analysis reveals that science communication coursework facilitates the developing of Science Literacy and establishing Science Identity as distinct and independent constructs. Science Literacy was revealed in terms of developing communication skills, nature of science and engagement while showing a stronger Science Identity in terms of recognition, performance, and belongingness. The study suggests that science communication course can serve as a useful pedagogical strategy to develop science literacy skills and to foster science identity in graduate science program.

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

Exploring Teacher Tolerance for Ambiguity: Implications for Authentic and Equitable Science Instruction

Christopher Wilson*, BSCS Science Learning, USA

Cynthia Passmore*, University of California, Davis, USA

Molly Stuhlsatz, BSCS Science Learning, USA

Cari Herrmann Abell, BSCS Science Learning, USA

Jeffrey Snowden, BSCS Science Learning, USA

Dennis Lee, BSCS Science Learning, USA

Chris Griesemer, University of California, Davis, USA

ABSTRACT

This roundtable will engage the NARST community in exploring the construct of Tolerance for Ambiguity (T4A) and its implications for science teaching and learning. Findings from an NSF-funded study of a high school biology modeling program revealed that teachers' T4A significantly moderated student learning gains, that is, teachers more comfortable with open-ended, or ambiguous tasks facilitated greater scientific sensemaking. Building on this, a new three-year NSF project will codesign and pilot professional learning aimed at increasing teacher T4A, investigate classroom differences between teachers with high and low T4A, and deepen our understanding of the T4A construct.

The session will begin with a brief overview of the T4A construct, its theoretical roots, and its relevance to science teaching reforms aligned with the NGSS. Participants will then address guiding questions on T4A's alignment with related constructs (e.g., productive struggle, scientific uncertainty), its potential to promote equity, effective professional learning designs, and promising research directions. By synthesizing perspectives from researchers, the discussion aims to clarify operational definitions, identify entry points for classroom

application, and chart a research trajectory. Outcomes will include key takeaways, points of consensus, and unresolved questions, with an open invitation for collaboration to advance this emerging line of inquiry.

Strand 2: Science Learning: Contexts, Characteristics and Interactions

WIP Roundtable

Exploring Multimodal Meaning-Making in Multilingual Science Classrooms: The Case of Lebanon

Salwa Ali*, Saint Joseph University, Lebanon

ABSTRACT

The study aims to investigate how multimodal teaching strategies support meaning-making in multilingual secondary chemistry classrooms, where science is taught in a second language different from the students' home language. Although multimodal strategies including verbal, visual, mathematical, and experimental modes are essential to enhance science learning, most of the research is situated in monolingual contexts. In multilingual classrooms, limited language proficiency poses challenges to students' understanding of the scientific discourse. This in turn increases reliance on non-verbal and semiotic resources. Drawing on Bakhtin's theory of dialogism and utterances in addition to Lemke's multimodal meaning-making framework, this qualitative study aims to explore the orchestration of diverse modes in three Grade 11 chemistry classrooms. Data collection will include observations and video recording of six consecutive chemistry sessions complemented by interviews. Multimodal interaction analysis will be employed to identify verbal, visual, gestures, and symbolic utterances. This will help examine their dialogic functions and their interplay with language for meaning-making within the classrooms. The study addresses four research questions concerning how students engage in meaning-making, the contributions of non-linguistic modes, the nature of multimodal communication, and the factors influencing these processes.

Strand 2: Science Learning: Contexts, Characteristics and Interactions

WIP Roundtable

What Added Value Do Neurophysiological Measures of Engagement Bring to Science Learning Research?

Yushuang Liu*, Boston College, USA

Xiaorui Xue*, Boston College, USA

Ido Davidesco*, Boston College, USA

Bruce McLaren, Carnegie Mellon University, USA

J Elizabeth Richey, University of Pittsburgh, USA

Hayden Stec, Carnegie Mellon University, USA

Leah Teffera, Carnegie Mellon University, USA

Jiayi Zhang, University of Pennsylvania, USA

Elana Zion-Golumbic, Bar-Ilan University, Israel

ABSTRACT

Engagement is a critical yet elusive component of science learning, characterized by dynamic cognitive, behavioral, and affective processes that are difficult to fully capture using self-reported and observational data. This roundtable discussion will critically examine the potential of two neurophysiological methods—EEG and eye-tracking—to provide more direct, continuous indicators of student engagement during science learning. Drawing on the Interactive, Constructive, Active, Passive (ICAP) framework, we explore how these tools can uncover moment-to-moment fluctuations in attention and engagement. We will review key EEG and eye-tracking indices, emphasizing their empirical support and applicability beyond controlled lab-based settings. Through concrete examples from recent science education research, we will discuss the added value of these methods in revealing individual differences in engagement and predicting learning outcomes. The discussion will also highlight challenges—such as data quality, validity, and ethical considerations—and explore future directions, including multimodal data integration and real-world classroom applications.

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

A Teacher's Philosophical Messages in Science Classrooms to Support Student Engagement in Knowledge Generation

Jale Ercan Dursun*, Baylor University, USA

JEE SUH, Baylor University, USA

ABSTRACT

This study investigates how an experienced elementary science teacher's discourse conveyed philosophical messages to support student engagement in knowledge generation. Grounded in the Next Generation Science Standards' emphasis on active participation in scientific practices, the research conceptualizes these messages across three dimensions: epistemological (nature of knowledge), ontological (roles and authority in knowledge generation), and axiological (value of epistemic tools such as language, dialogue and argumentation). Using a longitudinal instrumental case study, the authors analyzed 13 recorded lessons from a multi-week ecosystems unit, identifying 67 "critical episodes" in which the teacher fostered students' knowledge generation. Through open coding, the analysis revealed that the teacher, Teresa, explicitly and implicitly communicated messages that framed science as evolving and collaborative, positioned students as scientists and decision-makers, and emphasized the importance of talk, questioning, and argumentation in constructing knowledge. Collectively, these messages promoted epistemic agency, encouraged intellectual risk-taking, and legitimized student reasoning. The study extends prior research by showing how epistemological, ontological, and axiological dimensions work together in teacher discourse to create classroom environments where students authentically participate in scientific practices. The findings highlight the need for science educators to attend to the full philosophical landscape of their classroom messages to cultivate active knowledge construction.

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

Roundtable

Co-Creating Change: Building Authentic Collaborations Between Primary School Parents, Teachers, and University Researchers

Caitlyn Ishaq*, University of California, Davis, USA

Becca VanArnam*, University of California, Davis, USA

María Godoy, Independent Researcher, USA

Margarita Jiménez-Silva, University of California, Davis, USA

ABSTRACT

This roundtable examines how authentic connections turned into collaboration among parents, teachers, and university researchers to drive systemic change in primary school sustainability efforts. Building on a co-designed curriculum, we partnered with a dual immersion primary school to address lunchtime food waste while integrating students' cultural and home knowledge. Originating from a parent-led advocacy effort, the project evolved into a parent-school-university partnership that bridged home, school, and community experiences. Using pláticas as a methodology, we explored participant perspectives to understand how trust-building, shared decision-making, and consistent communication shaped this collaboration. Thematic analysis revealed a shift from parental involvement constrained by resources to a partnership that increased visibility, amplified parent voices, and fostered student agency in sustainability practices. We discuss how these authentic connections leveraged institutional attention, expanded access to resources, and empowered students as environmental stewards. This work contributes to literature on parent engagement, primary school teaching, parent-school-university partnerships, and student agency, offering a grounded example of how collaboration between parents, schools and universities can transform both primary school classroom practice and schoolwide systems. Participants will engage in discussion around strategies for co-designing curriculum, and also initiating, sustaining, and leveraging collaborative relationships in primary science education contexts.

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

Roundtable

Elementary Preservice Teachers ' Investigation Planning using a Toolkit to Support Responsive 3D Sensemaking

Anna Arias*, Kennesaw State University, USA

Soon Lee*, Kennesaw State University, USA

Preethi Titu, Kennesaw State University, USA

Rasheda Likely, Kennesaw State University, USA

Jessica Stephenson Reaves, Kennesaw State University, USA

ABSTRACT

Despite research and standards highlighting the benefits of planning and conducting investigations within three-dimensional (3D) science learning, opportunities to engage in such investigations remain uncommon in elementary classrooms. Elementary preservice teachers (PSTs) need opportunities to develop the skills and knowledge required to plan and conduct investigations, as well as to support children in this work. As part of a large design-based research project focused on developing a toolkit for PSTs to engage in 3D scientific sensemaking by planning and carrying out their own investigations, this qualitative case study examines the qualities of PSTs' investigation plans created using the toolkit. The toolkit was designed to support responsive 3D sensemaking during two integrated content courses for elementary education. Analysis of the PSTs' written work showed evidence of their engagement in responsive 3D sensemaking through their investigations, though the nature of their engagement varied. For example, some PSTs posed questions directly related to the health and safety of their students or themselves, while others developed questions based on relevant phenomena observed in class. These analyses provide evidence of PSTs' meaningful participation in scientific investigation planning, data collection, analysis, and conceptual reasoning using the toolkit, with implications for teacher educators and curriculum developers.

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

WIP Roundtable

Empowering Students Through Integrating Culturally Responsive Pedagogy with Evidence-Based Approaches to Teaching Science Writing

Yewon Lee*, University of Maryland at College Park, USA

Jooyoung Lee, University of Maine, USA

ABSTRACT

Writing is a powerful tool for learning in science and math classrooms, but many students from linguistically, culturally and academically diverse backgrounds (e.g., English learners, students with disabilities) struggle with writing. This challenge contributes to underachievement in science and math. Most science or math writing intervention are focused on supporting students' cognitive needs when writing, with little considerations for students' cultural or linguistic backgrounds. This calls for researchers to reimagine instructional approaches that leverage students' linguistic and cultural capital. This conceptual paper aims to disrupt teaching practices rooted in deficit by proposing a conceptual framework that integrates approaches to evidence-based science writing intervention with culturally responsive pedagogy.

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

Roundtable

Problems and Possibilities: Understanding an Early Career Science Teacher's Identity Development using the DSMRI

J. Elisabeth Kasner*, Florida State University, USA

ABSTRACT

This paper examines the evolving professional identity of early career science teachers (ECSTs) through a four-year longitudinal case study of Alexa, an ECST. Using the Dynamic Systems Model of Role Identity (DSMRI), the study highlights how an ECST navigates the transitional phases from pre-service training to in-service teaching. The DSMRI framework, anchored in complex dynamic systems theory, elucidates how Alexa's identity—shaped by her beliefs, self-perceptions, goals, and perceived action possibilities—transformed over time. Key findings indicate that while Alexa's core beliefs about instruction, students, and science remained stable, her perceived action possibilities shifted significantly. The study also reveals that Alexa's identity development was influenced by her interactions with peers, students, and the broader school environment. This research contributes to the field by demonstrating how ECSTs' professional identities evolve and adapt, emphasizing the importance of considering these identities in teacher preparation and induction programs. The findings offer valuable insights for science education researchers and teacher educators to support and understand the complexities of teacher identity formation.

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

Stand-Alone Paper

A Framework for Understanding Students' Experiences of Uncertainty during Scientific Sensemaking: Agency x Uncertainty Matrix

Bukola Akinbadewa*, Arizona State University, USA

Michelle Jordan, Arizona State University, USA

Ying-Chih Chen, Arizona State University, USA

Andrea Weinberg, Arizona State University, USA

ABSTRACT

Science learning is often framed as a search for certainty, yet moments of “not-knowing” can open powerful opportunities for students' epistemic agency. This study investigates how a middle school physical science teacher, following participation in the Student Uncertainty as a Pedagogical Resource professional development program, navigated student uncertainty to support equitable scientific sensemaking. We developed and applied a novel framework – Agency x Uncertainty Matrix, that integrates three uncertainty types (conceptual, epistemic, relational) with four socio-cultural equity principles (inclusion, belonging, access, power dynamics). Using an interpretive qualitative approach, we analyzed video and transcript data from a solar energy and circuits lesson, identifying episodes of uncertainty navigation and

coding teacher moves according to the matrix. Thematic analysis revealed how teacher discourse and classroom structures modeled uncertainty as a scientific practice, normalized help-seeking, prompted conceptual and epistemic justification, and supported individual reflection alongside collaborative learning. Findings demonstrate that explicit attention to uncertainty, combined with socio-cultural equity-oriented teaching moves, can redistribute cognitive authority, expand participation, and position all students as legitimate contributors to scientific sensemaking. This work offers both an analytic tool and practical implications for designing professional development that advances epistemic agency in science classrooms.

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

WIP Roundtable

Linking Academia and Industry: Exploring SSRL, 21st Century Skills, and Knowledge Construction in Collaborative Learning

Shirly Avargil*, Technion Israel Institute of Technology, Israel

Avida Shoham, Technion Israel Institute of Technology, Israel

ABSTRACT

This study explores the Socially Shared Regulation of Learning (SSRL) and 21st-century skills within a chemistry-themed educational escape room, aiming to understand how to bridge the gap between academic learning and industry demands. SSRL, a collaborative process where group members regulate their collective learning, is examined in the context of teamwork, communication, and knowledge construction, skills necessary in today's interdisciplinary workforce. Using a mixed-methods approach, the research investigates how university students engage in SSRL during escape room activities and how these experiences align with industry expectations. Data collection includes video observations, a designated SSRL questionnaire, and interviews with industry professionals. The study also aims to identify components for an intervention program to enhance students' industry readiness. By situating SSRL in an authentic, collaborative learning environment, this research contributes to both theoretical understanding and practical applications in science education. It offers valuable insights for educators seeking to design learning experiences that prepare students for real-world challenges through innovative pedagogical strategies.

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

Roundtable

Exam Previews: Evidence for Complexity and Related Learning within Undergraduate Assessment

Kerri Wingert*, Good Question Research, USA

Gregory Crowther, Everett Community College, USA

Ben Wiggins, Shoreline Community College, USA

ABSTRACT

This study explores the results of Exam Preview methods in undergraduate science courses. Recognizing the limitations of traditional high-stakes exams in fostering deep learning, this

research investigates how providing students with partial exam information in advance may be linked with cognitive complexity and student outcomes. Five two-year college faculty participated, with one section of their identical courses utilizing Exam Previews. Data included assessments, rubrics, instructor interviews, weekly surveys, student concept inventory data, and student interviews. While not all instructors increased exam complexity, those who did observed higher student change scores. Interestingly, increased instructor effort on Exam Previews, even without significant changes to exam complexity, correlated with improved student learning. The findings suggest that Exam Previews offer a low-entry model for instructors to potentially increase cognitive complexity in science coursework and can positively impact student learning, even when exam content remains largely similar. Further research is needed to fully understand the impact of the entire Exam Preview sequence on student experience.

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

WIP Roundtable

Civic Engagement among STEM Majors: Exploring Self-Determination and Identity through an Explanatory Sequential Mixed-Methods Study

Blessing Soyebi, Illinois State University, USA

Rebekka Darner, Illinois State University, USA

ABSTRACT

Undergraduate STEM attrition remains a national concern, with a sense of belonging often influencing persistence more than academic performance. This explanatory sequential mixed-methods study will use quantitative surveys and qualitative interviews to explore how STEM students' self-determination toward civic engagement relates to career decision-making and how identity factors shape the societal issues they aim to address in their STEM careers. Framed by self-determination theory, the STEM identity framework, and the social change wheel, this study examines STEM majors' experiences through quantitative surveys measuring self-determination toward civic engagement, career decision making behaviors, and STEM identity, while qualitative interviews explore aspects of identity that influence their civic focus in their STEM careers and explains the patterns observed in the quantitative data such as; STEM identity changes observed from pre and post survey data. The NARST roundtable will share emerging findings and engage participants in refining interview data analysis, considering quantitative findings, exploring connections between civic engagement and career trajectories, and generating strategies to prepare civically engaged STEM professionals better.

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

WIP Roundtable

Use of Video Role Models in Undergraduate Biology: A Focus on Career Pathways and Identities

Sierra Morandi*, Florida State University Schools, USA

Roxanne Hughes*, Florida State University, USA

Monica Paniagua Montoya, Florida State University, USA

David McNutt, Florida State University, USA

ABSTRACT

Current efforts to increase and diversify the STEM workforce have looked to K-12 science education spaces as spaces to increase motivation, recruitment, and support students into STEM professions. One avenue that has been recently taken up by science education researchers is the work of video-based role models in post-secondary spaces. This research sought to explore the use of pre-recorded video-based science role models on post-secondary students' career pathways, science skills, science identities, and biology identities. Data sources included student career pathway artifacts, discussion boards, and pre-post surveys from the course. The findings indicated a change in overall survey responses from pre to post. More specifically, these initial findings suggest a change in students' science interest and biology identities from the beginning of the semester to the end. This initial study, establishing a preliminary baseline of students' perception of themselves and their career pathways, given some video-based role models in science. Providing an on-ramp for future work to support the teaching and learning of science at the undergraduate level.

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

WIP Roundtable

Computational modeling for all? A study of AI-generated computational models in physics education

David Perl-Nussbaum*, University of Colorado Boulder, USA

ABSTRACT

This work-in-progress study investigates whether AI-generated computational models can democratize modeling-based physics education. Using natural language prompts, AI tools may reduce programming expertise barriers that have traditionally limited computational modeling experiences. Using a mixed-methods approach in a physics course for non-science majors, the study examines the relationship between students' computational background and success in AI-assisted computational modeling activities, while identifying which scientific modeling competencies become accessible to students with limited computational backgrounds.

Strand 6: Science Learning in Informal Contexts

WIP Roundtable

Mapping Joy and Justice: Black Girl Cartography and Radical Imagination in Informal Science Spaces

Tajma Cameron*, Morgan State University, USA

ABSTRACT

Despite ongoing efforts to improve diversity in STEM, Black girls remain underrepresented and underserved in science education. Traditional narratives often frame them as outsiders

or from deficit perspectives, disregarding their cultural identities, lived experiences, and creative potential (Anderson, 2020; King & Pringle, 2019; Likely & Wright, 2022). These narratives, shaped by dominant norms, marginalize Black girls' voices and experiences in both formal and informal science learning environments (Castro, 2014; Collins, 2018). This work in progress centers Black girls' perspectives and asks: How do Black girls reimagine science and STEM futures through identity mapping and storytelling?

Grounded in Butler's (2018) concept of Black Girl Cartography and Mauldin & Presberry's (2020) work on identity mapping, this study explores how informal science learning spaces serve as sites of liberation where Black girls can express multifaceted identities and envision radical, joyful futures in science. It adopts culturally sustaining and collaborative research methodologies that affirm identity, foster relationships, and amplify the voices of Black girls (King et al., 2023; Rogers et al., 2021). By positioning this work within broader discourses of inclusion and representation, this study contributes to expanding science education research that values the knowledge systems and lived experiences of Black girls in shaping equitable STEM futures.

Strand 6: Science Learning in Informal Contexts

Roundtable

From Compliance to Commitment: Science Identity and Persistence in Afterschool Robotics

Shikhar Kashyap*, Virginia Tech, USA

Brenda Brand, Virginia Tech, USA

Lezly Taylor, Virginia Tech, USA

ABSTRACT

Contemporary STEM reforms often overlook implicit norms and social dynamics that discourage marginalized youth. This study examines how the Pre-engineering Robotics Project (PRP)—a decade-long, grant-funded after-school program serving grades 9–12 in an underserved district—supported the persistence of African American high school students in STEM. Using a qualitative interpretive design, we analyzed focus-group interviews and participant-observation fieldnotes, coding students' narratives with Kelman's social influence processes (compliance, identification, internalization). PRP's structured, relationship-rich environment buffered negative performance stereotypes, cultivated belonging and recognition, and scaffolded skill development. Students progressed from tentative participation to confident engagement, increasingly articulating competence and future goals. Evidence across all three processes traced shifts from meeting external expectations to endorsing STEM identities and aspirations. Findings indicate that well-designed, equitable learning environments function as social-psychological interventions, enabling underrepresented students to build self-efficacy, persist in rigorous coursework, and see themselves as legitimate contributors to STEM knowledge and innovation.

Strand 6: Science Learning in Informal Contexts

Roundtable

Beyond the Classroom: Exploring Teachers' Roles in Extracurricular Stem Programs

HELEN SEMILARSKI*, University of Tartu, Estonia

HELIN SEMILARSKI, University of Tartu, Estonia

ABSTRACT

This study investigates Estonian educators' perspectives on extracurricular STEM (Science, Technology, Engineering, and Mathematics) programs, focusing on their awareness, motivation, and readiness to lead such programs. Based on questionnaire responses from over 100 teachers, the research studies show how familiarity with STEM extracurricular activities correlates with confidence in guiding STEM programs. The findings reveal key motivational factors—such as personal interest, student engagement, and opportunities for professional development—as well as common barriers, including limited time, resources, and institutional support. The study also presents educators' suggestions for enhancing the accessibility and sustainability of extracurricular STEM programs. These insights contribute to the broader understanding of informal science education and offer practical implications for policy and practice.

Strand 6: Science Learning in Informal Contexts

WIP Roundtable

Reimagining Contact with Science: A Freirian Perspective on Science Museums

Paula Silva Ribeiro Ferreira*, University of Nevada, Reno, USA

ABSTRACT

Science museums can be places of joyful discovery, connection, and excitement. Literature acknowledges these socio-emotional aspects of museums and discusses science learning in science museums, but other aspects of museums can be of interest to the science teaching community. This theoretical paper suggests the work of Paulo Freire as a perspective on science museums, exploring aspects of interaction with museums that go beyond science learning. The ideas of generative themes, dialogic education, and awareness, are used for investigating how these concepts converse with the experiences lived in science museums, and how they can help build a rationale for science museums as institutions committed to social change and the education for freedom. By affording visits that are not only focused on learning science content, but on embodied, joyful encounters with science, science museums could promote belonging. I identify areas of future research that could emerge from this proposal, as well as topics for discussion that could benefit this work in a work-in-progress roundtable format. This proposal could be impactful to NARST members because it discusses a justification for the position of science museums as defenders of social justice values.

Strand 6: Science Learning in Informal Contexts

WIP Roundtable

Reimagining Evaluation Through Relationality: Joyful Transgressions in Family STEM Learning

Diana Ballesteros, New York Hall of Science, USA

Franklin Aucapina*, New York Hall of Science, USA

Delia Meza*, New York Hall of Science, USA

Sarah Ketani, New York Hall of Science, USA

Alyssa Whu, New York Hall of Science, USA

Sylvia Perez, New York Hall of Science, USA

Susan Letourneau, New York Hall of Science, USA

ABSTRACT

This paper and roundtable discussion presents early findings from Museums United to Support Evaluation and Responsiveness (MUSEAR), a participatory co-design project co-led by informal STEM educators and researchers at a science museum and local community caregivers. Together, the co-design group is critically analyzing existing evaluation practices, and collaboratively reimagining how family learning in informal STEM settings is defined and assessed. Drawing on culturally responsive and relational pedagogy frameworks, the project shifts emphasis from institutionally-driven metrics to community-centered indicators of success. In the first year of a two-year co-design project, participants identified trust, belonging, and joyful, intergenerational memory-making as essential components of meaningful family program experiences. These components are often overlooked in traditional evaluation. The team is currently designing and testing strategies that disrupt extractive data practices and honor the relational, emotional, and cultural dimensions of learning. This work frames relational evaluation as a joyful transgression – an act of radical imagining where community voices shape what counts as evidence, and how learning, care, and connection are recognized within STEM learning environments. The roundtable discussion will engage attendees in learning about this partnership, sharing culturally responsive strategies, and connecting to broader conversations about equity, power, and meaning-making in educational evaluation.

Strand 6: Science Learning in Informal Contexts

WIP Roundtable

Exploring the Integration of Place-Based Education and Environmental Interpretation at an Informal Science Institution

Ryan Spencer*, Texas State University, USA

Meena Kharatmal, Texas State University, USA

Kristy Daniel, Texas State University, USA

ABSTRACT

For decades Informal Science Education (ISE) has been an important educational method in the United States and around the world. This preliminary study explores and seeks to

understand: To what extent if any, Place-Based Education is being incorporated at an Informal Science Institution that has adopted Environmental Interpretation as its chief educational methodology?

The research team employed naturalistic inquiry observing educators at an Informal Science Institute in Central Texas for one year. Data was collected using semi-structured interviews, focus groups, and tour observations. The paper explores the connections between Environmental Interpretation and Place-Based Education, highlights the study's preliminary findings, and offers some recommendations for the practice of Informal Science Education.

Strand 6: Science Learning in Informal Contexts WIP Roundtable

Developing Wicked Learners for a World of Wicked Problems

Shawn Rowe*, Exploratorium, USA

ABSTRACT

Many of the social, scientific, and ecological issues that we face today involve grappling with uncertainty, rapid pace of change, competing viewpoints, and a recognition that potential solutions carry both intended and unintended consequences, the impacts of some of which cannot be predicted. These wicked problems require learners with wicked problem-solving skills. Science centers are uniquely positioned to support the development of these wicked learners because they serve as civic learning spaces—settings where individuals can encounter multiple points of view, explore emotionally and politically charged issues, and develop the skills needed for navigating complexity. A review of literature identified twenty skills or dispositions associated with wicked problem solving in a variety of ILE adjacent fields. For this work in progress roundtable, we introduce the idea of wicked problems, share results of a literature review on wicked problem-solving skills, and share two observational rubrics illustrated with preliminary data collected from June through August, 2025 and being analyzed currently. The purpose is to further refine the rubrics and exemplars themselves) as well as learn from participants about similar efforts they may be aware of in both formal and informal learning environments.

Strand 7: Pre-service Science Teacher Education Roundtable

Developing Elementary Teacher Candidates' AI Assessment Literacy through STEMLEAD Self-Assessment Tool

Athena Hui Jiang, Iowa State University, USA

E.J. Bahng*, Iowa State University, USA

Stephen Fieffer, Iowa State University, USA

Omar Abudagga, Iowa State University, USA

Stephen Gilbert, Iowa State University, USA

Silmi Zafira, Iowa State University, USA

Syeda Chowdhury, Iowa State University, USA

Clark Coffman, Iowa State University, USA

Mack Shelley, Iowa State University, USA

ABSTRACT

As artificial intelligence (AI) reshapes formative assessment practices, there is a critical need to prepare elementary teacher candidates (ETCs) to engage with AI-supported tools pedagogically and ethically. This qualitative study explored how ETCs experienced and evaluated STEMLEAD, an AI-integrated self-assessment platform designed to support science conceptual learning through adaptive quizzes and immediate feedback. Grounded in Zimmerman's self-regulated learning theory and Vygotsky's sociocultural perspective, the study investigated 25 ETCs' evolving perceptions across pre- and post-surveys during a science methods course. Initial findings revealed that ETCs viewed AI as efficient but ethically complex, often using it personally but not pedagogically. After using STEMLEAD, participants reported increased awareness of AI's potential for formative assessment, learner autonomy, and student motivation. Importantly, ETCs identified how such tools can benefit underrepresented and underserved students by offering low-risk, personalized practice and reducing reliance on teacher-controlled feedback. However, they also voiced the need for training in ethical AI use, transparency, and instructional alignment. This study contributes to science education by demonstrating how structured AI engagement can develop ETCs' assessment literacy and critical pedagogical agency. It calls for teacher education programs to integrate experiential AI learning with reflective inquiry to ensure equitable, student-centered science instruction in increasingly digital classrooms.

Strand 7: Pre-service Science Teacher Education

WIP Roundtable

Connecting Creativity with PCK: Creating a Framework for Science Teacher Education

William Veal*, The College of Charleston, USA

Vanessa Kind*, The University of Leeds, United Kingdom

ABSTRACT

High-quality teachers are essential components of education systems across the world. These teachers are responsible for implementing their governments' vision of workforce preparedness in the 21st Century. How does a country, university, and society prepare effective and highly qualified teachers? In this paper, the qualities of effective teaching are explored with a specific focus on two constructs: creativity and pedagogical content knowledge (PCK). While creativity is an attribute that all teachers should have and be able to use while teaching, there remain many difficulties in identifying creativity in teaching science content. Similarly, PCK is an attribute that describes a highly qualified science teacher. Researchers provide different knowledge bases that make up PCK and how these teachers acquire them. An exemplary science teacher should be creative and have PCK so that content representations are presented appropriately, and students learn accordingly. These diverse yet similar constructs share many theoretical and methodological qualities. If the research literature is to advance in these areas, it might be necessary to unify these

frameworks. The amalgam of creativity and PCK to form an alternative theoretical framework can help researchers define and elaborate on what an exemplary science teacher does in the classroom.

Strand 7: Pre-service Science Teacher Education

Roundtable

Embedding Systems Thinking in Pre-Service Science Education to Promote Inquiry-Based Teaching

Azka Kiran*, Virginia Tech, USA

Monday Moju, Virginia Tech, USA

Lezly Taylor, Virginia Tech, USA

ABSTRACT

Despite global calls for reform, science instruction in many classrooms remains fragmented, emphasizing isolated facts over the interconnected and interdisciplinary thinking needed for real-world problem solving. This gap undermines the development of scientific literacy and limits students' ability to engage in authentic inquiry. Systems thinking, identified in the Next Generation Science Standards as a key crosscutting concept, offers a powerful lens for fostering complex reasoning, yet it is rarely emphasized in teacher preparation programs. Without exposure to systems thinking, preservice teachers often lack the conceptual tools and pedagogical strategies to implement inquiry-based instruction effectively. This qualitative study, grounded in sociocultural learning theory, examined how nine preservice secondary science teachers experienced and applied systems thinking during a yearlong methods course. Data from reflections, lesson plans, and interviews revealed that participants saw systems thinking as enhancing the relevance, coherence, and inquiry-driven nature of science instruction. Findings indicate that structured, collaborative engagement with systems thinking supports epistemological shifts toward integrative, real-world teaching. Embedding systems thinking in teacher education is essential for equipping future educators to bridge reform goals with classroom practice, fostering scientific literacy and preparing students to address complex societal challenges.

Strand 7: Pre-service Science Teacher Education

Roundtable

Empowering Pre-Service Teachers to Bridge Research and Secondary STEM Education

Katherine King*, Georgia Institute of Technology, USA

Heidi Turcotte*, Georgia Institute of Technology, USA

Meltem Alemdar, Georgia Institute of Technology, USA

ABSTRACT

This case study explores the experiences of eight STEM pre-service teachers (PSTs) participating in a six-week summer research program at a large R-1 university. Guided by a cognitive apprenticeship model (Brown et al., 1989; Farnham-Diggory, 1994), PSTs were

placed in research labs with the goal of building their methodological and procedural knowledge through social interaction with STEM faculty. Following a convergent parallel mixed methodological approach, quantitative (i.e., survey) and qualitative data sources (i.e., observations, artifact review) offered a rich understanding of how PSTs experience and interpret authentic research experiences. Findings revealed that PSTs quickly developed the skills to carry out experiments and analyses. PSTs valued research mentors who created a safe environment for learning through curiosity, collaboration, and patience. PSTs described a shift in how they perceived science, not as a quest for right answers, but as a collaborative, inquiry-driven process. This was reflected in the curricular materials developed by PSTs, which demonstrated interdisciplinary connections and inquiry-based strategies. The experience enhanced PSTs' sense of belonging in STEM and inspired them to create inclusive, curiosity-driven learning environments. This study contributes to the literature on teacher preparation by highlighting the transformative potential of research experiences for early-career STEM educators.

Strand 7: Pre-service Science Teacher Education Roundtable

Non-formal Education Pedagogy and Practices in K-12 Science Classrooms: A Phenomenological Study

Liz Carletta*, Rutgers University-Newark, USA

ABSTRACT

This paper is based on a qualitative, phenomenological study that explored how visitor-facing experiences in Informal Science Institutions (ISIs) shaped science teachers' practices in their K-12 science classrooms. It focuses on which parts of ISI pedagogy, including engagement strategies, object-based learning, understanding learners, and meaning-making transferred into participants' classroom teaching practices. Participants included 16 secondary science teachers from across the United States who had prior experience as educators in zoos, aquariums, nature centers, science centers, etc. before becoming teachers. Through individual and focus group interviews and an examination of work products, and as viewed through cultural-historical activity theory (CHAT) and Universal Design for Learning (UDL), it was apparent that: (1) the pedagogy of ISIs was largely used in both novice and experienced teachers' classrooms; (2) their ISI work helped teachers develop their identity as teachers, science teachers, and scientists; and (3) participants reported an ease with the implementation of NGSS in their classrooms compared to their colleagues. These findings suggest that ISIs are a useful site for pre-service teacher learning and may serve as a source of recruitment of future science teachers.

Strand 8: In-service Science Teacher Education

Roundtable

Science Teachers' Evolving Perceptions of Scientific Uncertainty Across Two Years of Practice-Based Professional Development

Yiwen Li*, Arizona State University, USA

Ying-Chih Chen, Arizona State University, USA

Michelle Jordan, Arizona State University, USA

Carlos Meza-Torres, Arizona State University, USA

Jongchan Park, University of Georgia, USA

Yu Ye, Arizona State University, USA

ABSTRACT

This qualitative longitudinal study examines how six in-service science teachers' perceptions of student uncertainty evolved across two-year practice-based professional development (P-BPD). Using a teacher uncertainty perceptions rubric, we analyzed interview data across five stages to trace changes in five dimensions: roles, types, sources, comfort level, and desirability. Findings revealed the most consistent growth in roles and comfort level, with five teachers reaching the highest level. Desirability also improved as teachers integrated key factors like relevance and complexity into instruction. However, recognizing the intertwined relationship between conceptual and epistemic uncertainty and identifying co-occurring sources proved more challenging. These results underscore the value of authentic inquiry experiences and iterative reflection in supporting teachers to embrace uncertainty as a pedagogical resource.

Strand 8: In-service Science Teacher Education

Roundtable

Exploring In-Service Science Teachers' Understanding of Systems Thinking Approach and Pedagogical Strategies to Foster it

Monday Moju*, Virginia Tech, USA

Akza Kiran*, Virginia Tech, USA

Olusegun Fashakin, University of Lagos, Nigeria

ABSTRACT

Science education in Nigeria faces the challenge of preparing students for a complex, interconnected world while operating within rigid, exam-driven systems. Despite the global recognition of systems thinking (ST) as a key competency for sustainability and problem-solving, little is known about how in-service Nigerian science teachers understand ST or implement it in their classrooms. Existing research focuses largely on developed contexts, leaving a gap in understanding the intersection between teachers' systems thinking competencies, pedagogical strategies, and contextual barriers in under-resourced environments. Guided by the Competency-Based Systems Thinking Model and Shulman's

Pedagogical Content Knowledge framework, this qualitative multiple-case study explored 20 in-service science teachers' understanding and practices across three states in Southwest Nigeria. Data from interviews, classroom observations, and document analysis were thematically analyzed. Findings reveal fragmented, content-bound conceptions of ST, limited classroom enactment due to exam-oriented pressures, and systemic constraints such as large class sizes, inflexible curricula, and lack of targeted training. While teachers expressed interest in inquiry-based strategies, contextual realities hindered their adoption. The study underscores the urgent need for localized, sustained professional development and curriculum reform to integrate systems thinking as a core pedagogical framework, enabling science education to move beyond rote learning toward transformative, systems-oriented instruction.

Strand 8: In-service Science Teacher Education
WIP Roundtable

Impacts of a Professional Development Program on Biology Teachers' Scientific Argumentation Competency and PCK

Shan LIN*, Beijing Normal University, China

Jian WANG, Beijing Normal University, China

ABSTRACT

Scientific argumentation (SA) is recognized as a scientific practice in science education, yet students often struggle with constructing and critiquing arguments effectively. Teachers play a crucial role in developing students' scientific argumentation competency (SAC), but many lack both SAC and the pedagogical content knowledge of scientific argumentation (PCKSA) needed for effective instruction. This study develops a professional development (PD) program that simultaneously enhances teachers' SAC and PCKSA, aiming to improve students' SAC. Grounded in relevant SA and PCK frameworks and informed by features of effective PD, the program integrates theoretical instruction, argumentation activities, classroom artifact analysis, instructional design, teaching practice, video discussion, and peer experience sharing. Using a mixed-methods approach, data will be collected from 20-30 in-service high school biology teachers through pre-/post-assessments, interviews, video recordings, and instructional artifacts. Quantitative and qualitative analyses will examine changes in teachers' SAC, PCKSA, and their relationship to students' SAC. The Findings are expected to contribute a validated PD model, assessment instruments, and evidence on the dual development of SAC and PCKSA, offering insights into designing effective, sustainable teacher education programs that promote students' engagement in scientific argumentation.

Strand 11: Cultural, Social, and Gender Issues

Roundtable

Broadening “Queering” in STEM: Advancing a Relational Paradigm Through Queer Cultural Praxis

K. Mendoza*, University of Nebraska at Omaha, USA

Khanh Tran*, Utah State University, USA

ABSTRACT

In alignment with the conference theme, Joyful Transgressions and Radical Imagination in Science Education, this roundtable reimagines what it means to “queer” STEM education. While existing scholarship on queering STEM can be generally organized within and across three paradigms—safety, equity, and critical—these approaches, while valuable, often remain limited by institutional logics that prioritize short-term, depoliticized interventions. We introduce the relational paradigm as a praxis-oriented framework that builds on and extends these inheritances. Rooted in trans, nonbinary, and decolonial epistemologies, the relational paradigm centers queer cultural production—creative expressions, kinship formations, and resistant traditions—as vital sites of STEM meaning-making. The roundtable aims to provide an open, generative space for imagining how relational praxis can expand methodological and theoretical possibilities in the field. Together, we will explore how queer and trans cultural knowledge not only critiques dominant norms but also actively generates new worlds for science education.

Strand 11: Cultural, Social, and Gender Issues

Roundtable

School and racial climate in the context of Science and Mathematics Teaching in Puerto Rico

Maria Medina, University of Puerto Rico, USA

Isabel Delgado*, University of Puerto Rico, USA

Sara Ocasio, University of Puerto Rico, USA

Melitza Nieves*, University of Puerto Rico, USA

ABSTRACT

This research presents the perceptions of school and racial climate manifestations in two middle schools in Loiza, Puerto Rico, mainly of Afro-Puerto Rican students, and their possible interactions with teaching of Science and Mathematics. Bronfenbrenner’s (1979) ecological system was adopted to understand these interactions. Through semi-structured interviews and classroom observations, the research team collected the voices and experiences of students, parents, in-service teachers, directors, and community members. A deductive and inductive qualitative data analysis was performed. This paper focuses on the findings of Phase 1 (qualitative) of a multiple case study design with mixed methods. The findings

indicate an absence of understanding among the different participants on how racial issues are embedded into the school climate.

Strand 11: Cultural, Social, and Gender Issues

Roundtable

Cultural and Linguistic Diversity in STEM Education: NARST and NSTA Perspectives

Narendra Deshmukh*, Ret. from Homi Bhabha Centre for Science Education, TIFR, India

ABSTRACT

This study examines how the National Association for Research in Science Teaching (NARST) and the National Science Teaching Association (NSTA) address cultural and linguistic diversity in STEM/STEAM education, focusing on strategies to foster equity, inclusion, and engagement in increasingly multicultural classrooms. Using qualitative comparative document analysis and thematic synthesis of organizational publications (2018–2025), the research identifies six shared priorities: culturally responsive and sustaining curricula; leveraging linguistic and cultural resources; authentic representation and role models; community-connected learning; equity-focused teacher development; and addressing systemic barriers. NARST contributions emphasize research-based frameworks, problem-based and place-based learning, critical pedagogy, multilingual inclusion, and equity-centered professional development. NSTA's contributions center on NGSS-aligned practice, Universal Design for Learning, arts integration, role model visibility, inclusive classroom environments, and professional learning communities. Both organizations promote adaptable, evidence-driven approaches linking policy and practice. The findings align with UNESCO's SDGs 4 and 10, offering globally transferable models for culturally sustaining STEM/STEAM curricula and pedagogy. These strategies can inform international curriculum reforms, teacher preparation, and community engagement across diverse contexts, from India's NEP 2020 to equity initiatives in Africa, Europe, and the Americas, building a globally competent and inclusive STEM talent pipeline.

Strand 11: Cultural, Social, and Gender Issues

Roundtable

Negotiating Cultural Expectations and Career Agency: East Asian Americans' STEM Career Choices

Layla Zang*, Virginia Tech, USA

Brenda Brand*, Virginia Tech, USA

Lezly Taylor*, Virginia Tech, USA

ABSTRACT

Asian Americans are portrayed as model minorities, with STEM education proficiency and a natural aptitude for STEM occupations. While the model minority myth presents Asian Americans as naturally suited for technical and academic success, it obscures diverse goals and can dehumanize by channeling individuals into narrowly defined career paths. Guided by Social Cognitive Career Theory and the Model Minority Myth, this qualitative study used

semi-structured interviews to examine East Asian Americans' career choices and how cultural values intersect with racial expectations in shaping STEM trajectories. Findings show decisions to pursue STEM reflect a complex interplay of cultural values, familial expectations, and racialized perceptions. Although regarded as an external stereotype, the Model Minority Myth is reinforced within East Asian American communities through family pressure, peer comparison, and communal definitions of success, complicating choice and identity formation. This study contributes to understanding the cultural pressures faced by Asian Americans and advances a social-justice agenda of fostering career diversity and freedom from racialized expectations. It calls on educators to rethink East Asian Americans' educational and career trajectories and implement culturally responsive curriculum and guidance.

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

Identifying High-Quality Teachers and Their Job Satisfaction in TALIS 2018

Elif Ozulku*, University of Notre Dame, USA

Sebnem Atabas, University of St. Joseph, USA

ABSTRACT

This study investigates the characteristics, practices, and job satisfaction of high-quality science teachers, defined as those who use cognitively activating instructional strategies at least one standard deviation above the average, using data from lower secondary science teachers in 47 countries participating in TALIS 2018. We employed random effects models to compare these teachers with their counterparts within the same national contexts and to examine factors associated with job satisfaction. Results indicate that high-quality teachers more frequently engage in professional collaboration, demonstrate stronger classroom management, and hold higher instructional self-efficacy. They also report greater job satisfaction, lower stress related to student behavior, and a stronger desire to remain in the profession, though the average additional tenure (1.36 years) falls short of the experience threshold typically associated with mastery. Findings highlight the importance of professional collaboration and supportive working conditions in sustaining high-quality teaching. We discuss implications for teacher retention policies, emphasizing targeted support to extend the careers of teachers who adopt rigorous instructional practices.

Celebrating the Everyday in Science Learning Across Contexts and Lifespans

Strand 6: Science Learning in Informal Contexts

20-Apr-26, 14:45-16:15

Location: Virginia (L4)

Related Paper Set

Science in the Strands: An Ethnographic Study of the Natural Hair Community

Grace Tukurah*, Michigan State University, USA

ABSTRACT

This study challenges commonly held deficit ideas about Black girls and women in science by demonstrating that they not only use their scientific knowledge to inform natural hair care, but they also engage in diverse scientific practices within the natural hair community by collecting data and producing knowledge that helps them care for their hair. Using digital ethnography as a tool of inquiry, this study investigates the activities of a global community of practice of Black girls and women within an online counterspace -the natural hair community. The data from this investigation was analyzed within a decolonial Black Feminist framework to attend to matters of intersectionality, as multiple identity markers influence how scientific knowledge is represented and understood within the community. Findings from this study indicate that not only do Black girls and women participate in science everyday, they do so in unique ways that challenge and disrupt canonical boundaries of science education.

Related Paper Set

A Right to Repair: The Navigation of a Black Learner's STEM Identity

Brandi Cannon-Force*, Stanford University, USA

ABSTRACT

The continued exclusion of Black learner's previous knowledge, history, and representation within the STEM canon, and disproportionately high discipline rate for young Black students throughout their K-16 education makes navigating the tumultuous landscape that is STEM education likely prohibitive in how they are able to engage with daily STEM. Yet, Black learners are resourceful, resilient, and imaginative.

I investigate how we can learn about and nurture the STEM identities of those who are no longer connected to formal STEM settings? I invited four participants to develop a counterstory to reflect on their past, present, and future STEM identities. I used Educational Digital Storytelling as a critical pedagogy tool, allowing learners to script, storyboard, and produce narratives that reveal how Black learners consider their STEM identity.

Through redefining what a STEM identity represents, and personally what it means to the Black learner, participants fought for the right to repair their relationship with STEM through alternative means. Participants did not assimilate into means pre-determined by scientific

western standards. Beyond the classroom, traditional avenues, and in a space where recognition of one's self as a STEM person is not only recognized by their peers, but acknowledged and applauded.

Related Paper Set

Fractal Thinking with Poly-Epistemic Families about Tortilla-Making

Alejandra Frausto Aceves*, Northwestern University, USA

ABSTRACT

Educational reforms continue to prioritize what I refer to as breathing out, moving knowledge from school to families. This paper works to challenge the unidirectionality of what counts in educational research on teaching and learning, by breathing in, moving from the holistic pedagogies of families to school science towards contributing to sustaining resilient practices amid climate crisis and broadened global migration. Specifically, this paper posits that a transnational, poly-epistemic understanding of the cultural practice of tortilla-making within Latine diasporic families could advance our understanding of the interconnectedness of ways of knowing with ways of learning and teaching in science education. Video footage and multimodal transcripts of two semi-structured session-types were analyzed - tortilla-making sessions in which families made tortillas in their homes and interpretative sessions in which families interpreted participants' tortilla-making repertoires of practice. Methodologically, this paper affords a possible way to analyze a mutually constituted diasporic practice fractally with families. This methodological contribution is consequential to welcoming poly-linguistic, poly-epistemic, and alternative semiotic resources into research and into classrooms. This is important not just because of the implications for migrant families or multimodal nature of science, but also because we know it to be a cultural preference when teaching and learning.

Building Preservice Teachers' Computational Thinking and AI-Integrated Modeling Practices

Strand 7: Pre-service Science Teacher Education

20-Apr-26, 14:45-16:15

Location: Columbia (L4)

Stand-Alone Paper

Pre-service science teacher learning about computational thinking through computational modeling practices

Amanda Peel*, New Mexico State University, USA

ABSTRACT

With the introduction of AI, the need to code from scratch is diminishing because AI will and is beginning to be able to generate code for users. It is now imperative that people know how

to read, understand, debug, and modify code to fit their needs. As such, this work focuses on building foundational computational thinking (CT) skills by introducing learners to unplugged, or computer-free, algorithm concepts and using it as a scientific practice. A series of modules were designed to integrate science, CT practices, and science teaching pedagogy, which is an innovative approach to teaching preservice teachers (PSTs) about CT. These modules were piloted, and data was collected to answer the following research question: How did PSTs learn about CT through their engagement in the CT lessons? Initial findings indicate small increases in confidence with teaching CT and science/math. The CT-Test results showed CT growth for most PSTs. PSTs were able to read NetLogo code and identify algorithm concepts. This study contributes a characterization of PSTs' CT knowledge and abilities when engaged in computational modeling in science. These results indicate PSTs did learn about CT as a scientific practice through the modules without learning how to code.

Stand-Alone Paper

Pre-service Teachers' Learning and Reflection Computational Thinking and Transdisciplinarity in an Out-of-School Project

Camila Gasparin, Georgia State University, USA

Sudha Awasthi, Georgia State University, USA

Patrick Enderle*, Georgia State University, USA

ABSTRACT

From an out-of-school project, that worked with students and educated pre-service teachers, whose interviews transcripts and produced artifacts have been analyzed through open and axial-coding. Analyses show computational thinking (CT) and multicultural ideas present in the teachers interviews and artifacts, concepts that were addressed in the course they attended as part of the project. Data also shows understanding of the concepts of cultural relevant pedagogy, real world problems, and the didactic practice of transdisciplinarity, i.e., the Freirian pedagogical perspective. Therefore, the participants (teachers) have reflected upon and identified the CT use for real world problems, beyond the limits of curricula subject and syllabi, through a multicultural and culturally relevant approach.

Stand-Alone Paper

Pre-service Science Teachers' Use of AI for NGSS Teaching and 3D Learning

Emil Eidin*, University of Wyoming, USA

Peng He, Washington State University, USA

Tingting Li, Washington State University, USA

ABSTRACT

As Artificial Intelligence (AI) becomes more prominent in society, preparing teachers for an educational environment shaped by AI is increasingly important. For science teachers, this involves designing activities that leverage AI to address challenges specific to science education. While proposals exist for incorporating AI into pre-service courses, little is known

about the impact of such approaches. This study examines a case of two pre-service teachers who participated in a one-week exploration module within a science methods course. The module engaged them in AI-based activities aimed at addressing known challenges in science education. We tracked their AI use throughout a 16-week teaching residency, triangulating data from a pre-survey, a post-module interview, and a post-residency interview. Findings indicate the module enhanced participants' operational capabilities, including tentative prompting and using AI to implement NGSS phenomenon-based lessons. Their experiences during the residency influenced their dispositions toward AI, highlighting both opportunities and considerations for integrating AI in teacher preparation. This exploratory work contributes to understanding how AI can be meaningfully embedded in pre-service programs.

Stand-Alone Paper

How Preservice Teachers Simplify Computational Thinking Concepts During Elementary Science Lessons: Strategies and Challenges

Drew Gossen*, University of South Alabama, USA

Shenghua Zha, University of South Alabama, USA

Na Gong, University of South Alabama, USA

Sanju Chhetri G C, University of South Alabama, USA

Kelly Byrd, University of South Alabama, USA

Jennifer Simpson, University of South Alabama, USA

ABSTRACT

As computational thinking (CT) becomes increasingly mandated in elementary curricula, preparing preservice teachers (PSTs) to integrate CT into science instruction requires not only conceptual knowledge but also practical pedagogical skill. This qualitative study examines how eleven elementary PSTs simplified complex CT concepts for young learners and managed real-time implementation challenges during their student teaching placements following comprehensive training in robotics and coding integration. Data sources included lesson plans, classroom video recordings, and post-lesson reflections, analyzed thematically to identify pedagogical moves and adaptive strategies. PSTs used relatable analogies, kinesthetic role-play, and concrete representations linking numerical inputs to observable robot behaviors. CT was embedded in diverse science topics, from simulating animal behaviors to exploring wave properties. To address practical challenges, PSTs established clear behavioral expectations, facilitated collaborative troubleshooting, differentiated support for varied learner needs, and developed logistical solutions for limited resources and technical issues. Findings move beyond outcome-focused research to reveal the moment-to-moment instructional decisions that operationalize CT integration in authentic science contexts. Implications for teacher preparation include targeted development of technology-rich classroom management, troubleshooting skills, and cross-curricular instructional design.

Exploring STEM educators' professional learning pathways

Strand 8: In-service Science Teacher Education

20-Apr-26, 14:45-16:15

Location: Cedar AB (L2)

Stand-Alone Paper

Discrepancies in Feedback Perceptions of STEM Teachers and their Students: Giving or Discussing Feedback

Josine Görtzen*, Eindhoven University of Technology, Netherlands

Gonny Schellings, Eindhoven University of Technology, Netherlands

Nienke Nieveen, Eindhoven University of Technology, Netherlands

ABSTRACT

Teachers transitions from providing one-sided feedback to discussing feedback is key for fostering student engagement, reflection and learning. This study investigates perceptions of feedback practices among STEM secondary school teachers and their students before and after a two-year professional development (PD) program designed to promote feedback dialogues. The program aimed to shift classroom feedback from traditional teacher-led to interactive dialogues that support personal growth. Drawing on questionnaire data from both teachers and students, the study examined changes in perceived feedback behaviors across two scales: About the Student (teacher-led) and With the Student (dialogic). Results indicate student-reported increases in teacher-led feedback across both years. In the second year, a significant growth on the With the student' scale: was found, mirroring that feedback dialogues were emerging. At the end of the program, teacher self-reports showed mixed perceptions of feedback behaviors, often underestimating their occurrences rated by their students. This discrepancy reflects the complexity of self-assessments. Findings also suggest that teachers' growth is related to students taking more active roles in feedback processes. The study underscores the value of student perceptions as complementary indicators of teacher behavior and highlights the importance of sustained, practice-based PD for embedding dialogic feedback in everyday teaching.

Stand-Alone Paper

Evolving Educator Practices: Integrating Professional Learning in the STEM for All Project

Melissa Livingston*, Oregon State University, USA

Cory Buxton, Oregon State University, USA

ABSTRACT

This study examines how science educators engage in and sustain professional learning across formal and informal settings through participation in a multi-year, justice-oriented PD program centered in after-school STEM clubs. Drawing on third generation Cultural Historical Activity Theory (CHAT) and practice theory, this collective case study investigates how five educators adapt and enact project practices across club and classroom contexts. Data sources include educator logs, interviews, observations, and teaching artifacts. Findings

highlight three key insights: (1) Educators make agentic pedagogical decisions within institutional constraints, balancing personal commitments with systemic demands; (2) Community networks support but unevenly structure collaborative learning; and (3) Teachers personalize project-aligned practices based on local relevance rather than fidelity to the PD program. This study challenges linear models of PD effectiveness and argues for an interpretive framework that centers teacher agency, contextual adaptation, and pedagogical negotiation. It contributes to science education research by demonstrating how third spaces enable sustained professional learning, and how sustainability stems not from replication, but from meaningful, situated enactment. Findings offer implications for designing flexible, equity-focused PD models that value variation and foster educator-driven change across learning environments.

Stand-Alone Paper

Interaction among Pedagogical Content Knowledge Components for Teaching STEM In High School Science Teachers

Mustakeem Awae*, Kasetsart University, Thailand

Chatree Faikhamta, Kasetsart University, Thailand

ABSTRACT

This study investigates the interaction among Pedagogical Content Knowledge (PCK) components in high school STEM teaching, offering a novel lens on how interdisciplinary pedagogy operates in practice. Using a qualitative multiple-case design, three experienced science teachers were observed, interviewed, and analyzed through PCK mapping to visualize structural and functional relationships between knowledge domains. Findings reveal that while teachers adapt instructional strategies (KIS) and assessments (KA) in response to student understanding (KSU), a persistent disconnect between Content Knowledge (CK) and assessment design remains. This gap allows engineering products to flourish without deepening scientific reasoning, challenging assumptions in existing PCK models that integration inherently ensures conceptual rigor. The study extends prior work by reframing STEM PCK not merely as integration of domains but as interactional coherence, where disciplinary reasoning and assessment are deliberately synchronized. The implications are twofold: advancing PCK theory for interdisciplinary contexts and providing actionable pathways for designing teacher education and professional learning to bridge CK–KA alignment in engineering-rich STEM instruction.

Stand-Alone Paper

Rural high school teachers' experience with micro-credential-based professional development: A collective case study

Madeline Stallard*, North Carolina State University, USA

M. Gail Jones, North Carolina State University, USA

Kathleen Bordewieck, North Carolina State University, USA

Amber Meeks, North Carolina State University, USA

ABSTRACT

This study investigated the impact of micro-credential-based professional development on rural Appalachian teachers' beliefs, knowledge, and skills. Using a collective case study methodology, data were gathered through pre and post-surveys, and a series of semi-structured interviews conducted across one academic year. Participants were asked to complete three curated STEM-focused micro-credentials hosted on a national micro-credential platform and were supported in their professional development by instructional coaches who guided evidence collection and resubmissions. Findings showed that the micro-credential program had a differential impact on teachers depending on their capacity to engage in self-directed learning. Those teachers who had the motivation and time to commit to self-directed professional development benefited more than their peers who had struggles with motivation, as well as time and work demand challenges. These results suggest that the effectiveness of micro-credential-based professional development may depend on teachers' capacities for self-directed learning and the context under which they are receiving it (e.g., the support teachers have for professional development such as time, resources, and materials). These findings highlight the need for tailored support strategies to ensure equitable benefits across varying levels of self-regulatory skills.

Elementary teacher development in science and engineering

Strand 8: In-service Science Teacher Education

20-Apr-26, 14:45-16:15

Location: Juniper (L2)

Stand-Alone Paper

"You can learn the science together": Insights from bright spot elementary teachers

Ryan Nixon*, Brigham Young University, USA

Stefan Sorge, IPN - Leibniz Institute for Science and Mathematics Education, Germany

ABSTRACT

A persistent challenge in science education is the limited science subject matter knowledge (SMK) of elementary teachers. While formal learning opportunities exist, teaching experience may offer abundant opportunities for SMK development. This study uses a bright spot approach to identify elementary teachers who scored unexpectedly high on SMK assessments despite typical qualifications. Using a sequential explanatory mixed-method design, we surveyed 346 teachers and identified bright spots through regression analysis. Nine teachers participated in interviews and classroom observations, which are the focus of this study. We report findings from four participants, highlighting four characteristics that may contribute to their strong SMK: (1) attending to student thinking, (2) valuing science, (3) identifying as science people (or being recognized as such), and (4) enacting strategies for attending to uncertainty. These findings suggest that cultivating curiosity, valuing science, and attending to student thinking may be key levers for improving teacher SMK in classroom contexts.

Stand-Alone Paper

Teacher Identity Development in Elementary Science Education: A Longitudinal Study through an Identities-In-Practice Lens

Selin Akgün*, University of Minnesota, USA

ABSTRACT

Promoting meaningful and equitable science learning experiences for students is an essential goal in science education. Achieving this goal is deeply tied to developing science teacher identities of teachers. Teachers' developing identities shapes by their personal histories/positionality, conceptions of science and science teaching, as well as their way of teaching science in real-time classrooms. Therefore, this study investigates one teacher's identity development—focusing on her positionality, changing conceptions and implementation of science teaching—through a longitudinal case study of Ms. Spark, a 3rd-grade teacher. From 2018 to 2023, I investigate how she teaches science (through the implementation of sensemaking practices) within classroom observations, interviews, and student work. The findings reveal that Ms. Spark's teacher identity grew through the interplay of her personal history, her views on science and teaching, and her use of sensemaking practices to promote equitable science instruction. This transformation became visible by her constant curriculum adaptations and a stronger focus on connecting science to students' academic, community and cultural resources, and cultivating their critical consciousness on science and its role in society. The study offers key insights for transforming science teacher identity work, as well as pre- and in-service science teacher education and professional development.

Stand-Alone Paper

Impacts of Professional Learning on Elementary Teachers' Engineering Teaching Self-Efficacy to Support Multilingual Learners

Meghan Macias*, WestEd, USA

Ashley Iveland, WestEd, USA

ABSTRACT

Elementary teachers are expected to teach engineering aligned with the Next Generation Science Standards, yet many report limited preparation and confidence—especially in engineering (Bunch, 2013; NASEM, 2018). This study examines whether a year-long professional learning (PL) model (which involved a summer institute and six professional learning community meetings) was associated with changes in teachers' engineering teaching self-efficacy. Guided by sociocultural perspectives on learning and language development, the PL emphasized authentic engagement in engineering design, explicit integration of discourse-rich pedagogy, and community building. Pre to post-survey data (10 Likert-type self-efficacy items) showed increases across all items for participating teachers. The average self-efficacy score across all items rose from 3.15 (pre) to 4.22 (post). Largest gains were seen for items pertaining to understanding engineering concepts well enough to

teach, knowing steps to teach effectively, explaining why engineering activities work, teaching effectively, and responding when students struggle. We discuss how specific PL design features (e.g., authentic adult engineering experiences, explicit scaffolding moves for MLs, and PLCs centered on student artifacts) may have contributed to these shifts, along with implications for equitable engineering instruction.

Using content analysis to advance equity

Strand 11: Cultural, Social, and Gender Issues

20-Apr-26, 14:45-16:15

Location: Willow B (L2)

Stand-Alone Paper

Proposing Evidence-based STEM Curriculum for Latinx Students' Success: A Meta-Synthesis of Effective Intervention Elements

Noushin Nouri*, University of Texas Rio Grande Valley, USA

Maryam Saberi, Ministry of Education, Iran, Islamic Republic of

Amir Hossein Karimi Aghbolagh, University of Texas Rio Grande Valley, USA

ABSTRACT

The underrepresentation of Latinx individuals in STEM fields constitutes a critical national challenge. This study introduces the LaSTEM (Latinx-Affirming STEM) Curriculum Model, developed through comprehensive meta-synthesis of 23 successful STEM interventions for Latinx students extracted from our systematic literature review of 196 Scopus-indexed articles. We applied van den Akker's curriculum design research framework to examine ten interconnected curriculum components (e.g., rationale, learning activities, teacher role) across successful STEM interventions. Through systematic coding of 467 direct quotes using established qualitative methodology, we identified recurring themes contributing to program effectiveness. Critical gaps identified include limited bilingual content delivery with only one program utilizing Spanish instruction and minimal culturally relevant assessment tools. The evidence-based LaSTEM framework integrates successful strategies across all curriculum components while addressing identified gaps through culturally sustaining pedagogy, rightful presence, and translanguaging approaches. This research provides science educators with concrete, empirically-supported strategies for advancing equity in STEM education while addressing concerns about the lack of evidence-based STEM integration approaches. The framework offers systematic guidance for teacher preparation programs and curriculum developers seeking to create inclusive STEM environments.

Stand-Alone Paper

Feminist men of science: The better roles for men that feminist research suggests
Bjørn Johannsen*, University College Copenhagen, Denmark

ABSTRACT

This study investigates strategies used by science education research to address the “essential [hegemonically white] masculinity of science” and whether masculine science identities can be constructed without marginalizing other identities. Using a systematic literature review of the journals *Science Education*, *Cultural Studies of Science Education*, and *International Journal of Science Education* (1995–2000; 2020–2025), 466 records were screened, with 300+ studies thematically synthesized. Five overlapping strategies emerged: 1) Looking – documenting exclusionary practices; 2) Doing/Pedagogy – interventions disrupting hegemonic norms; 3) Changing/Content – curricular redesign; 4) Being – identity-based approaches; and 5) Conceptualizing – theoretical development of inclusion/exclusion. No studies directly advised on cultivating benign masculine identities, indicating methodological limitation in either premising the question or searching for the answer. Instead, findings suggest that science education remains shaped by masculine hegemony and that framing its challenges as a “masculinity crisis” is premature. The question is likely to remain topical, but future work can benefit from integrating the existing strategies identified to continue the work to address structural inequities.

Stand-Alone Paper

Science for Whom? Examining Teachers Pay Teachers Materials Using a Culturally Relevant Science Teaching Framework
Jennifer Simons*, George Mason University, USA

ABSTRACT

Science education is often positioned as a vehicle for equity, yet many classroom materials fail to affirm students' cultural identities or disrupt dominant power structures. This exploratory study examines the availability and quality of culturally inclusive science resources on Teachers Pay Teachers (TPT). Using the culturally responsive science teaching (CRST) framework, the study analyzes 342 self-described culturally inclusive middle and high school science resources. A sequential mixed-methods analysis reveals significant disparities in the availability and quality of resources across scientific disciplines, with environmental and general science resources dominating the field. A closer analysis of six randomly selected lessons highlights several limitations, including a tendency to prioritize representation over meaningful engagement, reinforce White, middle-class norms, and omit instructional support for teachers. Few resources foster scientific inquiry, affirm students' identities, or encourage critical examination of sociopolitical contexts. These findings raise concerns about the quality of so-called “inclusive” resources and the implications of relying on unvetted

digital marketplaces for culturally responsive science instruction. This study presents a new application of the CRST framework to curricular resource evaluation, calling for greater scrutiny of educational materials marketed as culturally inclusive.

Stand-Alone Paper

Exploring Approaches to Equity: A Content Analysis of Two Scripted Curricula in Science Education

Adrienne Dizon*, University of Nevada, Las Vegas, USA

Dilara Kara-Zorluoglu*, University of Nevada, Las Vegas, USA

Debika Jana*, University of Nevada, Las Vegas, USA

Ambreen Islam, University of Nevada, Las Vegas, USA

Sameul Hoque Fahad, University of Nevada, Las Vegas, USA

Chike Elue, University of Nevada, Las Vegas, USA

Burak Sahin, University of Nevada, Las Vegas, USA

Katherine Wade-Jaimes*, University of Nevada, Las Vegas, USA

ABSTRACT

In the last few decades, calls for reconceptualizing equity in education have surfaced. There is an urgent need to investigate how widely used scripted curricula in the U.S. address equity in science education. Grounding on Burgess and Williams' (2022) multi-layered definition of equity, this study explores equity in terms of macro, meso, and micro levels. Content analysis of five OpenSciEd and three Amplify units were used to evaluate educational materials in terms of representations and science activities. Analysis of teacher documents, slides, worksheets, readings, activities, assignments, language materials, and curriculum descriptions were conducted. Each document was explored to identify recurring themes, levels of activity, languages used, connections to daily life, and pedagogical intentions. A comparison of the units indicated science is presented through pictures and activities as an enterprise devoid of human beings. Despite the connection to NGSS 3-dimensional learning, these curricula miss opportunities to authentically connect science content to students' identities or lived experiences. These approaches do not serve as a tool of empowerment for students and their communities. Given the importance of equity approaches, this study offers not only academic learning outcomes, but also meaningful and transformative science must be included in science curricula.

Stand-Alone Paper

Discourse of Power and Gender in STEM: A Feminist Discourse Analysis of General Chemistry Textbooks

Lauren Dudley*, Western Washington University, USA

ABSTRACT

Chemistry is the foundational course for any science major, along with many post-baccalaureate programs. It is part of the unified field of science, technology, engineering, and mathematics (STEM). This research explores the current call for reform to the STEM

environment to become more equitable for all students in higher education settings. Focusing on a general chemistry textbooks, a feminist discourse analysis was utilized to examine the nature of power and gender. This research will question: How is power reflected in the text? In what ways does the discourse position the reader? In what ways do discourses used in science textbooks perpetuate the gendered nature of STEM? What impact does the text have in creating the environment of STEM in the classroom? This project will use two forms of discourse analysis. First, the use of Gee's tools for Identities and Activities building will be utilized to reveal the roles of the text and what cultures support the norms embedded throughout the activities of the text. Results indicate that textbooks used in classrooms contribute to the gendered framing of STEM education and thereby contribute to the embedded nature of inequalities in the field.

AI, Identity, Representation, & Science Culture

Strand 12: Technology for Teaching, Learning, and Research

20-Apr-26, 14:45-16:15

Location: Ballard (L3)

Stand-Alone Paper

Artificial Intelligence Generates Stereotypical Images of Scientists But Can Also Detect Them: A Draw-A-Scientist Test

Gyeonggeon Lee*, National Institute of Education, Singapore

ABSTRACT

How the general public perceives scientists has been of interest to science educators for decades. While there can be many factors, the impact of recent generative artificial intelligence (AI) models is noteworthy, as they are changing how people acquire information. We a study examining how generative AI represents images of scientist using the Draw-A-Scientist Test (DAST). As a data, 1,100 images of scientist were generated using Midjourney v 6.1. Among them, 100 images were analyzed using the DAST-Checklist by the researcher. The researcher went through prompt engineering to instruct gpt-4.1-mini to automatically analyze the remaining 1,000 images. The results show that generative AI represents stereotypical images of scientists, such as lab coat (97%), eyeglasses (97%), male gender (81%), and Caucasian (85%) in the 100 images analyzed by the researcher. However, gpt-4.1-mini could detect those stereotypes in the accuracy of 79% in the same 100 images. gpt-4.1-mini also analyzed the remaining 1,000 images and found stereotypical features in the images (lab coat: 97%, eyeglasses: 95%, male gender: 82%, Caucasian: 67%). Discussions on the biases residing in today's generative AI and their implications on science education were made. The researcher plans to conduct a more comprehensive future study with an expanded methodology.

Stand-Alone Paper

Prompt Engineering for Mathematics Disciplinary Literacy: A Qualitative Case Study of an Elementary Bilingual Teacher

Magdalena Pando, Southern Methodist University, USA

Maricela Leon*, The University of Texas at Arlington, USA

ABSTRACT

Informed by Shulman's (1986; 1987) notion of teacher professional knowledge, Systemic Functional Linguistics, and Generative Artificial Intelligence, we investigate how one bilingual teacher reasons pedagogically for mathematics disciplinary literacy. Data sources include a lesson plan, a log of input-output interactions with ChatGPT 3.5I, and teacher reflections. A thematic analysis revealed three themes: 1-prompt engineering for vocabulary, 2-prompt engineering for syntax and activities, and 3-affordances and challenges in teacher-led prompt engineering for mathematics disciplinary literacy. Results demonstrate the teacher's integration of content and language while using GenAI for a 1st grade mathematics lesson design. Implications suggest the need to explore the integration of GenAI into bilingual teachers' professional knowledge and the need for AI literacy PD in STEM education.

Science Education in the Age of Uncertainty: Epistemic and Pedagogical Perspectives

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

20-Apr-26, 14:45-16:15

Location: Jefferson B (L4)

Symposium

Science Education in the Age of Uncertainty: Epistemic and Pedagogical Perspectives

Benedikt Heuckmann*, University of Münster, Germany

Kostas Kampourakis, University of Geneva, Switzerland

Marcus Kubsch, Freie Universität Berlin, Germany

Eve Manz, Boston University, USA

Genelle Diaz-Silveira, Boston University, USA

Ayelet Baram-Tsabari, Technion – Israel Institute of Technology, Israel

Yael Rozenblum, Technion – Israel Institute of Technology, Israel

Orli Wolfson, Technion – Israel Institute of Technology, Israel

Douglas Allchin, University of Minnesota, USA

Jonathan Osborne, Stanford University, USA

ABSTRACT

Uncertainty is an inherent and inevitable feature of scientific inquiry, shaping how knowledge is generated, communicated, and applied. In an era marked by misinformation,

polarization, and science denial, the ability to recognize and navigate different forms of uncertainty – whether in nature, in science, or in decision-making – has become a critical component of scientific literacy. This symposium examines uncertainty as both an epistemological hallmark of science and a pedagogical challenge for science education. Drawing on theoretical, empirical, and design-based perspectives, the five contributions stimulate discussion and explore: (1) how embracing uncertainty deepens understanding of scientific phenomena; (2) a functionally emergent approach to fostering science practice through designed uncertainty; (3) the potential of Bayesian reasoning to scaffold probabilistic thinking and navigating uncertainty; (4) strategies for distinguishing genuine from manufactured uncertainty in media discourse; and (5) contrasts between media framing and scientists' perspectives on uncertainty, based on analyses of news articles. Collectively, the contributions illustrate how contemporary science education is fundamentally shaped by uncertainty. The symposium aims to advance conceptual clarity, offer practical strategies for classroom implementation, and identify priorities for future research, ultimately promoting science education that prepares learners to navigate an uncertain world.

Climate Justice, Civic Action, and Imagining Just Futures

Strand 14: Environmental Education and Sustainability

20-Apr-26, 14:45-16:15

Location: Issaquah AB (L3)

Stand-Alone Paper

Youth Pursuing a Just, Sustaining and Thriving Future through Climate Civic Action

Hosun Kang*, University of California Irvine, USA

Nelly Tsai*, Northwood High School, USA

Tesha Sengupta-Irving, University of California Berkeley, USA

ABSTRACT

Despite the call for novel and expansive approaches to designing and studying learning for social transformation in historical, political, and sociocultural contexts, the majority of research on the learning of climate and environmental issues still focuses on analyzing individuals' progress towards narrowly defined disciplinary learning outcomes within one setting. In this social design experiment, we explore the processes of youths' collective learning in a year-long high school interdisciplinary climate change course. Participants were six high school students from diverse backgrounds who worked together as a team. They engaged in a civic action project to mitigate the climate crisis while exploring the food waste issues at the school cafeteria. Using the notion of pursuit, we analyzed multiple forms of qualitative data collected throughout the six-week long unit. This analysis focuses on tracing the trajectories of the collective's interactions, relations, and participation over time and across settings. The findings show how their pursuit to mitigate the climate crisis emerged, were challenged and re-shaped over time in relation to social and material conditions

designed and emerged socioeducational ecologies. Implications for curriculum, pedagogy, and research on teaching and learning for social transformation are discussed.

Stand-Alone Paper

Seeing the System: Grade-6 Learners Navigate Components, Mechanisms, and Phenomena in Climate Change

QINGNA JIN*, Cape Breton University, Canada

Mijung Kim*, University of Alberta, Canada

Josh Markle*, University of Alberta, Canada

ABSTRACT

This qualitative case study traces how Grade 6 students' systems thinking develops across a 12-week, climate-focused, design-based sequence. Using the Components–Mechanisms–Phenomena (CMP) framework, we analyzed interviews, classroom video, field notes, and student artifacts as learners (N = 18) moved from explaining the climate system to designing “climate-friendly” cities and integrating them into a metropolitan network via a purposeful perturbation (siting an amusement park). Across tasks, students readily identified components (e.g., vegetation, atmosphere, oceans, energy and transport infrastructures) and named phenomena (global warming, sustainable urban design) but often offered partial or linear accounts of mechanisms linking components to outcomes. Mechanistic reasoning increased during design and was most salient when the perturbation required coordinating interdependencies and negotiating value-laden trade-offs (minimizing travel-energy vs. ensuring equitable access). Findings suggest elementary systems-thinking performances are multifaceted and context-dependent rather than strictly hierarchical. We propose a practical instructional arc (elicitation → design → integration/perturbation) and CMP-aligned prompts (“If we add __, then __ because __”) that reliably elicit mechanism talk, and argue for treating equity and efficiency as phenomena-level goals in socio-ecological decision-making.

Stand-Alone Paper

Feet in the Field, Joy in the Heart: Designing Climate Change Education Through Photovoice

Imogen Herrick, University of Kansas, USA

Michael Lawson*, Kansas State University, USA

Jaclyn Dudek, University of Kansas, USA

ABSTRACT

We investigate how photovoice can cultivate joy and emotional resilience in climate change education for elementary students, while simultaneously addressing the intense worry students feel in response to climate change. Recognizing that climate education often emphasizes crisis narratives, we resist the notion that children must be motivated by crisis and instead seek to understand design principles for how climate curricula can cultivate joy. We conceptualize joy as a feeling that broadens and builds during learning, one that emerges from a situated alignment of self, context, and purpose and a shared focus and

mutual mood with others. We used data (e.g., students' photos, reflections, interviews; teacher interviews; classroom audio) collected from two iterations (Midwestern, Southwestern) of a design-based study and employed a retrospective thematic analysis to identify design principles for joy. In each iteration photovoice was used as a sensemaking unit during climate change education. Through our analysis, four design principles emerged: cultivate feet-in-the-field wonder, validate feelings as evidence, integrate arts as analysis, and position students as designers over time. These design principles supported joy as a force that broadened and built sensemaking, deepened care, and sustained engagement, offering a reimagined science curriculum rooted in care, imagination, and collective hope.

Stand-Alone Paper

Urban Gardens as Educational & Speculative Technologies for a more Just and Joyful Futures

Colin Hennessy Elliott*, Drexel University, USA

Christopher Wright, Drexel University, USA

ABSTRACT

Community gardens and farms – as currently constructed and the radical possibilities they offer – are important learning spaces for communities to develop place-based knowledges and relations. We argue for the conceptualizing urban gardens – in all their plurality – as educational technologies themselves: tools for learning and teaching about one's relation to the lands, waters, flora and fauna and our relations to each other. Further, we take up theorizations of spatial imaginaries to further develop the ways that gardens are learning technologies. To explicate the conceptualization, we depict three different garden infrastructures – social, material, and cultural – and their alignment to a larger theorization of education technology. We see the different types of urban garden as shades of technologies: tools and infrastructures used to support learning. Each has undergirding infrastructures of social organization, lands, histories, and material & machines that make them what they are.

Science in Relationship: A Radical Reset for Science Education

20-Apr-26, 14:45-16:15

Location: Seneca (L4)

Administrative Session

Organizers

Lucy Avraamidou, University of Groningen, Groningen, Netherlands

Betzabe Torres Olave, University of Groningen, Netherlands

Contributors

Alejandra Frausto Aceves, Northwestern University, USA

Sara Tolbert, Monash University, Australia

Tatiane Russo Tait, University of Georgia, USA

Mindy Chappell, University of Illinois Urbana-Champaign, USA

Olayinka Mohorn-Mintah, University of Memphis, USA

Jonathan (JD) McCausland, Iona University, USA

ABSTRACT

As science education research increasingly grapples with questions of equity, sustainability, and purpose, this symposium draws from interdisciplinary scholarship, Indigenous knowledge systems, and contemplative and critical traditions to explore transformative possibilities that offer alternative philosophical and methodological directions for science education. Key guiding questions: How might wonder, love, and care become central to doing and learning science? How can science education serve collective flourishing? What does a more relational and expansive approach to science and science education imply for our methodological and philosophical traditions? What concerns does it bring to the forefront of our work? In doing so, we aim to reflect on plural ways of being and doing science education and how our field advances with such plurality. The session will have two moments where panellists will present their current work, followed by an open discussion with attendees engaging in a dialogical way.

Identifying Mechanisms and Networks for Senior Scholar Support of Early-Career NARST Researchers

20-Apr-26, 14:45-16:15

Location: Jefferson A (L4)

Administrative Session

Organizers

Sharon Nelson-Barber¹, WestEd, USA

Gail Richmond², Michigan State University, USA

Troy Sadler, University of North Carolina Chapel Hill, USA

Greg Kelly, University of Massachusetts Amherst, USA

Stefanie Marshall, Michigan State University, USA

Travis York, AAAS, USA

Patrick Enderle, Georgia State University, USA

Contributors

Bhaskar Upadhyay, University of Minnesota, USA

Tali Tal, Technion - Israel Institute of Technology, Israel

Noemi Waight, University at Buffalo, USA

Jessica Thompson, University of Washington, USA

Abstract

The goal of this session is to share resources for senior NARST members to support early-career scholars. In the first half of the session, we will share ideas surfaced at the recent PSERC-sponsored town hall and encourage additional contributions. This will be followed by a brief moderated discussion with invited senior NARST scholars on ways to support early-career colleagues at their institutions and elsewhere. Roundtable discussions guided by these individuals and PSERC committee members will then take place, and these will focus on identifying specific priorities and developing resources that might be used to support our early-career colleagues' professional trajectories. After a debriefing of these roundtable discussions, a list of priorities will be identified, and attendees will be invited to work with PSERC committee members in the coming months on developing these resources, which will in turn be made available to the NARST membership for their use.

Graduate Student Forum

20-Apr-26, 14:45-16:15

Location: Cirrus Ballroom (35th fl)

Discussion Session

Organizers

Muhammad Guntur Purwanto, University of Minnesota, Minnesota, USA

Collins Moga, UMass Dartmouth, Massachusetts, USA

Souhaila Nassar, Boston University, Massachusetts, USA

Abstract

The Graduate Student Forum hosts round table discussions, which focus on topics that range from preparing for the job market to networking. There are a minimum of eight tables for graduate students to choose from, facilitated by experts in the field. The topics are selected based on feedback from the graduate students themselves. There are two roundtable sessions of 30 minutes each during the session.

Outdoor Science Teaching and the “Not-So-Hidden” Curriculum of Schools

Strand 2: Science Learning: Contexts, Characteristics and Interactions

20-Apr-26, 16:30-18:00

Location: Willow A (L2)

Symposium

Outdoor Science Teaching and the “Not-So-Hidden” Curriculum of Schools

Gail Richmond*, Michigan State University, USA

Kara Haas, Michigan State University, USA

Grace Tukurah, Michigan State University, USA

Cory Miller, Michigan State University, USA

Ly Duong, Michigan State University, USA

ABSTRACT

Our intent in this proposed symposium is to address the fact that the “curriculum” of schools and schooling does not typically promote the development of communities of practice for either students or teaching staff, nor does it address the importance of a critical sense of place for meaningful outdoor teaching and learning. In the session, we use the conceptual/theoretical and empirical work the panelists have done across pre-service and in-service contexts to help classroom educators develop knowledge and skills to work within systems and to provide outdoor learning experiences for their students. Our first goal is for educators to help their students become knowledgeable citizens who can recognize the affordances and limitations of the spaces they occupy and draw on their understanding of the natural world to acquire a sense of place and a commitment to improving these places for themselves, their families, and their communities. Our second goal is to use our work and the interactions and feedback occurring in this proposed session to make a set of coherent suggestions for ways that such pedagogical stances and strategies can be integrated into teacher preparation programs at scale.

How Teachers’ Epistemological Framing Shapes Science Learning

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

20-Apr-26, 16:30-18:00

Location: Ravenna C (L3)

Stand-Alone Paper

A Case Study of Biomimicry-Focused Professional Development and Implementation of Teacher-Designed Integrated Units

Michael Cassidy*, TERC, USA

Kathryn Hobbs, TERC, USA

Debra Bernstein, TERC, USA

Kristen Wendell, Tufts University, USA

Bill Church, CRCS, USA

Xu Geling, Tufts University, USA

Tyrine Pangan, Tufts University, USA

Ethan Danahy, Tufts University, USA

ABSTRACT

This study describes how two middle school science teachers designed and implemented integrated STEM units focused on biomimicry following a professional development program. Using a framework that positions teachers as designers, the study explores how two teachers—one from the Midwest and one from New England—planned, adapted, and enacted lessons that connected science, engineering, and biomimicry. Through a summer workshop and ongoing coaching, teachers developed engineering design challenges aligned to science and engineering standards and anchored in the crosscutting concept of structure and function. Using qualitative data from interviews, lesson materials, and student artifacts, the analysis highlights how teachers supported students in analyzing biological systems and constructing engineering models. Findings reveal high student engagement and thoughtful teacher integration of science and engineering practices. However, both teachers experienced tensions as students often shifted focus from bioinspired design to functional prototyping. These cases highlight the importance of sustained support for helping students make meaningful connections between their biological inspiration and the engineering solutions they create. This research contributes to growing efforts to position teachers as designers of integrated STEM instruction and illustrates how biomimicry can serve as a powerful lens for bridging disciplinary boundaries in science and engineering education.

Stand-Alone Paper

Authenticity and entomology knowledge in science classrooms

David Stroupe*, University of Utah, USA

Megan Walser*, Michigan State University, USA

Sarah Haavind, Independent, 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). Thirteen years after the release of NGSS, we still wonder about how to support students to engage in “authentic” science in classrooms. Our presentation will examine relationships between authenticity, epistemic agency, uncertainty, and equity. The presentations will approach the topic in two ways: expectations and norms for students, and the role of teachers. Students may be engaging in “authentic” science when they are exercising epistemic agency. We will conclude with questions for the field to consider.

Stand-Alone Paper

Teachers' Strategies for Supporting Epistemic Practices in Small-Group Middle School STEM Design

Muhammad Purwanto*, University of Minnesota-Twin Cities, USA

Cillian Roehrig, University of Minnesota-Twin Cities, USA

Jeanna Wieselmann, Southern Methodist University, USA

ABSTRACT

As engineering becomes a vital component of K–12 science instruction, understanding how teachers support students' engagement with epistemic practices of engineering (EPEs) is critical. These practices—such as defining problems, reasoning with evidence, and iterating on solutions—are essential for authentic participation in engineering. While prior research has highlighted peer interaction, less is known about teachers' facilitation in small-group settings. This multiple case study examines how two middle school teachers supported students' engagement with EPEs during an integrated STEM unit. Primary data sources included video- and audio-recorded small-group interactions over seven days of an engineering design challenge. Secondary data included student artifacts, curriculum materials, and field notes. Using frameworks for EPEs and teacher discursive moves, analysis revealed similarities and differences in facilitation strategies, including procedural modeling and contextual questioning. Findings suggest that while teachers' guidance helped students apply mathematics and science knowledge, opportunities for student-led reasoning were limited. The study offers implications for designing professional development and curriculum that foreground engineering as a disciplinary practice in middle grades STEM classrooms.

Stand-Alone Paper

The Role of Affect in Science Teachers' Workplace Discourse

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

Tal Meltz, Ben Gurion University of the Negev, Israel

ABSTRACT

This study examines emotions in science teachers' everyday professional discourse through a case study of a high school Life and Agricultural Sciences teacher team. While research has established emotions as integral to teaching, limited attention has been directed to teacher affect in informal workplace discourse. Drawing on situative learning theories and socio-cultural views of emotions, we explore how emotions are displayed and entangled with power dynamics in teacher interactions. Through audio recordings of eight team meetings, we followed three teachers planning a field trip. Using linguistic ethnographic discourse analysis, we analyzed emotionally charged episodes to examine displayed emotions and how power dynamics shape collaborative work. Findings reveal complex emotional dynamics intertwined with gendered power structures and expertise hierarchies. Two female teachers, new to the program, displayed frustration with the team collaboration and traditional teaching methods and excitement about innovative approaches. The veteran male teacher displayed impatience toward detailed planning and disdain for their enthusiasm. Analysis

demonstrates how veteran teachers suppress innovation through emotional means. This research contributes to science teacher emotion literature by revealing how emotions entangle with power dynamics in collaborative settings, demonstrating how emotions hinder pedagogical innovation even when formal local leadership supports change.

Stand-Alone Paper

Phenomenon- or Concept-Focused: Differences in Teachers' Epistemological Framing in an Integrated Computational Modeling Chemistry Unit

J. Elisabeth Kasner*, Florida State University, USA

Aditi Wagh, Massachusetts Institute of Technology, USA

ABSTRACT

Computational modeling has the potential to enhance science education by providing multiple representations of scientific phenomena. However, how teachers frame these activities can significantly affect both their instructional approach and students' learning outcomes. Using a multiple case study, this work explores how two high school chemistry teachers' epistemological framing of a computational modeling unit influences their instruction and students' understanding of the targeted scientific phenomenon. Our findings suggest that one teacher's phenomenon-focused framing led them to emphasize reasoning by asking more open-ended questions, emphasize student ideas over vocabulary, and use the model as a tool to explore a phenomenon otherwise invisible to the naked eye, while the other's concept-focused framing led them to highlight key concepts through more close-ended questions, emphasize use of terminology, and use the model as a tool for data collection. These differences impacted students' understanding of the mechanisms underlying the phenomenon. This study highlights how teachers' framing of computational modeling activities can shape instruction and influence student sense-making. The implications for curriculum design, professional development, and future research on integrating computational modeling into science education are discussed.

Quantitative Problem-Solving and Reasoning Across STEM

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

20-Apr-26, 16:30-18:00

Location: Aspen (L2)

Stand-Alone Paper

The role of metacognition and confidence in quantitative reasoning in college biology courses

Joseph Dauer*, University of Nebraska-Lincoln, USA

Brian Couch, University of Nebraska-Lincoln, USA

Anum Khushal, University of Nebraska-Lincoln, USA

Robert Mayes, Georgia Southern University, USA

Kent Rittschof, Georgia Southern University, USA

ABSTRACT

Quantitative modelling is a fundamental skill for biology students with performance determined by a host of cognitive and metacognitive resources and requiring instructors to integrate key quantitative dimensions into teaching biology. Using an assessment of quantitative modelling in biology, we explored biology students' (n=930 higher education students) modelling practices (i.e., prior knowledge, abilities), metacognition about modelling, and confidence in their capabilities to model. Students performed best on items related to understanding variables used in models and performed more poorly on items related to interpreting, creating, and using models to understand biological phenomena. Students possessed a high level of metacognition about the nature and purpose of models for science and were highly confident, even overconfident, in their abilities to use, create, and interpret models in science. Students' metacognition of modelling and confidence were significantly correlated with performance on modelling practices, suggesting that knowing the utility of models in science and confidence in one's abilities can relate to model use. Improving the knowledge, skills, and abilities of biology students to perform quantitative interpretations and quantitative modelling and supporting their metacognition about and confidence in their abilities may be a crucial step toward better preparing students for careers in biology fields.

Stand-Alone Paper

Blending Science and Mathematics Sensemaking: Exploring Undergraduate Responses to Biological Quantitative Problem Solving Prompts

Amber Armstrong, University of Minnesota, USA

Kevin Haudek*, Michigan State University, USA

Michael Fleming, California State University, Stanislaus, USA

Anita Schuchardt*, University of Minnesota, USA

ABSTRACT

Students often struggle to make connections between mathematical equations and represented biological phenomena, leading to difficulty in quantitative problem solving. Students who can make sense of these connections (i.e., engage in blended sensemaking) are better able to solve novel and complex mathematical problems in science. Few studies have examined sensemaking elicited by written prompts, which can allow for broad use of formative assessment of students' mathematics and science sensemaking. To understand how undergraduates engage in science and mathematics sensemaking in written responses when solving quantitative biology problems, we developed two items on two different biology topics: Hardy-Weinberg Equilibrium and Mendelian genetics. The items were randomly distributed to 78 undergraduates at the end of an introductory biology course at a large R1 university. Two authors independently coded responses for types of science and mathematics sensemaking. We observed all sensemaking types in student responses, including a diverse array of coordinated sensemaking (connections between science sensemaking or between mathematics sensemaking) and blended sensemaking. However,

the pattern of blended and coordinated sensemaking varied across context, questions within each item, and individual students. These results suggest that student sensemaking is a complicated interaction between context, question and student.

Stand-Alone Paper

A Study of Exploring Undergraduate Students' Interpretations of Biological Sense-Making with Equations Using Eye Movements

Mallika Saha*, Texas State University, USA

Kristy Daniel, Texas State University, USA

Anita Schuchardt, University of Minnesota, USA

ABSTRACT

Understanding scientific equations requires recognizing variables and operators, grasping relationships, preserving meaning in transformations, and connecting math to real-world concepts. These abilities form the foundation of scientific equation understanding. Students often struggle to connect equations with natural phenomena and physical processes. Many resort to algorithmic problem-solving, which can hinder deeper conceptual understanding. There is a significant gap in understanding how to introduce equations effectively for meaningful comprehension in science education. This gap persists because we lack insight into students' cognitive processes to interpret equations. This study aims to uncover the mechanisms of how students understand scientific equations. We used eye-tracking method combined with think-aloud voice recording data to analyze students' eye movements to examine how they visually interact with mathematical equations. We experimented with exploring biological sense-making using quantitative equations. To establish experiment validity, we collected data ($n = 30$ students) for this sense-making project. We figured out the differences in students' dwell times and gaze patterns when looking at various equation components, such as operators and variables. We also analyzed their voice data, their thinking approach while seeing the equations. This approach helps researchers understand how students process and engage with different aspects of mathematical expressions.

Place-Based Environmental Learning

Strand 6: Science Learning in Informal Contexts

20-Apr-26, 16:30-18:00

Location: Virginia (L4)

Stand-Alone Paper

Citizen/Crowd-sourced Science as a Gateway to Education, Outreach, & Research at a Nature Center

Syed Nauman Wazir*, University of Massachusetts, USA

Hamza Malik, Lloyd Center for the Environment, USA

Stephen Witzig, University of Massachusetts, USA

ABSTRACT

Nature centers are pivotal in promoting environmental education, research, and public engagement. This study investigates how citizen/crowd-sourced science (CS) initiatives, introduced through a socioscientific issues (SSI) based instructional approach, enhance these functions, particularly by increasing accessibility and participation in science education activities for K-16 students. CS involves the general population in the scientific research process, whether it is data collection, analysis or, in some projects, even the project design. SSI embeds scientific learning within socially relevant issues where the learner demonstrates their understanding through a culminating experience. Utilizing a qualitative exploratory research design, data were collected from professional development (PD) workshops, classroom observations, participant surveys, and interviews with nature center leadership. Findings indicate that CS fosters scientific literacy, bridges accessibility gaps, and integrates research into K-16 education and were organized around three assertions: 1) CS at the nature center enhanced engagement by linking participants to locally relevant environmental issues through authentic research; 2) CS integrated education, outreach, and research, contributing to scientific datasets while supporting learning goals; and 3) Combining digital CS tools with direct, place-based experiences improved accessibility for diverse audiences. The study underscores the potential of CS to democratize scientific inquiry and promote inclusive environmental stewardship.

Stand-Alone Paper

Teeth in the Tide: Advancing Ocean Literacy Through After-School Programs in Underrepresented Coastal Communities

Cameron Shaw*, University of Miami, USA

ABSTRACT

Despite living near the coast, many students in underrepresented urban communities have limited access to marine science education, resulting in low levels of ocean literacy and limited understanding of critical environmental issues. This study examines how an experiential after-school program, designed around localized marine science content, supports the development of ocean literacy among 12 fourth and fifth-grade students in a southeastern United States coastal community. Grounded in Kolb's (2014) Experiential Learning Theory (ELT) and Roberts' (2012) emphasis on the power of learning by doing, this informal marine science program included hands-on activities such as shark tooth identification, SCUBA demonstrations, and sea turtle conservation lessons. Using a multimodal qualitative approach, including informal conversations with students, field notes, photographs and videos, and student-generated artifacts (paintings, drawings, written work), this study explored students' participation, engagement, and understanding of marine science content. Data was analyzed using Braun and Clarke's (2006) thematic analysis, combining theory-driven coding based on Ocean Literacy Principles with inductive coding to capture emergent patterns. This research contributes to experiential learning models across the world that are grounded in community context for advancing ocean literacy through

informal education), particularly among students historically excluded from marine science learning.

Stand-Alone Paper

Mining in the Mountains: Problem-based Learning in Informal Education to Support Perspective and Argumentation

Katherine Sharp*, Missouri University of Science and Technology, USA

Carson Dudley, Missouri University of Science and Technology, USA

Carly Carron, Missouri University of Science and Technology, USA

ABSTRACT

Students from rural communities often have marginalized access to science engagement and feel disconnected from science content. Traditional science curriculum is often perceived as nonlocal, despite their everyday lived experiences, particularly around agriculture and nature. Schools within rural communities often receive less funding, furthering the need for informal education. However, a geographic remoteness can present a challenge when providing informal education to rural students. Within the present study, we implemented a case study on mining within a university-ran summer camp. The camp allowed learners to engage in a research project that compared urban and rural environment, which their research project was anchored in a case study with a local example of mining that was based on a news story. The objective of this study was to consider how students used perspective while constructing scientific arguments. Upon conclusion of the camp, learners' use of perspective was observed within their claims, evidence, and rebuttals. Specifically, learners' claims were often contingent on context, evidence implicitly compared open and closed mines, and rebuttals provided cases where a counter argument could be acceptable. The findings of this study suggest informal education experiences that connect local rural knowledge through case studies can support scientific argumentation.

Stand-Alone Paper

Expansive Perspectives on Children's Environmental Advocacy During a Critical, Place-Based Podcasting Unit

Lauren Connelly*, Vanderbilt University, USA

Heidi Carlone, Vanderbilt University, USA

Hannah Ziegler, Vanderbilt University, USA

ABSTRACT

This qualitative study investigates children's perceptions of environmental advocacy through a three-week STEM summer camp, focusing on their experiences creating podcasts about a creek in the southeastern U.S.. Engaging 28 middle school students in place-based learning, the camp combined hands-on exploration, interviews, and multimedia storytelling to foster advocacy skills. Analyzing the resulting podcasts, we uncovered three key tensions: the desire to advocate authentically without adopting the "eco-hero" persona; the challenge of

reconciling advocacy with capitalist discourses; and the students' reluctance to identify as environmental advocates despite their proactive engagement.

Findings reveal that the children embraced their own voices, opting to present their messages in personal and relatable ways rather than embodying traditional heroic narratives. By highlighting their unique perspectives and the importance of play in environmental connection, the participants model an alternative understanding of advocacy that expands beyond standard definitions. This research contributes insights into child-centric ways of empowering youth and demonstrates the potential of podcasting as a tool for doing so. The study underscores the importance of rethinking environmental advocacy frameworks to include youth voices, promoting a more inclusive discourse in science education and advocating for a broader recognition of children's roles in socioecological thriving.

Examining the Pedagogical Praxis of Science Teacher Educators and Professional Learning Facilitators

Strand 7: Pre-service Science Teacher Education

20-Apr-26, 16:30-18:00

Location: Columbia (L4)

Related Paper Set

Exploring science teacher educators' language orientations and their approaches for teaching science with multilingual learners

María González-Howard*, 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

In this study, we examine the relationship between science teacher educators (STEs)' language orientations for scientific sensemaking (i.e., notions around what is language, how is language used, and which language should be used) and the instructional approaches STEs employ to prepare preservice teachers to teach science with multilingual learners. Data sources include 23 STEs' responses to a researcher-designed and validated instrument grounded in translanguage theory and pedagogy, which was developed to measure individual's language orientations for scientific sensemaking, and follow up interviews with 10 of those STEs (specifically, with five STEs who on average responded narrowly to instrument items, and five STEs who on average responded expansively). Our findings revealed that overall STEs across both groups employ many similar strategies in their methods courses, including classroom video analyses, designing science lessons, and engaging in self-reflection. However, deep dives into each approach revealed critical and consequential nuances. In particular, STEs who demonstrated more expansive language orientations addressed systematic injustices multilingual learners face, and unpacked ways teachers might push back. This study contributes to emerging research on STEs and the need to

create ongoing (un)learning opportunities for those individuals because of the critical role they play in preparing future teachers.

Related Paper Set

Attending to Complexity in Science Teacher Educator Self-Study

Kerri Wingert*, Good Question Research, USA

Shelley Stromholdt, Aspect Research and Evaluation, USA

ABSTRACT

This conceptual paper addresses a critical gap in science education research by proposing how science teacher educators can meaningfully reflect on their pedagogical practice amidst systemic complexities. It argues that traditional summative evaluations are insufficient for fostering improvement and instead advocates for developmental evaluation methods. These methods support self-study and acknowledge the intricate “system of systems” within which teacher educators operate, encompassing universities, districts, curricula, and standards. The paper reviews literature from evaluation journals, highlighting the shift towards more reflective and complex approaches like developmental evaluation. It suggests methods such as reflective journaling, structured with specific questions to promote reflexivity and address challenges. Ultimately, this contribution makes a case for integrating principles of complexity and a developmental orientation into the evaluation of STEM teacher education, offering a promising avenue for enhancing science teacher educators' pedagogies.

Related Paper Set

Facilitators learning to cultivate interpretive power: The need for race-explicit facilitation

Bethany Daniel, Vanderbilt University, USA

D. Teo Keifert, University of North Texas, USA

Ashlyn Pierson, The Ohio State University, USA

ABSTRACT

In service of equitable teaching and learning, science education has shifted from a focus on canonical correctness toward students and sensemaking (Campbell et al., 2016; Tekkumru-Kisa et al., 2023). In response, Rosebery et al. (2016) conceptualized and supported teachers' development of interpretive power—their ability to see students' resources and experiences as generative and meaningful. We argue that ideologies of whiteness can limit teachers' interpretive power. Here, we focus on two manifestations of whiteness in science: (a) science as white property (Mensah & Jackson, 2018)—which presents science as a fixed body of knowledge created by white men—and (b) constructing “kinds of students” based on race and norms of whiteness (Hacking, 2007)—e.g., framing Black males as troublemakers (Warren & Rosebery, 2011) or their behavior as problematic (Gholson et al., 2012). Research demonstrates that explicitly naming race and racism can disrupt the silence of whiteness as educators engage with rather than avoid race (Philip et al., 2016; Shah & Coles, 2020). We

propose that in professional learning settings, facilitators' race-explicit framing is needed to support teachers in developing interpretive power. We analyze examples of race-evasive and race-explicit facilitation.

Related Paper Set

Pedagogically strategic uses of generative AI in science methods courses

Christina Krist*, Stanford University, USA

Polly Diffenbaugh*, Stanford University, USA

ABSTRACT

This study explores how science teacher educators (STEs) are strategically integrating generative AI (genAI) into their methods courses to support pre-service teachers' (PSTs') instructional planning. While genAI is often framed as a time-saving tool for generating full lesson plans, this approach risks undermining the complex, contextual reasoning central to high-quality planning. Using an instrumental case study design, we interviewed six STEs actively utilizing genAI in their methods courses. We found that genAI integration varied in ways that aligned with three pedagogical orientations represented amongst participants. STEs with a practice-based orientation used genAI to simulate instructional moments; those with a coherence-based orientation used it to surface a range of alternative student ideas or lesson sequences that then prompted PST pedagogical sensemaking; and those with a cultural responsiveness orientation used it to support PSTs in reframing science through culturally relevant contexts. In each case, genAI served not as a shortcut, but as a pedagogical tool to deepen PSTs' engagement with core representations of teaching practice. These findings illustrate how genAI can be leveraged to enhance the reasoning and reflection integral to learning to plan for instruction.

Related Paper Set

Shifting Worldviews: How Science PL Facilitators Support Teachers to Adapt Science Curricular Materials for Equity.

Enrique Suárez*, University of Massachusetts, Amherst, USA

Rachel Hale, University of Massachusetts, Amherst, USA

Danielle Crabtree, University of Massachusetts, Amherst, USA

ABSTRACT

While the practice turn in science education is recognized as a momentous shift towards improving student learning, it also created two needs that the field has been addressing for over a decade: science curricula that align with NGSS and curriculum-based professional learning (PL) that builds in-service teachers' capacity. Knowing how to adapt curricula to reflect students' sociopolitical and socioecological realities is particularly important for making science education more equitable. These demands create a new context within which PL facilitators must (learn how to) design and provide PL that meet in-service science teachers' needs, while also recognizing their strengths and constraints. This study is part of a larger project—IGNITE—that created and implemented PL workshops for developing

secondary science teachers' capacities to adapt and enact science curricula. We qualitatively explore how PL facilitators from IGNITE decide and reflect upon the pedagogical goals of the PL workshops through semi-structured interviews scheduled at pivotal milestones. Our analyses provide insight into how PL facilitators can bring together their knowledge about effective science teaching practices, impactful pedagogical designs for supporting teacher learning, and the strengths and needs of the teachers they serve to create more meaningful PLs.

Innovative professional learning networks and contexts

Strand 8: In-service Science Teacher Education

20-Apr-26, 16:30-18:00

Location: Cedar AB (L2)

Stand-Alone Paper

Rural Science Teachers' Professional Networks and Instructional Growth During Multi-Year Hybrid PD: An Ego-Network Analysis

Syahrul Amin*, Texas A&M University, USA

Magda Villwock, Texas A&M University, USA

Rebecca Sansom*, Texas A&M University, USA

ABSTRACT

Our study examines how rural science teachers' advice-seeking networks and instructional practices change through participation in a multi-year hybrid professional development (PD) program. Using an ego-network approach, we focus on two rural high school science teachers who engaged in Technology-Mediated Lesson Study (TMLS), a PD model designed to overcome geographic isolation by combining virtual collaboration with the structure of traditional lesson study. Data sources included Social Network Analysis surveys and semi-structured interviews. Descriptive survey results indicated that both participants expanded their advice-seeking networks beyond their immediate schools and districts, forming new and sustained ties with teachers in distant locations. Interview data suggested that these expanded networks coincided with greater confidence in implementing three-dimensional (3D) science instruction and increased opportunities for feedback, idea sharing, and problem solving. Although each teacher's trajectory reflected their unique personal, school, and district context, both described enhanced access to instructional resources and professional support as outcomes of TMLS participation. The findings illustrate the potential of hybrid PD to strengthen professional connections and build science teaching capacity in geographically isolated schools.

Stand-Alone Paper

"Iron Sharpens Iron:" Making Sense of Equity in a Teacher-driven Professional Learning Community

Karen Woodruff*, Kean University, USA

ABSTRACT

This NARST presentation reports on findings from a design-based research study situated in a structured community of practice (CoP) involving seven science teachers. The study explored how teachers made sense of equity by engaging in a protocol-guided process in which each participant identified and examined a personally meaningful “problem of practice” connected to equity and the NGSS science and engineering practices. By self-selecting the focus of their inquiry, teachers exercised agency over their learning while working on relevant and context-specific aspects of their teaching. Over a 16-week period, the group collaborated in an online space, critically reflecting on challenges and opportunities for adopting equity-focused approaches. Central to the work was the Teaching with Attention to Equity (TAE) protocol, which prioritized time, balanced participation, and ensured that all members contributed meaningfully. Analysis highlights the protocol’s role in fostering shifts in how educators conceptualized and enacted equity when designing and facilitating science instruction. The study offers a nuanced account of how structured, collaborative routines can support equity-oriented professional growth from within existing educational systems. Implications extend to both in-service professional development and pre-service teacher preparation, suggesting that TAE can serve as a replicable model for cultivating equitable teaching practices in diverse contexts.

Stand-Alone Paper

From Creekbeds to Confidence: How Place-Based Professional Learning Expands Teacher Perspectives on Place and Data

Amanda Garner*, University of Tennessee, USA

Leah Rosenbaum, Columbia University, USA

Joshua Rosenberg, University of Tennessee, USA

Zhen Xhu, University of Tennessee, USA

Kimberly Jones, University of Tennessee, USA

ABSTRACT

When data connects directly to place and community, it becomes more than numbers—it becomes relevant, engaging, and worth investigating. Yet many teachers feel uncertain about designing these experiences or navigating the complexity of authentic, real-world data. This study examines how a three-day immersive professional learning (PL) experience at a U.S. National Park shifted 17 middle and high school educators’ perspectives on place-based learning, data, and uncertainty in science. Pre- and post-PL focus groups were analyzed using inductive thematic analysis. Findings show that teachers broadened their concept of “place” from outdoor destinations to include schoolyards, neighborhoods, and community partnerships. They expanded their view of “data” to value qualitative evidence alongside quantitative measures and began embracing uncertainty as integral to scientific inquiry. Many reported greater confidence, finding data work “less daunting” and more relevant to their students’ lives. These results suggest immersive, place-based PL can support

instructional growth, strengthen confidence, and encourage approaches to science that reflect its iterative and evolving nature.

***Reexamining PCK and Its Roles in Researching Science Teacher Expertise
Required for 21st-Century Science Education***

Strand 8: In-service Science Teacher Education

20-Apr-26, 16:30-18:00

Location: Juniper (L2)

Symposium

Reexamining PCK and Its Roles in Researching Science Teacher Expertise Required for 21st-Century Science Education

Janet Carlson*, Stanford University, USA

Jan van Driel, The University of Melbourne, Australia

Soonhye Park, North Carolina State University, USA

Hanna Stammes, Radboud University, Netherlands

Ineke Henze, Radboud University, Netherlands

Pernilla Nilsson, Halmstad University, Sweden

Amanda Berry, RMIT University, Australia

William Veal, College of Charleston, USA

Moritz Krell, IPN – Leibniz Institute for Science and Mathematics Education, Germany

Melanie Kinskey, Texas A & M University, USA

ABSTRACT

Pedagogical content knowledge (PCK) was first introduced as a unique domain of knowledge that enables teachers to make content accessible and comprehensible to students. While widely utilized to examine science teachers' professional knowledge and practices, PCK has been criticized for its limitations in fully capturing science teacher expertise. These concerns are especially pertinent in the context of 21st-century science education, where content knowledge alone is not sufficient for preparing students to thrive in an increasingly complex and uncertain global society. This symposium brings together researchers from four continents to address the critical question: How can PCK be reexamined to study the science teacher expertise required for 21st-century science education? Panelists will share perspectives and reflections on how PCK can be repositioned to remain relevant in contemporary contexts, drawing on insights from the recent international workshop entitled "21st Century Science Education: What Does It Mean for Teachers?" and their recent theoretical and empirical studies. Symposium attendees will engage in a critical and productive dialogue about the role and utility of PCK in researching science teacher expertise required to meet the challenges of 21st-century science education. The symposium will conclude with a discussion of implications for teacher education and future research.

Enhancing Science Learning Through Curriculum Design

Strand 10: Curriculum and Assessment

20-Apr-26, 16:30-18:00

Location: Greenwood (L3)

Stand-Alone Paper

Using multi-modal texts to improve middle school students' argumentation related to vaping

William Romine*, Wright State University, USA

Amelia Whorton, Wright State University, USA

Delinda VanGarderen, University of Missouri, USA

Amy Lannin, University of Missouri, USA

William Folk, University of Missouri, USA

ABSTRACT

Vaping poses significant health risks to adolescents, yet many are misled by advertising and underestimate the dangers. We describe the implementation and evaluation of a multi-modal text set designed for middle school students to enhance their critical thinking and argumentation skills concerning vaping. The intervention, implemented with 180 students, utilizes a text set grounded in science content and literacy practices to help students evaluate evidence and question the motives behind advertising. Using a repeated measures mixed-effects model, we evaluated pre- and post-intervention changes in three areas: claim-evidence-reasoning (CER) ability, confidence in argumentation, and interest in reading about the issue. The curriculum resulted in significant average gains in CER ability ($b=0.73, p<0.001$) and confidence in argumentation ($b=0.27, p=0.021$), both representing small but meaningful effect sizes. These findings suggest that a short-term, argumentation-focused curriculum can effectively improve students' ability and confidence in navigating complex public health issues like vaping, thereby equipping them to make more informed decisions. Further research is needed to determine if these gains influence a student's likelihood of initiating or continuing to vape.

Stand-Alone Paper

A Case Study Comparing Primary/Middle School Science Teachers' Use of Scripted Science Curriculum

Tina Vo*, University of Nevada, Las Vegas, USA

Chike Elue, University of Nevada, Las Vegas, USA

Mayra Marquez-Mendez, University of Nevada, Las Vegas, USA

Adjoa Mensah, University of Nevada, Las Vegas, USA

ABSTRACT

In the United States, contemporary elementary and middle School science educational contexts have begun using scripted science curricula. These scripted curricula aim to address the inequalities within the school system by providing instructional uniformity that aligns with the Next Generation Science Standard (NGSS) and narrowing the achievement gaps, especially in under-resourced minority communities. This qualitative study explores how elementary and middle school teachers use, adapt, and engage with scripted curricula to foster inclusive and equitable science teaching. Using max variation sampling, we conducted interviews with primary and middle school science teachers' conceptualization of their role in implementing and adapting scripted science curriculum. Through this research, we found that elementary and middle school teachers enact the scripted curriculum to align with the learning needs of students from varied backgrounds to enhance classroom participation. Additionally, it reveals that elementary and middle school teachers viewed scripted curriculum as a beneficial resource for acknowledging experiences from varied backgrounds through the implementation of inclusive instructional routines. This study offers insights for teacher educators and curriculum developers on designing instructional practices that foster community connection, cultural responsiveness, and equity.

Stand-Alone Paper

Science Curriculum Standards and Teacher Development: A Comparative Study of Australia, Indonesia, and the US

Rika Mardiana*, The Ohio State University, USA

Lin Ding, The Ohio State University, USA

ABSTRACT

This study compares junior secondary science curriculum standards in Australia, Indonesia, and a Midwestern U.S. state, using frameworks of knowledge types (Anderson et al., 2001) and cognitive processes (Anderson, 2006). Building on Wei and Ou (2019) and the Program for International Student Assessment (PISA) 2022 data, it examines how curricular emphases align with international assessment outcomes and how teacher professional development (TPD) systems influence implementation. A key paradox emerges: while Australia and East Asian regions prioritize conceptual knowledge and mid-level cognitive skills, Indonesia—despite similar curricular patterns—underperforms (PISA 2022: 383 vs. Australia's 507, U.S. 499). The Midwestern U.S. state spans a wider range of knowledge and cognitive demands, yet its performance does not exceed Australia's. These findings suggest that curriculum design alone is insufficient; effective interpretation, enactment, and support are essential. TPD analysis reveals stark contrasts: Australia offers structured, career-long support; Indonesia's model is fragmented and policy-driven; the U.S. system is decentralized and inconsistent. The study concludes that curriculum reform must be integrated with context-sensitive TPD to foster meaningful student learning.

Stand-Alone Paper

The Performance and Cultivation Strategies of Students' Collaborative Problem Solving in Project-based Learning

Yanan ZHAO*, Shandong Provincial Institute of Educational Sciences, China

Lei WANG, Beijing Normal University, China

ABSTRACT

This study examines the performance and cultivation strategies of students' collaborative problem solving (CPS) within project-based learning (PBL). Drawing on a self-constructed CPS in PBL (CPSIPBL) framework, comprising four collaborative elements and four problem-solving stages, a 42-item Rasch-based assessment was developed and administered to 3,268 ninth-grade students across five Chinese regions. Results classified students into three performance levels, revealing an overall intermediate level with notable disparities across stages ($P3 > P4 > P2 > P1$) and elements ($D > C > A > B$). Weaknesses were identified in willingness to collaborate, personal contribution, and early project stages. Based on ten classroom cases, targeted instructional strategies were distilled for each element-stage combination and validated via a quasi-experiment ($N = 195$). The experimental group showed significantly greater gains in multiple dimensions, including willingness, personal contribution, and project reporting. Findings provide empirically grounded, stage-specific strategies to guide CPS cultivation in authentic PBL contexts. The study offers both theoretical insight and practical tools for science educators, supporting students in developing essential 21st-century skills for addressing complex real-world challenges.

Advancing activism, equity, and justice in science education

Strand 11: Cultural, Social, and Gender Issues

20-Apr-26, 16:30-18:00

Location: Willow B (L2)

Stand-Alone Paper

Embodying STEM teacher activism in uncertain sociopolitical terrains: An autoethnographic exploration of queer radical allyship

Olivia Magnuson*, HL Harshman Middle School, USA

Khanh Tran, Utah State University, USA

ABSTRACT

Despite the increase in overall acceptance of Two-Spirit, lesbian, gay, bisexual, transgender, and queer (2SLGBTQ+) individuals, the 2024 federal administration has targeted them with legislation upholding white supremacist, settler colonial, and cisheteropatriarchal ideologies. In response, science teachers are resisting these subjugations and becoming activists to create safe learning environments. This study employs an autoethnographic methodology to examine the reflections and dialogues of a teacher activist and an education researcher to

address the question: How can STEM curriculum and pedagogies serve as resistance for human flourishing and liberation? Building on Picower's framework for teacher activism, we conceptualize radical queer allyship as a co-liberatory practice rooted in relational responsibility, reflexive accountability, and continuous unlearning, everyday disruption, creative pedagogies of resistance, and embodied relationality. Data sources included weekly reflective journaling over six months and monthly co-generative dialogues. Thematic narrative analysis using the radical queer allyship framework identified three themes: (1) Beyond mentor and mentee to partners of unlearning and accountability; (2) Disrupting normative scriptures of Eurocentric cisheteronormativity; and (3) Dignifying queer and trans personhood. Findings highlight the creative, insubordinate work STEM teachers and researchers undertake to dignify and amplify 2SLGBTQ+ youth, offering concrete pedagogical and curricular moves for K-12 STEM education.

Stand-Alone Paper

Science as White Property in a Behavior-Focused Alternative School

Maizie Dyess*, University of Rhode Island, USA

ABSTRACT

This critical ethnographic study investigates how science education is facilitated within a behavior-focused alternative school and how the property functions of Whiteness shape its structure, access, and implementation. Drawing from Critical Race Theory and Harris's (1993) concept of Whiteness as property, this study analyzes the racialized dynamics embedded in the everyday practices of science instruction. Data for this study was collected through schoolwide and science classroom observations, teacher interviews, fieldnotes, and school artifacts. Findings are organized around the four key property functions of Whiteness: the right to disposition, the right to use and enjoyment, the right to status and reputation, and the right to exclude. These themes reveal how Whiteness operates materially and symbolically in alternative education, influencing who is granted access to meaningful science learning and under what conditions. Science instruction was frequently overshadowed by behavioral management, institutional interruptions, and a pervasive culture of surveillance, resulting in a learning environment focused more on control than on scientific inquiry.

Stand-Alone Paper

Establishing Radical Spaces for Pluriversal Reimagining of Science Education

Isis Howard*, University of Calgary, Canada

Sheliza Ladhani, University of Calgary, Canada

Kristal Turner, University of Calgary, Canada

Kristen Schaffer, Mount Royal University, Canada

Jennifer Adams, University of Calgary, Canada

ABSTRACT

The normative structure of Western Modern Science (WMS) tends to exclude the voices of Black, Indigenous and other non-white and non-cis male genders in STEM. However, it is necessary to have diversity in STEM to bring in new innovative discoveries. While there has been a movement for more transdisciplinary scholarship, it is necessary to engage in dialogue that deconstructs the normative structures and perspectives of WMS. Design innovation engages in speculative and justice-based methodologies in order to determine how learners engage in the radical reimagining of STEM. This paper proposes a research design innovation that engages learners in reimagining the dominant perspective of WMS using syllabus co-constructions and action research cycles. This research is instrumental in positioning learners in speculative activism by dismantling the normative structure of STEM in their educational journey and careers.

Stand-Alone Paper

Extending Justice-Centered Science Through Trauma-Informed Praxis

Symone Cyles*, University of California, Irvine, USA

Sharim Hannegan-Martinez, University of Michigan, USA

ABSTRACT

Justice-centered science education has come about within the last decade as a pedagogical and instructional approach to attuning to the political, social and scientific aspects of disciplinary learning to challenge value-neutral and objective approaches to teaching and learning. Despite its uptake in science education research and practice, there still remains an under-conceptualization of how justice-centered learning can, and should, attend to the moral, emotional and physical dimensions of engaging in such practice, especially when students are investigating their own communities and lived experiences. This conceptual paper presents a framework for Trauma-Informed Science (Authors, 2025), a critical pedagogical approach to justice-centered praxis, that works to support students' holistic well-being. Through an exploration of the current literature, as well as reflections on our own empirical work, we present this framework to support science education researchers and educators in constructing justice-centered learning experiences that center student healing and well-being as integral to justice.

Designing and Implementing AI-Generated Feedback to Support Science Learning

Strand 12: Technology for Teaching, Learning, and Research

20-Apr-26, 16:30-18:00

Location: Ballard (L3)

Related Paper Set

The Impact of Tailored Feedback on Students' Movement along a Learning Progression

Wenxiu Tang*, South China Normal University, China

Clare Franovic, Michigan State University, USA

Leonora Kaldaras, Texas Tech University, USA

Kevin Haudek, Michigan State University, USA

Yangyi Qian, South China Normal University, China

Joseph Krajcik, Michigan State University, USA

ABSTRACT

This study investigates how tailored feedback supports high school students' progression along a learning progression (LP) in the context of three-dimensional (3D) science tasks. Thirteen students from four science classes across three high schools, enrolled in the Interactions curriculum, completed an assessment task addressing core ideas of Coulomb's Law and charge transfer, which involved constructing scientific models and reasoning about cause and effect. They then received individualized feedback—separately for their model and justification, revised their responses, and participated in think-aloud, semi-structured interviews. LP levels for drawn models, written justifications, and overall reasoning were scored pre- and post-feedback using a validated rubric. Findings show that tailored feedback prompted upward movement on the LP for many students, though patterns varied across modalities. In some cases, students demonstrated advancement on the LP on one question type which occurred alongside decline in another, revealing the complexity of developing coherent reasoning and expression across modalities. Notably, additional LP advancements emerged during back-and-forth exchanges with students during interviews, underscoring the potential of sustained, multi-round feedback. The study highlights the need for responsive feedback systems that offer iterative, targeted prompts aligned with students' evolving ideas to deepen scientific reasoning and promote knowledge-in-use.

Related Paper Set

Training AI To Produce Guiding and Meaningful Feedback To Support Learning and Foster Knowledge-In-Use

Leonora Kaldaras*, University of Houston, USA

Clare Franovic, Michigan State University, USA

Yucheng Chu, Michigan State University, USA

Jiliang Tang, Michigan State University, USA

Joseph Krajcik, Michigan State University, USA

Kevin Haudek, Michigan State University, USA

ABSTRACT

Deep science understanding, or knowledge-in-use, is the ability to apply learning to explain phenomena. Supporting this skill requires open-ended tasks and high-quality, tailored feedback—both challenging to scale. We address a key challenge in educational AI: training models to provide student-guiding feedback grounded in pedagogical theory. We developed an AI training approach based on learning and feedback principles, along with a validated rubric to assess feedback quality. This method produces cognitively appropriate,

personalized feedback and shows promise for designing AI systems that foster knowledge-in-use skills in a developmentally appropriate way.

Related Paper Set

How Do Biology Undergraduates Engage with AI Feedback On Research Proposals?

Michele Weston*, Michigan State University, USA

Tammy Long, Michigan State University, USA

ABSTRACT

This study investigates how undergraduates engage with generative AI (genAI) feedback when revising research proposals. The investigation took place in an introductory biology laboratory course where students completed multi-week independent research projects. Two student teams revised their research proposal drafts after receiving customized feedback developed using a custom GPT tool and reviewed by the instructor. The study focuses on behavioral engagement—specifically, meaning-based revisions made in response to AI feedback. Using a revision operations coding scheme, the analysis revealed that both teams made substantive changes, with additions being the most frequent. Team 1 fully or partially addressed a greater proportion of their feedback comments than Team 2, which corresponds with Team 1's higher number of revisions overall, and supports prior findings that behavioral engagement can enhance the quality of revisions. The teams fully or partially addressed 13 out of 24 feedback comments, suggesting other factors related to the individual and context may influence the effectiveness of revisions. The findings expand our understanding of how students engage with AI feedback and highlight the role of behavioral engagement in shaping the effectiveness of their revisions.

Related Paper Set

Designing and validating three-dimensional, learning-progression-aligned cognitive feedback for AI-generation

Clare Franovic, Michigan State University, USA

Leonora Kaldaras, University of Houston, USA

Wenxiu Tang, South China Normal University, China

Selin Akgun, University of Minnesota Twin Cities, USA

Joe Krajcik, Michigan State University, USA

Kevin Haudek*, Michigan State University, USA

ABSTRACT

To support learners as they develop knowledge-in-use abilities, it is critical that formative feedback be designed with intentionality and grounded in learning theory, such as learning progressions (LPs). In this paper, we share a process for generating cognitive feedback that aligns with a validated LP and a set of four general principles. These principles were previously established based on a literature review and interviews with teachers. The principles, along with the LP, guide the generation of the feedback statements (in this case,

for a particular assessment item); however, analysis of the student response is equally important so as to make it personalized and meaningful. To validate the presence of the principles in our feedback statements, we conducted 13 think-aloud, semi-structured interviews with high school students. While the coding scheme represents a range of themes, this paper focuses on the broader theme of Evidence of feedback principles, sharing example excerpts as validity evidence. For example, several students found the feedback to be constructive and actionable, which they expressed by providing reasoning for changes from their pre- to post-feedback responses. The results here inform our ongoing efforts of training AI to generate feedback that aligns with these principles and the validated LP.

Teacher Technology Integration & EdTech Adoption
Strand 12: Technology for Teaching, Learning, and Research
20-Apr-26, 16:30-18:00
Location: Capitol Hill (L3)

Stand-Alone Paper

Understanding Pre-Service Teachers' Barriers and Decisions Around Educational Technology Use in Science Teaching

Emmanuel Atiatorme*, Indiana University, USA

Meredith Park Rogers, Indiana University, USA

ABSTRACT

This study investigates the perceived barriers and decision-making processes that influence pre-service elementary teachers' choices to implement or avoid educational technologies in science instruction during field experiences. The research employs Ertmer's barrier theory, distinguishing between first-order (external) and second-order (internal) barriers, alongside critiques of Digital Nativity Theory that challenge assumptions about automatic transfer from personal technology use to pedagogical implementation. Using a mixed-methods approach, the study surveyed 65 pre-service elementary teachers at a Midwestern university to examine their perceived barriers, technology avoidance behaviors, and willingness to invest time in learning educational technologies for science instruction. Findings reveal three key themes: (1) multi-layered barriers combining external obstacles with internal concerns create implementation challenges, (2) pre-service teachers actively avoid technology as a protective strategy during field experiences despite recognizing its benefits, and (3), significant misalignment exists between interest in learning educational technologies and willingness to invest adequate time for skill development. These results demonstrate that digital nativity does not predict educational technology readiness, with barriers manifesting as deliberate avoidance behaviors during high-stakes teaching situations. The study contributes evidence-based insights for teacher preparation programs to develop realistic expectations and targeted support strategies for meaningful technology integration in science education.

Stand-Alone Paper

Toward Developing a Valid and Reliable Questionnaire to Assess Nature of Technology Views

Isaiah Kent-Schneider*, Purdue, USA

Jerrid Kruse, Drake, USA

Lucas Menke, Drake, USA

ABSTRACT

Scholars within education literature (Clough, 2013; Digironimo, 2011; Authors., 2017; Krutka et al., 2022; Pleasants et al., 2019; Waight & Abd-El-Khalick, 2012) have called attention to the importance of holding informed nature of technology (NOT) views and asking critical questions of technology. In particular, NOT understandings have been linked to technological decision-making and more thoughtful engagement with socioscientific issues (SSI) (Authors, 2025; Authors, 2023). Yet, despite the attention in the literature and technology's ever-presence in society, little research has been done toward understanding how people think about the relationships among themselves, technology, and society. One inhibiting factor to conducting substantive research into views about technology is the lack of a comprehensive research tool. This study describes steps taken toward developing a valid and reliable NOT research tool, the Views on Nature of Technology (VNOT) questionnaire, that may be used to assess individuals' NOT conceptions. Then, this study compares NOT experts and NOT novices' conceptions of NOT as assessed by the VNOT questionnaire using Mann-Whitney U Tests and Fisher's Exact Tests. Findings indicate that the VNOT questionnaire effectively distinguishes expert and novice NOT views. Specific differences in expert and novice NOT views will be shared.

Stand-Alone Paper

Technology as a Gateway to Sensemaking in Science: Secondary Science Professional Development

Adam Bennion*, Brigham Young University, USA

Julio Escobedo, Oak Canyon Jr High, USA

ABSTRACT

This study explores how novel classroom technologies can serve as gateways to sensemaking in secondary science education. We designed and implemented a weeklong professional development workshop for six in-service teachers, integrating CAD and 3D printing, Sphero robotics, and Microbit sensors. Grounded in constructivist and inquiry-based principles, the workshop emphasized hands-on engagement, collaborative design, and iterative exploration. Teachers developed and tested classroom applications of each technology, culminating in a Mars rover-style data collection task. Data from surveys, interviews, and workshop artifacts revealed increased teacher confidence with technology, shifts in instructional practices, and nuanced conceptions of sensemaking. While initial beliefs about sensemaking remained largely stable, participants began to describe it as a dynamic, student-driven process enriched by play, experimentation, and "messiness." This work

contributes to science education by offering a framework for technology-focused professional development and expanding sensemaking theory to include elements of “play” as a part of the process.

Trust and social justice perspectives

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

20-Apr-26, 16:30-18:00

Location: Jefferson B (L4)

Stand-Alone Paper

Functions of Epistemic Trust Within the Narratives of Scientists with Disabilities

Mila Rosa Carden*, University of North Texas, USA

Jonathan Hall*, California State University San Bernardino, USA

ABSTRACT

Epistemic trust in the science community is pivotal to their everyday work. Without it, scientists have a limited voice in their field. However, it has been unjustly limited due to ascribed characteristics (race, gender). Furthermore, our understanding of how epistemic trust functions within the narratives of scientists with disabilities (ScWDs) is limited. Using a life story interview narrative inquiry, this research amplifies the voices of seven professional ScWDs as meaningful sources of knowledge and insight into their lives. Findings provide more nuance to the concept of epistemic trust—inherent in their stories is the powerful balance between competence and humility and the impact of disability on integrity and goodwill. These theoretical nuances have been discussed and can support future research in science education in understanding how people with disabilities develop relationships with their peers, colleagues, managers, and teachers. Teachers can reflect on their concepts of competency and how students with disabilities might demonstrate their knowledge, creativity, and contribute to the science classroom. Researchers, teachers, and administrators can reengage with concepts of goodwill and how people with disabilities are motivated by helping others.

Stand-Alone Paper

Reframing Nature of Science as Methodology: Public-Health Scientific Literacy Through Stories and Curricular Mapping

Zachary Patterson*, University of Calgary, Canada

ABSTRACT

Scientific literacy in public health needs more than recall of facts. This study reframes the Nature of Science (NOS) as a methodology that guides inquiry and translation into teaching, rather than only a pedagogical topic. NOS supplies shared language for researchers, scientists, and teachers to talk about evidence, uncertainty, error, consensus, ethics, and

communication. Guided by this frame, I conducted qualitative interviews with four public health researchers across distinct subfields and analyzed the transcripts with reflexive thematic methods anchored to NOS commitments. Participants converged on scientific literacy as a practical toolkit: understanding core mechanisms and how evidence is generated, using method-aware appraisal to weigh claims and uncertainty, applying everyday numeracy, evaluating sources in contested information spaces, and translating that appraisal into equitable decisions that account for history and community trust. I then completed a directed content analysis of Alberta's Program of Studies to map four anchor public health stories to existing outcomes. The stories function as NOS-carrying cases that support data reasoning, ethical reflection, and population-level thinking. The project advances NOS as a research method, offers a synthesized, teachable definition of public health scientific literacy, and delivers concrete curricular links teachers can use without creating new courses.

Stand-Alone Paper

What if cooking isn't chemistry? The harm in metaphorical connections between science and everyday activities

Noah Weeth Feinstein*, University of Wisconsin-Madison, USA

Ryan Stowe*, University of Wisconsin-Madison, USA

ABSTRACT

This theoretical paper examines why we make claims like "cooking is chemistry," what these claims mean, and what good or harm they accomplish. We make three interrelated arguments: First, the relationship between scientific and everyday practices is more complicated and less obvious than is often claimed; second, educators and scientists link scientific and everyday practices for reasons that have little to do with the accuracy of those links; and third, pushing everyday practices under the umbrella of science can actually do harm—not least because it ignores the independent history and value of those practices. We conclude by discussing how more useful connections - and distinctions - between scientific and everyday practice could enrich both science education and public discourse. NOTE: the arguments presented in this paper are an abbreviated form of the full essay.

How and Why Teach about Indigenous Self-Determination Through Science Education: Lessons from the Fish Wars

Strand 14: Environmental Education and Sustainability

20-Apr-26, 16:30-18:00

Location: Redwood AB (L2)

Symposium

How and Why Teach about Indigenous Self-Determination Through Science Education: Lessons from the Fish Wars

Kelsie Fowler*, University of Washington, USA
Philip Bell*, University of Washington, USA
Willie Frank III*, Nilly Frank Jr Institute, USA
Megan Bang*, Northwestern University, USA
Pauline Chinn*, University of Hawaii, USA
Shana Brown*, University of Washington, USA
Anastasia Sanchez, PSED, USA
Dawn Hardison-Stevens*, University of Washington, USA

ABSTRACT

Addressing the current socio-ecological climate and environmental catastrophes requires learning models of living and relating to each other that defy colonial, extractive, and patriarchal axiologies. In this session Indigenous community leaders teach about the local history of the Fish Wars and the landmark Boldt Decision (1974). Then we will open a community panel, with Indigenous science education researchers, educators, and allies. This discussion is intended to support attendees in understanding how Native Sovereignty, Treaties, and histories of colonial resistance relate to science education—and can cultivate socio-ecological caring, more rigorous and holistic ecological thinking, and responses to the escalating ecological and climate crises. We will draw connections between these ongoing histories and events, and the impacts these can/should have on the work of science educators and researchers. Lastly, this symposium offers a robust example of how environmental education and sustainability learning can disrupt the gap between the teaching of science and history/civics, and turn into more rigorous and transdisciplinary models of learning and action.

Advancing Connections Between Research and Practice

20-Apr-26, 16:30-18:00

Location: Issaquah AB (L3)

Administrative Session

Organizers

Carla Zembal-Saul, Penn State University, USA
Meredith Park Rogers, Indiana University - Bloomington, USA
Colby Tofel-Grehl, Teachers College - Columbia University

Abstract

In this session, recipients of the NARST and National Science Teaching Association (NSTA) co-sponsored recognition, *Research Worth Reading*, will share their published research and the implications of the research for science teachers (broadly defined). Presenters are honorees selected from the complete JRST 2025 volume for their work's relevance and applicability to practitioners. The group discussion that follows will explore exciting opportunities and

approaches for, as well as challenges to, synergizing connections among science education research and practice.

The Science Relevancy Bridge: Connecting intersectionality and science identity in science learning experiences

Regina McCurdy

Characterizing variations in the figured worlds of teachers and students in science class

Jessica L Alzen, Jason Y Buell, Kelsey Edwards, Brian J Reiser, Cynthia Passmore, William R Penuel, Chris D Griesemer, Yang Zhang

Learning to evaluate sources of science (mis) information on the internet: Assessing students' scientific online reasoning

Daniel Pimentel

Poster Session

20-Apr-26, 18:00-19:30

Location: Metropolitan Ballroom A/B (L3)

Strand 1: Science Learning: Development of student understanding Poster

Mapping Minds: A Comprehensive Review of Conceptual Modeling Methodologies, Methods, and Tools in Education

Roe Peretz*, Technion - Israel Institute of Technology, Israel

ABSTRACT

Conceptual modeling has emerged as a crucial methodological approach in educational settings, serving as a powerful tool for facilitating meaningful learning, fostering critical thinking, and enhancing students' ability to grasp complex concepts across various disciplines. This systematic review synthesizes existing theoretical frameworks and empirical findings from seminal works and contemporary research spanning the past 15 years. It highlights the historical evolution of conceptual modeling methodologies—such as concept mapping, mind mapping, entity-relationship (ER) diagrams, system dynamics, Unified Modeling Language (UML), and Object-Process Methodology (OPM)—and examines their implementation and impact in high school and higher education contexts. Findings indicate that conceptual modeling consistently improves students' comprehension, retention, and higher-order cognitive skills by making abstract relationships explicit and supporting active learning. Additionally, advancements in digital technology and collaborative modeling have further amplified its educational potential. The review concludes by discussing implications

for educators, outlining future research directions, and emphasizing the continued importance of conceptual modeling as a foundational skill for learners in the 21st century.

Strand 1: Science Learning: Development of student understanding

Poster

First Graders' Reasoning About Celestial Motion and Daylight: Strengths and Challenges Aligned to NGSS PEs

Arif Rachmatullah*, SRI International, USA

Marta Mielicki, SRI International, USA

Nonye Alozie, SRI International, USA

Hui Yang, SRI International, USA

Daisy Rutstein, edCount, LLC, USA

Anna Jennerjohn, SRI International, USA

Doug Gagnon, SRI International, USA

ABSTRACT

This study investigates first-grade students' reasoning about celestial motion and daylight using NGSS-aligned formative assessment tasks developed through an Evidence-Centered Design (ECD) framework. Focusing on two Earth and Space Science performance expectations (1-ESS1-1 and 1-ESS1-2), we designed five tasks to assess students' ability to observe, describe, and predict patterns in the Sun, Moon, stars, and seasonal daylight. Data were collected from 134 students and analyzed thematically to identify strengths and conceptual challenges. Findings show that most first graders demonstrated strong observational skills and pattern recognition when supported with appropriate scaffolding and visual representations. Students accurately identified celestial motion and daylight changes and began applying these patterns to make predictions. However, challenges emerged in linking specific times of day or seasons to celestial positions or seasons to celestial positions. Some students relied on personal experiences or held simplified mental models (e.g., straight up-and-down Sun motion), which limited prediction accuracy. This study contributes to science education by demonstrating that first graders are capable of engaging in complex astronomical reasoning when provided with developmentally appropriate assessments. It underscores the importance of intentional task design in supporting early learners' conceptual understanding and expression of scientific ideas.

Strand 1: Science Learning: Development of student understanding

Poster

Conceptualizing Core Ideas in Science Education: A Systematic Literature Review

HELEN SEMILARSKI*, University of Tartu, Estonia

HELIN SEMILARSKI, University of Tartu, Estonia

ABSTRACT

Core ideas provide a framework for science education, helping students connect concepts rather than memorize different facts and allowing for deeper understanding. However, there

is ongoing debate about how they should be defined and implemented. This study used a systematic literature review to explore the conceptualizations and applications of core ideas in science education. It examines their role in curriculum design, teaching, and assessment. The findings emphasize the importance of learning progression and advanced assessment methods, e.g., digital assessment tools, in supporting student learning. This study helps improve science education, guiding curriculum designers, educators, and policymakers in creating more effective and integrated learning experiences.

Strand 1: Science Learning: Development of student understanding

Poster

Fourth Graders' Reflections on Engineering During a Rube Goldberg Machine Design Challenge

Lisa Borgerding*, Kent State University, USA
Gözde McLaughlin, Kent State University, USA
Sima Ahmadi, Kent State University, USA
DeNae Kizys, Kent State University, USA
Elena Novak, Kent State University, USA
Rui Liu, Kent State University, USA

ABSTRACT

Engineering careers are growing and require a workforce educated about engineering and proficient in the use of the epistemic practices of engineering. Engineering design challenges engage students in the epistemic practices of engineering (EPE) and foster the development of their engineering identities. This study investigates how fourth grade students from a large urban school district reflect on their use of EPEs after a four-week Rube Goldberg Machine (RGM) engineering design challenge. Data sources included researcher field notes, focus group interviews, student teams' presentation slides, and student teams' responses during a public demonstration of their learning event. Students most frequently described using EPEs such as developing prototypes, learning from design failure, and iterative design. To a lesser extent, they mentioned seeing themselves as engineers and engaging in teamwork during their design challenges. These findings are contextualized in the nature of the research prompts and curricular supports provided. Implications for assessment prompts and curricular revision are provided.

Strand 1: Science Learning: Development of student understanding

Poster

Exploring Nutrition Through Multiple Experiential Activities: A 7th Grade Classroom Study

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ABSTRACT

In today's sedentary society, obesity, cardiometabolic diseases and other physical and musculoskeletal conditions are increasingly prevalent – even among youth. These public health concerns are linked to insufficient physical activity and excessive caloric intake. Additionally, many consumers struggle to interpret complex health-related information, such as nutrition labels, which poses a significant barrier to informed decision-making.

We designed a nutrition unit incorporating multiple experiential activities (MEAs)—defined here as two or more co-deployed activities that connect varied types of experiences in teaching and learning—to explore how MEAs enhanced students' conceptual understanding and influenced their nutritional choices. It was implemented in Spring 2025 at a 7th-grade public middle school in the southeastern U.S.

Findings suggest that a nutrition curriculum integrating MEAs significantly improved learners' conceptual understanding, as shown by statistically significant pre and post test score gains. Qualitative data revealed that students valued the integration of activities, highlighting hands-on and social elements, enjoyment, and the diverse perspectives each activity offered—contributing to a more holistic understanding.

Integrating diverse instructional methods and experiential activities around complex topics like nutrition could foster deeper understanding and practical application of nutrition concepts among learners and may help address challenges of sedentary lifestyles and complex health information.

Strand 2: Science Learning: Contexts, Characteristics and Interactions

Poster

Students' Learning Characteristics in a Polar Education Program Reducing Psychological Distance

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ABSTRACT

The polar regions span all fields of science, offering strong potential for integrated science education. While polar research has progressed steadily (Aksnes & Hesselent, 2009; Elzinga, 2009; Kim, 2011), educational applications remain limited, with significant attention emerging only in the 2020s (Mun & Shin, 2025). Current polar education is narrow in scope, limiting students' opportunities to acquire scientific knowledge. To address this, lessons incorporating diverse topics and teaching methods are needed.

The polar regions have evolved from being solely subjects of research and exploration to becoming important themes in education. However, their physical remoteness and low accessibility make them unfamiliar to students. Although environmental problems in the polar regions ultimately affect human society, many students view them as distant global issues unrelated to their own lives (Gold et al., 2021; Choi et al., 2022).

This study underscores the value of polar science and addresses the gap between students' recognition of its importance and their limited knowledge. It focuses on reducing the psychological distance mirroring the actual geographic distance that students feel toward the polar regions. The aim is to develop a polar education program and examine students' learning characteristics during the learning process, fostering closer connections and deeper understanding of polar issues.

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

Perspectives on Effective Science Teaching: Case studies of Noyce teachers and their students

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ABSTRACT

Reformed science teaching has required shifts in how teachers engage students in the learning process. This paper examines: In what ways are students experiencing effective science teaching (EST) in rural and urban high needs schools as compared to how teachers describe they are engaging with EST practices? We apply qualitative methods using a case study design (Yin, 2014) to explore effective teaching. Teachers' voices, as well as our observations of their classroom, and their student's voices, are essential to our exploration of effective science teaching practices. In analyzing the data from Mrs. Masters, Northeastern University, three main themes emerged: Engaging Students in Interactive Learning Opportunities, Making Space for Open Discussion and Questioning, and Fostering Productive Struggle. In analyzing the data from Ms. Smith, Southeastern University, three main themes emerged: Building Relationships, Engaging Lessons and Routines, and Perseverance in Problem Solving. Their students reiterated these practices when asked about effective practices and found them to be very important to their learning. The inclusion of student perspectives in the literature is often limited due to the challenges associated with utilizing students as research participants. Their inclusion in this study has deepened our understanding of the impacts of using core teaching practices.

Strand 2: Science Learning: Contexts, Characteristics and Interactions

Poster

A Three-Dimensional Framework for Visualizing Epistemic Agency Patterns in Small-Group Scientific Argumentation

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ABSTRACT

This study proposes a three-dimensional framework for analyzing and visualizing epistemic agency in small-group scientific argumentation, comprising the dimensions of Epistemic Practice, Collaboration, and Metacognition. Forty-six eighth-grade students in 12 small groups from two science classes in Seoul participated in an “Animals and Energy” unit redesigned for experimental inquiry and argumentation. Video data from lessons on respiration and filtration principles were segmented into clusters and coded, with AI assistance used to support and cross-check the coding process. The analysis identified recurring interaction patterns, such as students moving from evidence gathering to explanation construction, or from claim–critique exchanges to inquiry-driven explanation building. Visualization of these patterns yielded three key affordances: (1) identifying dominant interaction tendencies across groups and tasks, (2) tracing shifts that marked deeper engagement, especially when metacognition emerged, and (3) distinguishing between stagnant and progressively developing discussions. The framework provides a practical tool for researchers and teachers to interpret participation dynamics and pinpoint moments for targeted instructional support.

Strand 2: Science Learning: Contexts, Characteristics and Interactions

Poster

Fostering a Physicist's Mindset: The Influence of Contextual Factors in an Taiwanese Undergraduate Physics Course

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ABSTRACT

This study tackles the persistent challenge of cultivating a physicist's mindset in Taiwanese undergraduate physics students, where learning often prioritizes standardized tests. Over a year, we conducted a design-based research to support the instructor redesign pedagogy, followed by using an observational approach in a physics course to investigate the contextual factors that influence students' thinking. Data from journals, reflections, and classroom observations were analyzed thematically. Our findings reveal key student strategies and constructive learning patterns, as well as a pedagogical shift from instructor-led lectures to problem-based, student-centered learning. These insights illuminate the conceptual

changes experienced by both students and the instructor, providing valuable suggestions for designing effective physics learning environments in higher education.

Strand 2: Science Learning: Contexts, Characteristics and Interactions

Poster

Elaborating How Different Types of Coherence May Influence Science Learning and Transfer: A Theoretical Model

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ABSTRACT

Science standards documents like the Framework for K-12 Science Education and the Next Generation Science Standards have drawn upon learning research to specify how science education can become more coherent to better support student learning that is relevant outside of the science classroom. Curriculum developers have likewise prioritized coherence in designing instructional materials. Yet, student science achievement continues to stagnate, and there is little evidence that students use their school science learning to guide their continued learning and engagement outside of school. We argue that one reason for this lack of progress is insufficient theoretical clarity regarding what constitutes coherence in science instruction and how different types of coherence may influence student learning in the classroom and their ability to transfer their school learning to new contexts. We propose a theoretical model to specify how different types of coherence in science instruction (designed, enacted, and perceived) may interact with motivational and contextual factors to influence student learning and transfer. This theoretical model may help to guide future research and instructional design.

Strand 2: Science Learning: Contexts, Characteristics and Interactions

Poster

The Effects of Frequency and Duration of Thinking Periods on Science Learning

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ABSTRACT

Students often struggle to remain engaged during science learning, especially when they take online courses. One of the reasons is that attention naturally fluctuates between perceptually guided and self-generated thoughts (external vs. internal attention). Internal attention is often labeled as mind wandering and assumed to be detrimental to learning, but recent research suggests it can also have positive effects. The current study examined how the frequency and duration of in-lecture thinking periods—brief periods where students are prompted to shift their attention internally and reflect on lecture content—affect engagement and learning. Seventy-seven undergraduate students watched a pre-recorded biology lecture with thinking periods lasting either 30 or 60 seconds and appearing every 4

or 8 minutes. Preliminary results indicate that shorter thinking periods (30 s) may be more beneficial: students reported higher engagement, and differences in learning gains approached significance. In contrast, the frequency of thinking periods did not significantly affect engagement and learning outcomes. These findings suggest that the duration of thinking periods is an important factor that should be considered when designing online science courses.

Strand 2: Science Learning: Contexts, Characteristics and Interactions

Poster

Highschool Students' Coding Strengths and Challenges in a Computational Thinking-Focused Biology Unit

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ABSTRACT

Computational thinking (CT) is used by professionals in STEM and is an important thinking tool for all learners. Thus, there is a critical need to incorporate CT into a broad range of STEM courses to support students to understand the interdisciplinary and fundamental nature of CT and to promote access to computing education. Although distinct from coding, coding can be used to support students' developing CT. This study explored students' successes and challenges when using a visual coding language in an integrated life sciences and engineering unit focusing on developing a simplified bionic arm. The month-long unit was implemented in five high schools in northeastern USA. Looking at three coding tasks, we found that most students were able to achieve at least partial success at simple coding tasks and showed evidence of spontaneous exploration of the coding language. However, their struggles suggest that they may have needed additional support to understand each program as a piece of a more complex biological or engineered system that they were aiming to develop in the unit or lesson. Given CT's importance across STEM contexts, this study provides valuable insight about what supports students may need to develop their CT in wider STEM contexts.

Strand 2: Science Learning: Contexts, Characteristics and Interactions

Poster

Challenges and Affordances in Engaging K-12 Students in Authentic Data Investigations

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ABSTRACT

There have been increasing calls for K–12 students to engage with data in ways that reflect authentic scientific practice; however, classroom data work often lacks authenticity, complexity, and strong connections to core science ideas. Through a research–practice partnership, we collaborated with four secondary science teachers to co-design and implement place-based, data-intensive activities. This study examines challenges and strategies across three dimensions: developing questions and communicating insights, datafying the world, and visualizing and analyzing data. Using a qualitative comparative case study approach, we analyzed co-design sessions, classroom and field observations, and teacher- and student-generated artifacts. Findings reveal a gap between overarching unit questions and the narrower student-generated questions, as well as tensions between generating and processing primary datasets and secondary datasets. Results suggest the value of strategically combining primary and secondary datasets by beginning with primary, student-collected data before introducing curated local secondary data. The study offers practical design considerations for researchers and educators seeking to engage students in meaningful, authentic data investigations that connect science learning to local contexts and strengthen students' capacity to work with complex data.

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

Poster

Teacher Adaptations to Curriculum as a Window into Culturally Responsive Instruction: A Case Study

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ABSTRACT

Culturally responsive instruction (CRI) requires teachers to adapt curricula, tailoring to the needs of their students in a local context, instead of using curriculum as a script (Gay, 2010). The context-specific nature of CRI creates challenges in identifying what CRI 'looks like' in practice. Yet, curricular adaptations may provide opportunities to understand their uptake of culturally responsive pedagogy. As part of a larger study, researchers observed one elementary teacher implement a unit about a local marine environment with summer campers, and then again with students during the academic year. Researchers compared the teacher's enactments to identify adaptations made to the curriculum, then interviewed the teacher regarding her rationale. This case study reports on that teacher's goals and

intentions for CRI, as evidenced by her curricular adaptations and reasoning. We provide an example of how CRI can be operationalized and enacted in elementary science instruction, providing evidence that teachers have multifaceted conceptions and goals for CRI. This study affirms the importance of examining both a teacher's practice and reasoning in developing and understanding a teacher's conception of CRI, and suggests teachers' curricular adaptations can serve as a targeted means to learn about their conceptions of and goals for CRI.

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

Theory-Informed Design of an XR Wildfire Education Program Based on Hazard Literacy and PPRR

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ABSTRACT

This study presents the design and validation of an XR-based wildfire education program integrating five dimensions of hazard literacy (knowledge/understanding, cognitive skills, values/attitudes, psychological resilience, and behavioral competence) with the PPRR disaster management framework and Earth system thinking. Developed through a six-phase Design-Based Research methodology, the program was implemented on the ZEP metaverse platform to deliver immersive, data-driven, and socio-ethical learning experiences for upper elementary students. Six narrative zones embed authentic meteorological, topographic, and vegetation datasets, interactive NPC dialogues, and branching decision scenarios to foster systems thinking, equity-oriented reasoning, and action competence. Grounded in situated learning theory, the design sustains engagement by situating all tasks in realistic, socially embedded contexts.

The program's originality lies in its balanced operationalization of all hazard literacy dimensions, often underrepresented in disaster education, through authentic datasets and socio-scientific dilemmas in an XR environment. This approach develops cognitive, affective, and behavioral competencies, addressing persistent limitations in hazard education. The resulting model is replicable, adaptable to hazards beyond wildfires, and applicable across formal and informal settings. By aligning science education with climate resilience, equity, and sustainability, the study offers both a conceptual framework and a practical pathway for immersive, justice-oriented hazard science instruction.

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

Fostering young scientists: How educators and families communicate to support preschool science learning.

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ABSTRACT

This study examines how preschool educators and families build communication strategies to support children's inquiry-based science learning in a nature-based program, drawing on Bronfenbrenner's ecological model (1979) to understand the home-school mesosystem. Families value the immediacy of in-person conversations, while educators highlighted the convenience of digital updates, yet both faced time constraints that limited reciprocal exchange. Findings underscore the importance of varied, trust-based strategies, whether the brief daily interactions or structured updates, to strengthen relationships and extend inquiry learning beyond the classroom. These insights emerged from semi-structured interviews with three educators and multiple parents in a qualitative case study.

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

Poster

Investigating the Development of Science Literacy Skills

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ABSTRACT

This study investigates preschoolers' perceptions of the nature of scientific knowledge (NOSK) and scientific inquiry (SI). Building on earlier studies directed to students of different age groups utilizing the Views about Scientific Inquiry (VASI), this study employs the Young Children's Views of Science (YCVS) protocol. As part of a larger international study, 33 children in a country in Northern-Africa aged 3-6 participated in focus group interviews involving guided activities, observations, and hypothetical scenarios designed to explore foundational scientific concepts and processes. Responses were audio/video-recorded and analyzed, revealing that children's perceptions of science were predominantly "inadequate," followed by "mixed," "no answer," and "adequate." Approximately 25% provided "adequate" answers about scientific processes like observation, inference, and evidence-based conclusions. Meanwhile, 67% demonstrated a "mixed" understanding, and 3% offered "inadequate" answers. When asked, "What is science?", more than 50% gave "inadequate" responses, highlighting significant gaps. These findings suggest that preschoolers lack sufficient knowledge of SI and NOSK. The predominance of "inadequate" responses across most categories highlights the need for targeted interventions. Strengthening foundational scientific literacy through curricula reforms is essential for fostering scientific competence, promoting critical thinking, and preparing them to navigate the complexities of modern science-driven societies and their demands.

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

Poster

Elementary teachers' and students' perceptions of quantum and its relevance in elementary school

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ABSTRACT

Quantum science and engineering (QISE) and its applications are increasingly important in modern society, yet quantum concepts are rarely taught in K-12 science, technology, engineering, and mathematics (STEM) classrooms. Prior research on K-12 quantum education has focused on its implementation in secondary classrooms. This study reports on initial findings of a grant-funded project that integrates quantum concepts into elementary classrooms and examines elementary teachers' and students' beliefs about the nature of quantum science and why it matters in elementary school.

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

Poster

Iterative Growth and Persistent Barriers: Navigating the Realities of Elementary Science in NGSS-Aligned Classrooms

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ABSTRACT

Elementary teachers face unique challenges in adopting NGSS-aligned science instruction, which departs from traditional, answer-driven approaches. This study examines the experiences of 370 K-5 teachers during the first two rounds of a four-round professional learning (PL) program supporting the Mosaic Elementary Curriculum, a phenomenon-based, three-dimensional (3D) science program. Grounded in the Interconnected Model of Teacher Professional Growth (IMTPG), the PL featured immersive lesson experiences, classroom video analysis, and collaborative reflection.

Across rounds, teachers reported steady gains in confidence, smoother pacing, and more skillful use of phenomena and science and engineering practices (SEPs). Classroom discussions became more student-led and connected to real-world contexts. Yet, stubborn

challenges persisted: limited instructional time, high material preparation demands, and difficulty sustaining engagement during extended discussions. Literacy-related barriers diminished by Round 2, but structural constraints continued to limit the depth and reach of instruction.

Findings highlight how iterative, curriculum-based PL can accelerate teacher growth while revealing systemic barriers that require targeted solutions. The results offer actionable insights for PL designers, curriculum developers, and education leaders seeking to cultivate reform-oriented science teaching in real-world classroom contexts.

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

Poster

How do learners solve an optical black box made up of combinations of polarization filters?

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ABSTRACT

This paper explores how learners approach solving an optical black box consisting of various polarization filters. Utilizing a black-box experiment, the study examines the strategies employed by twelfth-grade students as they determine the orientation of polarization filters and a beam splitter. The research identifies six distinct representation strategies used by the learners, ranging from input-output tables to pictorial representations. By analyzing the relationship between these strategies and problem-solving achievement, the study reveals that systematic documentation significantly influences outcomes. The findings indicate that while multiple representation formats can be effective, complete and organized documentation is critical for capturing the full range of solutions and drawing accurate conclusions. This research provides valuable insights into the processes involved in experimental problem-solving and emphasizes the need for further exploration of representation strategies in educational contexts.

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

Poster

Designing and Evaluating a Digital Learning Unit for Undergraduate Chemistry: Impacts on Learning and Perception

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ABSTRACT

STEM degree programs like chemistry show high dropout rates internationally (e.g., Seymour et al., 2019). Mathematical content areas, such as redox chemistry, are particularly challenging

for students (e.g., Ye et al., 2024). Universities are therefore tasked with presenting this fundamental knowledge in an accessible way while addressing the different backgrounds of first-year students, for example regarding their prior knowledge.

To support first-semester chemistry students in understanding mathematical-chemical concepts and mastering related tasks in redox chemistry, a two-phase learning unit is being developed and evaluated. First, students engage with educational videos, followed by a training, in which they work on exercises and receive one of three digital support measures (Flowcharts, Worked Examples, or Brief Solutions).

The evaluation examines, among other aspects, the students' content knowledge development and their perception of the learning unit. Results from a first iteration (N = 90) show that both phases promote content knowledge acquisition, with Worked Examples leading to significantly higher learning gains than Flowcharts in phase two. Furthermore, students rated the videos significantly higher than the training in terms of attractiveness and usability. Regarding usability of the support measures, Worked Examples were rated significantly higher than the Flowcharts. No significant differences regarding attractiveness were identified.

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

Poster

Bridging Perception and Physiology in Undergraduate Physiology Courses: Investigating Cognitive Reengagement Following Interruptions

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ABSTRACT

Interruptions in undergraduate physiology classrooms such as announcements or peer interactions can disrupt students' cognitive workflow and hinder learning. This study used functional near-infrared spectroscopy (fNIRS), behavioral telemetry, and self-reported readiness to examine how university students reengage with computerized inquiry-based science tasks after interruptions. Behavioral reengagement occurred significantly earlier than both self-reported readiness and fNIRS-derived markers of dorsolateral prefrontal cortex (DLPFC) activation, revealing a temporal dissociation. Visual reorientation aids (e.g., such as digital, what I was doing notes, or reengagement panels) significantly reduced reengagement latency. Findings suggest that students often resume tasks before they are cognitively ready and that external scaffolds such as digital reengagement panels can support more effective reengagement. Implications for classroom design, instructional pacing, and neuroadaptive learning environments are discussed.

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

Poster

Undergraduate students' engagement in cross-disciplinary learning of energy concepts

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ABSTRACT

We used think-aloud interviews to investigate college students' cross-disciplinary learning of energy concepts. Interview subjects were enrolled in a set of four science content courses (physics, biology, geology, and chemistry) for preservice K-8 teachers. The interview tasks were designed to probe how students apply energy concepts originally learned in the physics course in less familiar contexts in geology, biology, and chemistry. Transcripts were analyzed using a coding scheme based on conceptual resources. Thematic analysis was then conducted to identify common patterns in students' cross-disciplinary reasoning. Our data suggest that students activated ideas related to energy forms and the objects these forms are attached to with relatively high frequency, and ideas related to physical indicators and mechanisms for energy transfers and transformations with relatively lower frequency. Students applied potential energy concepts across disciplines, but often struggled to identify physical manifestations of potential energy changes in less familiar contexts. We also found that certain pedagogical moves or questions may support students in engaging in cross-disciplinary learning, particularly with respect to potential energy. While this study was conducted in a set of courses for preservice teachers, findings have implications more broadly for students enrolled in introductory undergraduate science courses in different disciplines.

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

Poster

Monitoring students' understanding and assignment design through formative assessment in a nutritional science course

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ABSTRACT

Research in formative assessment at the college level has increased in recent years. However, studies about using evidence to adjust instruction are still limited. Therefore, it is necessary to develop a deeper understanding of this teaching practice at the college level. In this proposal, we aimed to report on the integration of a formative assessment process in the final assignment of a nutritional science asynchronous course. Our study seeks to contribute to this field by addressing the following research question: How does the integration of a formative assessment opportunity inform instructors and students about the teaching and learning process? The outcomes show how instructors can use the information to identify

areas where students may require additional support to complete the assignment and adjust the assignment for future semesters.

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

Poster

Building a Sustainable Community College Course-Based Undergraduate Research Experience Program

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ABSTRACT

A Course-based Undergraduate Research Experience (CURE) is an authentic research experience embedded into a course as part of the regular requirements for a program of study. CUREs provide an opportunity for students to engage in authentic research without having to solicit a mentored research experience, and spend uncompensated time in research labs. Prior to this work we had CUREs in two courses at our community college and we sought ways to expand these offerings to all of our science courses with the overarching goal of every student at our college experiencing a CURE course at least once. Our strategic project created a sustainable CURE program through a learning community approach with a focus on institutional change. This project addressed barriers by creating a research “culture” and providing support to faculty. Goals of the program were to increase the number of science courses using CUREs and to increase the number and diversity of students engaged in scientific research at our community college. We were successful in supporting fourteen faculty in developing CUREs in geology, astronomy, general chemistry, organic chemistry, anatomy, non-majors biology, and environmental science. Data presented will include surveys from faculty participants, student survey data, interview data, and institutional data.

Strand 6: Science Learning in Informal Contexts

Poster

Competencies and Confidence: Mapping Hiring Priorities and Self-Efficacy Among Informal Science Educators

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ABSTRACT

Informal science educators (ISEs) play a critical role in connecting diverse audiences with science, yet questions remain about how well professional competency frameworks align with institutional hiring priorities and educators’ own confidence in their abilities. This paper presents findings from two complementary studies grounded in informal science education competency frameworks. Study 1 surveyed hiring managers from informal STEM learning institutions to rank the importance of key competencies across undergraduate, graduate, and continuing education preparation. Study 2 examined survey data from 406 ISEs assessing self-reported self-efficacy across nine professional domains. Results reveal areas of

alignment and notable gaps between what educators are trained to do, what they feel confident doing, and what institutions value most when hiring. The analysis identifies distinct competency emphases at different career stages, highlighting opportunities to structure preparation and professional learning to build foundational skills early, cultivate advanced systems-level competencies over time, and target persistent areas of lower confidence or competence. This work contributes a model for aligning professional preparation with evolving institutional priorities in informal science education.

Strand 6: Science Learning in Informal Contexts

Poster

Addressing STEM Skill Obsolescence in a Technologically Advanced Economy

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ABSTRACT

Skill obsolescence is a global concern that significantly impacts the economy. Research has shown that all occupations suffer from this phenomenon, although it is particularly pronounced in Science, Technology, Engineering, and Mathematics (STEM) occupations. Specifically, what drives this high skill turnover rate across these occupations is the evolving qualities of software requirements. Potential remedies—like continuing education and reskilling training—have been proposed, though it is unclear what this training looks like and if it is feasible given the cost. Thus, this paper argues the value of informal STEM education (ISE) for STEM workers experiencing skill obsolescence through the lens of the Job Demands-Resources (JD-R) model. Under this lens, skill obsolescence is seen as a demand, whereas ISE is seen as a resource to mitigate this demand. ISE offers a unique form of continuing education due to its dynamic and flexible nature, and has been associated with various benefits, including increased STEM identity, 21st-century skills, and long-term STEM interest. Although there is a gap in research on how ISE is implemented across an adult population, clear advantages have been seen in how ISE experiences shape career trajectories and retention, making a viable claim for its use in the STEM workforce.

Strand 6: Science Learning in Informal Contexts

Poster

Leading STEMM: An Ecological Systems Analysis of Science Education Leadership in Urban Schools

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ABSTRACT

This study examines how principals in a large, urban public school district in the southeastern U.S. navigate the implementation, sustainment, and expansion of STEMM (Science, Technology, Engineering, Mathematics, and Medicine) opportunities, focusing on a

districtwide afterschool STEMM club. Using multi-site narrative analysis of three schools with varied club attendance rates, demographics, and academic standings, it explores principals' roles in shaping access, participation, and perceptions of STEMM education. Guided by Bronfenbrenner's (1979) ecological systems theory, the study considers influences across the STEMM learning ecosystem. The research addresses persistent inequities in urban education shaped by school choice, segregation, and resource disparities. In this district, STEMM is framed both as workforce preparation and a school reform strategy, yet barriers, such as stereotyping, linguistic prejudice, and limited exposure, continue to restrict access for marginalized communities. The afterschool STEMM club, launched in 2018, offers hands-on learning to fifth graders, providing a lens into how leaders adapt externally supported initiatives to local contexts. Variation in program attendance across schools enables comparative insights into the systemic, cultural, and organizational factors that influence participation and program sustainability.

Strand 6: Science Learning in Informal Contexts

Poster

Coding with ChatGPT: High School Students' Experiences in a STEM Camp

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ABSTRACT

The rapid emergence of generative artificial intelligence (AI) tools, such as large language model (LLM) chatbots, has created new opportunities for novice programmers to generate functional code with minimal prior experience. While these tools can lower entry barriers, they also raise concerns about students' actual learning processes and long-term impact. This study explores how high school students engaged with LLM-assisted programming during a two-week summer STEM camp that integrated "Coding with AI" sessions into an agricultural automation project (Farmbot). Students participated in introductory AI literacy sessions, learned basic HTML programming with support from a chatbot (ChatGPT), and developed applications in a culminating project. Data were collected through pre- and post-surveys measuring coding interest, confidence, and perceptions of coding and AI, alongside focus group interviews at the program's end. Statistical analysis revealed no significant shifts in the measured constructs. However, interview findings showed novice coders enjoyed and valued AI-assisted coding, describing it as impactful. In contrast, more experienced students expressed concerns that AI reduced their agency, making them feel limited to copy and pasting. Findings highlight both the potential of LLMs as accessible entry points into programming and the need for differentiated instructional design to support diverse learners in AI-assisted environments.

Strand 7: Pre-service Science Teacher Education

Poster

Bridging Science and Engineering: Evaluating Engineering Design Lesson Quality in Preservice Teacher Preparation

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ABSTRACT

This study employed a situated learning framework to investigate the quality of secondary science preservice teachers' (PSTs) engineering design integrated science (EDIS) lesson plans implemented during student teaching. We sought to evaluate the quality of PSTs planned EDIS units. Evidence from EDIS lesson plans and interviews showed that a majority attained the reformed practice level with the quality of their EDIS lesson plans. The results demonstrated that PSTs had the prerequisite knowledge to integrate engineering concepts in a science lesson, possibly enhancing educational outcomes. This indicated a beneficial effect of the approach, underlining the capacity of such theoretical frameworks to advance science education. Further, we analyzed the interview reflections from PSTs on their instructional strategies, providing insights into their cognitive processes and the impact of situated learning. Ultimately, this study highlights the critical role of structured frameworks in improving the quality and effectiveness of teacher preparation programs by enhancing PSTs' ability to integrate complex engineering principles into practical teaching scenarios.

Strand 7: Pre-service Science Teacher Education

Poster

Testing Times: Agency and Identity in a Competitive Science Teacher Selection System

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Heesoo Ha, Pusan National University, Korea, Republic of

ABSTRACT

While much research exists on science teacher shortages, less attention has been directed to countries facing the opposite challenge: an oversupply of science teachers. This study addresses this research gap by examining the experiences of 12 prospective science teachers in South Korea where passing a high-stakes, once-a-year competitive exam is a prerequisite for securing a public school position. Drawing on interviews, study group observations and exam artefacts, and analyzing through Archer's morphogenetic framework, we show how candidates' perceptions of the exam's legitimacy interact with their emerging science teacher identities to produce distinct agentive strategies. When candidates perceived alignment between their envisioned teacher identity and the exam's values, they enacted structurally reproductive agency, internalising exam norms as professional growth. When candidates perceived misalignment, they employed resistant workarounds that prioritized passing over engagement with content. A third pattern involved strategic "gaming": reverse-

engineering the exam while decoupling it from professional growth as a science teacher, employing various “workarounds” and passing it down to future test-takers. These findings illustrate how individual agency can both reproduce and transform educational structures, offering new insights into science teacher agency and identity-in-the-making in an underexplored, exam-based selection context.

Strand 7: Pre-service Science Teacher Education

Poster

“Empowering us to teach science”: Future elementary teachers’ perceived relevance of college science coursework

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ABSTRACT

College science courses are often the final formal science learning experiences for preservice elementary teachers (PSTs), yet little is known about how PSTs perceive their relevance. This study explores how PSTs perceive the relevance of three types of college science courses—general education science courses, specialized science courses (SSCs), and a modified SSC—through three dimensions: personal association, practical usefulness, and identification. Semi-structured interviews with 32 PSTs were analyzed qualitatively. While all course types fostered personal association, SSCs and especially the modified SSC were more likely to be perceived as personally useful and helped PSTs envision themselves as science teachers. The modified SSC, which explicitly connected science content to elementary teaching and included pedagogical elements, was perceived as the most relevant in terms of personal usefulness and identification. The findings presented in this poster suggest that thoughtful course design can enhance perceived relevance and potentially influence PSTs’ motivation and identity development, while raising important questions about balancing pedagogical and science content goals.

Strand 7: Pre-service Science Teacher Education

Poster

Exploring the Link between Student Teachers’ Decision-Making for SDG Lessons and their Executive Functions

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ABSTRACT

This study explored the relationship between pre-service science teachers’ instructional decision-making in planning an SDG-focused lesson and their executive functions (EFs). Thirty-six teacher education students voluntarily participated, completing EF assessments

through the Running Span Task, Hanoi Tower Test, and Design Fluency Test. Instructional decision-making was evaluated via a lesson planning task, which required selecting instructional elements from lists, including SDG 13 subgoals, science/environmental competencies, and types of knowledge (content, inquiry/procedural, and epistemic) to be addressed. While no significant EF differences were found across majors, a gender difference emerged in the Updating measure, with female students scoring higher. Correlation analyses and t-tests indicated that students with higher EF scores tended to be more selective in choosing SDG subgoals, de-emphasized traditional science competencies such as scientific explanations, and prioritized environmental competencies along with inquiry-based knowledge in their lesson plans.

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Poster

Examining Elementary Pre-Service Teacher Learning of Science Content through Learning Progression-based Models

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ABSTRACT

Elementary science teacher education faces a major challenge: while high-quality science instruction is essential at the elementary level, many preservice teachers (PSTs) enter teacher preparation programs with limited science content knowledge and few required science courses. Research suggests that effective undergraduate science courses—those that align with pedagogical practices expected in K–12 classrooms—can improve PSTs' attitudes, confidence, and understanding. This study investigated the use of Learning Progression-based Models (LPMs) in science content courses at a small Midwestern university to support PSTs' content learning before they begin science methods coursework. Researchers developed “idea cards” aligned with various levels of LPMs to represent student thinking. Through qualitative analysis of post-course interviews, findings revealed that these tools helped PSTs in four key ways: (1) encouraging meta-reflection about their own and future students' learning, (2) helping visualize science content developmentally, (3) supporting interpretation of student thinking, and (4) boosting confidence in their science ability. Ultimately, LPMs helped PSTs view science as more accessible and taught them how students' ideas develop over time—laying a stronger foundation for future teaching. This suggests LPMs can be powerful tools in early teacher preparation, bridging content learning with pedagogical insight.

Strand 7: Pre-service Science Teacher Education

Poster

Clarifying our shared commitments across science education reform approaches to support pre-service teacher learning

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Daeun Jung, The University of Alabama, USA

ABSTRACT

Science education reform has produced various instructional frameworks that transcend traditional “coverage” models and toward generative teaching and learning. Yet, pre-service teachers often face two challenges: (1) systemic constraints in schools that push them toward traditional instruction, and (2) varied exposure to reform approaches across preparation programs. This project addresses these challenges by identifying “common commitments” that cut across major science education frameworks, offering a meta-framework to help teacher educators and pre-service teachers analyze, adapt, and design instruction across contexts. We conducted a review of 131 publications representing 12 influential frameworks, which we identified using a survey of science teacher educators, citation analysis, and our professional knowledge of the field. Using the instructional triangle as an analytical lens, we synthesized seven design commitments: content as anchored, content as purposeful, students as knowers, students as doers, students as collaborators, teachers as self-reflective, and teachers as facilitators. While each framework embodied these commitments differently, they were all committed to these characteristics of high-quality science instruction. This meta-framework can serve to strengthen course design in teacher education, equip new teachers with adaptable analytical lenses, and enable the field to articulate a unified vision of science teaching across various program emphases and school contexts.

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Poster

Integrating Participatory Science into Secondary English Writing Methods

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ABSTRACT

Science and writing are vital components of a comprehensive education. Unfortunately, science teachers at the middle and high school levels often feel uncomfortable supporting students with writing about science. As a result, writing instruction often falls to English language arts (ELA) teachers, who may feel ill-equipped to support students in developing writing practices for participation in scientific discourse. This study investigates the impact of an interdisciplinary participatory science experience on secondary preservice English teachers' self-efficacy, with particular attention to their ability and willingness to integrate

science into writing instruction at the secondary level. Participants included 11 undergraduate students who were English teacher education majors with senior-level standing enrolled in a secondary writing methods course. Our inquiry revealed three findings: new possibilities for interdisciplinary connections, shifts in understanding about scientific contributions, and entry points for learning related to curiosity and collaboration. This study makes an important contribution to the teaching and learning of science because it adds to the literature on how participatory science is being leveraged in higher education to support student learning. Additionally, this study shows possibilities for interdisciplinary connections between science and the humanities.

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Poster

Transformative Learning Through Place and Pedagogy: Preservice Teachers' Reflections on the Deepwater Horizon Oil Spill

Lauren Wagner*, University of North Alabama, USA

ABSTRACT

This study examines how elementary preservice teachers engaged with place-based education (PBE) in a science methods course focused on the Deepwater Horizon oil spill. Guided by the three-dimensional transformative learning framework of connection, compassion, and creativity (Pisters et al., 2019), the research explores how preservice teachers connected to environmental issues, reacted emotionally through personal experiences, and considered possible solutions to mitigate community challenges. Findings revealed that preservice teachers identified environmental impacts on community well-being, expressed compassion for affected populations, but in only one case, questioned systemic reliance on oil. This study contributes to science education by highlighting the value of teacher educators integrating PBE into elementary science methods courses as environmental challenges grow more urgent within communities.

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Poster

Citizen Science: Learning Context for Teaching and Learning the Nature of Science

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ABSTRACT

There is scarcity of studies on the learning outcomes associated with citizen science (CS) projects, particularly on the understanding the nature of science (NOS). This study examined how integrating CS projects with explicit-reflective NOS instruction improves preservice early childhood and elementary teachers' (PST) NOS and perceptions of science. Data for NOS understanding were analyzed quantitatively and qualitatively, while perceptions were

analyzed qualitatively. Findings showed that majority of the PSTs reported a positive impact of CS on their NOS understanding as evidenced by the improvements in five out of six aspects of NOS: with substantial improvement in creativity, use of diverse methods and tentativeness. Furthermore, PST's involvement in CS improves their understanding of science as a human endeavor—provided them opportunity to make sense of the real-world data and appreciate the relevance of science to their lives. Findings of this study add to the research on establishing learning outcomes from participating in CS on NOS understanding. The study addressed the research gaps involving CS integration in formal education and NOS studies in early childhood education. We call for advocating program initiatives such as integration of CS to allow students to actively engage in science, leading to a transformative science learning journey.

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Poster

Pre-service Science Teachers' Epistemic Beliefs about Biotechnology

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ABSTRACT

This study investigates pre-service science teachers' epistemic beliefs about biotechnology, a rapidly advancing field that may have social, ethical, and educational implications for science education. The research adopted a qualitative case study design, with a theoretical framework based on Hofer and Pintrich (1997)'s epistemic beliefs framework (certainty of knowledge, simplicity of knowledge, source of knowledge, and justification for knowing). Participants were pre-service science teachers enrolled at a Midwestern university in the US. Data were collected using a structured survey instrument developed by the researchers that consisted of three parts: (1) demographic background and sources of scientific knowledge, (2) biotechnology content knowledge and interest, (3) domain-specific epistemic beliefs in biotechnology. Through content analysis of participants' open-ended survey responses, supported by descriptive insights from close-ended items, the study aimed to determine how participants conceptualized the nature and acquisition of biotechnological knowledge, their strategies for resolving ambiguity or conflicting information, and the standards of evidence they applied when forming opinions. This study aims to contribute to science education research by highlighting the impact of pre-service teachers' epistemic beliefs on shaping their understanding about biotechnology and to inform teacher preparation programs by emphasizing both scientific literacy and critical engagement with socio-scientific issues.

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Poster

Orienting Towards Linguistic Justice: An Exploration of Preservice Teachers' Language Orientations for Scientific Sensemaking

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ABSTRACT

Science classrooms often marginalize multilingual learners by privileging White, upper-middle-class, Anglocentric language norms, limiting students' authentic engagement in scientific sensemaking. Importantly, how we approach instruction with students, particularly multilingual learners, is often influenced by our orientations towards language, including our beliefs about what, how, and why language is used for scientific sensemaking. Grounded in translanguaging theory, this exploratory mixed-methods study examined the language orientations held by PSTs participating in a southern U.S. elementary teacher preparation program. Their language orientations were measured using the researcher-developed Language Orientations for Scientific Sensemaking (LOSS) survey, which focuses on three orientations consequential for multilingual learners: LO(A) — what counts as language, LO(B) — why language is used, and LO(C) — which language resources are deemed appropriate. Findings revealed that PSTs held moderately expansive views of what counts as language but narrow orientations toward why and which language resources should be used, often privileging English-only and formal linguistic modes. Significant differences emerged by certification program, program level, and racial identity, though narrow orientations persisted across groups. Findings highlight the need for teacher education programs to foreground language's central role in scientific sensemaking to advance linguistic justice for multilingual learners.

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Poster

From Sage to Negotiator: Preservice Teachers Reimagining Voice and Authority in Science Classrooms

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Brian Hand, University of Iowa, USA

ABSTRACT

This study investigates how elementary preservice teachers in a science methods course wrestled with authority, voice, and epistemic trust through dialogic pedagogy. Rooted in generative learning theory, the methods course invited students to reconsider traditional classroom hierarchies and experiment with student-centered, inquiry-based instruction. Using reflections, lesson plans, Equity Maps, and pre/post surveys, participants began to shift from control-oriented metaphors to more relational roles like “teacher as negotiator.” Dialogic tools made participation visible and surfaced discomfort, especially around equity and authorship. Findings suggest that disrupting transmission-based teaching requires ethical, reflective practice, where teaching becomes an invitation to co-construct meaning and nurture inclusive science classrooms where all voices matter.

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Poster

Conceptual Infrastructures for Culturally Ambitious Science Development in Novice Teachers: Supporting Learning and Resistance

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ABSTRACT

This study investigates how novice elementary teachers can be supported to enact culturally ambitious science that directly contests the race-neutral norms embedded in U.S. science education. Specifically, what happens when novice elementary teachers, motivated to push against the grain (Cochran-Smith, 1991), are provided with support to challenge their constraints? Grounded in the Conceptual Infrastructure Model, which integrates culturally ambitious curricula, communities of practice, and teacher agency, we followed two early-career teachers over two years as they engaged in justice-centered professional learning. Drawing on the pedagogical judgment framework (Horn & Garner, 2022) and sociocultural theory, we analyzed classroom observations, interviews, PLC's, and artifacts to trace the conceptual shifts that underpinned both instructional change and resistance to the status quo.

Findings show that culturally ambitious curricula became critical entry points for questioning institutional logics, while communities of practice served as incubators for collaborative problem-solving and collective imagination. Agency emerged as essential to sustaining reform, manifesting in actions that challenged administrative decisions, redesigned lessons around students' funds of knowledge, and broadened definitions of what counts as science. The interplay among these infrastructures enabled teachers to disrupt hegemonic narratives and re-center joyful transgressions for novice educators to re-imagine the purposes, participants, and possibilities of science.

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Poster

Spiraling Student Understanding and Agency: Supporting Teacher Instructional Design for SSI

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ABSTRACT

Reframing science and math learning to attend to local issues have been found particularly effective for enhancing student engagement, particularly among historically marginalized populations. In this poster proposal, we describe a professional development (PD) program to make secondary science and math learning local, relevant, and equitable by drawing upon two existing frameworks to support teachers in effectively designing instructional units attending to local, community-based issues: socioscientific issues (SSI) and

sociotransformative constructivism (sTc). Specifically, we focus on instructional strategies utilized in the instructional unit they designed, implemented, and revised across the two years of the PD. Findings indicated in their revisions, teachers were more intentional in attending to different dimensions of the SSI through the use of high leverage practices to decentralize teacher authority and empower students to understand and resolve the SSI. Overall, teachers' revisions were more responsive to student academic needs and developing their agency by spiraling the SSI, spiraling integration of evidence, spiraling criticality, and spiraling students taking a position. Implications include the importance providing sustained PD experiences for SSI embedded within their authentic teaching context and utilizing high leverage practices, such as Take a Stand and Question Walls, to attend to the complexity of SSI.

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Poster

Reconceptualizing Collaborative Pedagogical Reasoning of Middle School Science Teachers in a Professional Learning Community

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ABSTRACT

This study aims to uncover and describe interactions among components of pedagogical reasoning in the professional learning community (PLC). Three novice middle school science teachers who majored in chemistry and general science education in South Korea, voluntarily formed a PLC with a common goal of designing 8th grade science lessons and had weekly meetings over a year. The main data sources are transcripts from audio-recordings of nine PLC meetings. Data were analyzed using both deductive and inductive approaches based on Shulman's pedagogical reasoning and action model. Interactions among components of pedagogical reasoning were identified when one component appeared to influence teacher understanding and decision-making about the other component. Data analysis revealed that collaborative pedagogical reasoning comprises not only preparation, representations, instructional selections, and adaptation but also evaluation, reflection, and new comprehension in the transformation stage. We elaborated the structure of transformation based on two-way interactions among all components of transformation. We also expanded pedagogical reasoning and action model based on two-way interactions between components other than transformation and components of transformation, and two-way interactions among components other than transformation. This study implies that interactions among components of pedagogical reasoning in PLCs become activated, dynamic, organic, and multifaceted through teacher collaboration.

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Poster

Navigating Contradictions in Teacher-Scientist Collaboration: An Activity Theory Analysis of Curriculum Co-Development Across Grade Bands

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ABSTRACT

Science teachers experience challenges in gaining access to high-quality PD focusing on curriculum development, particularly in integrative subjects like the agrisciences. Research suggests for teacher PD to be high-quality, the PD should be specific to the participants' teaching assignments (grade level, content area), offer sustained engagement (for days or weeks), involve the participants in developing curriculum for their classroom, and led by experts (scientists) in the field. The quality of the collaboration in such PD programs is important given the outcomes of teacher-scientist collaborations and partnerships in improving curriculum, teachers' knowledge and pedagogy. Across three summers, four high school, four middle school, and six elementary teachers (respectively) collaborated for four-weeks with three agriscience university faculty members in a PD to co-develop agriscience-focused laboratory (kit) curriculum. Activity theory was applied to a data set consisting of seven individual journal entries from K-12 faculty, audio from three (of six) collaborative meetings and end-of-PD focus groups with each set of faculty to reveal similarities and differences in their collaborations (by year-grade level). Findings revealed common contradictions in tools and division of labor with the greatest impacts on PD object(ives) and outcomes from the rules node. Contradictions increased by descending grade levels.

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Poster

Urban-Rural Disparities in Chinese Primary Science Teachers' Interdisciplinary Competence

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ABSTRACT

This study investigates urban-rural disparities in primary science teachers' interdisciplinary teaching competencies in China. Using a self-developed questionnaire and a validated five-dimension competence scale—encompassing Professional, Conceptual, Practical, Affective, and Developmental elements—data were collected from 1,000 teachers across Zhejiang and Hubei provinces. Confirmatory Factor Analysis and measurement invariance testing ensured the scale's reliability and suitability for cross-group comparison. Results reveal significant urban-rural differences, with the largest gap in Developmental competencies, reflecting

variations in teachers' lifelong learning and reflective abilities. Competence disparities are associated with multiple factors, including regional resource allocation, career stage, professional rank, employment status, and workload, while individual academic qualifications alone are insufficient to bridge the divide. Based on these findings, targeted recommendations are proposed: short-term measures include collaborative professional learning, peer review, reflective logs, and micro-certification programs; mid- to long-term strategies involve equitable resource allocation, structured professional development, and policy support for rural teachers' career advancement. The study highlights the critical role of interdisciplinary teaching in science education and provides evidence-informed strategies to enhance teaching quality and reduce urban-rural inequities.

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Poster

A Longitudinal Study of Mentor Teachers' Implementation of Educative Mentoring to Support Model-Based Science Teaching

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ABSTRACT

Mentoring plays a critical role in teacher learning and growth, yet traditional approaches often position mentees as passive recipients of guidance rather than actively engaging in constructing their own understanding and instructional decisions. Educative mentoring (EM), grounded in constructivist principles, offers a more effective alternative for supporting student-centered, reform-oriented instruction. However, little is known about how EM principles are enacted in practice. This study examined how two mentors developed and implemented EM to support a model-based science teaching approach over two years. Data included video-recorded mentoring sessions and interviews, analyzed deductively using an educative mentoring observation rubric and inductively through the constant comparative method. Findings show that mentors implemented EM in consistent patterns that evolved into routines, blending traditional and educative approaches while balancing Provider and Facilitator roles. Situated Inquiry, Collaborative Learning, and Reflective Discourse were most frequently enacted, often interwoven through purposeful questioning. Focus on Student Thinking was least evident and tended to remain surface level. These findings highlight strengths and missed opportunities in EM implementation, particularly in supporting deeper attention to student thinking, underscoring the need for targeted professional learning that models best practices for underused components and supports intentional integration of all EM principles into mentoring practice.

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Poster

Customizing for Sustainability: How Teacher Beliefs, Values, and Challenges Influence K-12 Teachers' Customization Work

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ABSTRACT

To support three-dimensional learning (NRC, 2012) and redistribute epistemic agency, teachers can customize curricula to meaningfully incorporate sustainability. Incorporating sustainability concepts provides opportunities for students to investigate community issues and apply results to real-world solutions (Marouli, 2021; Trott & Weinberg, 2020). However, how teachers customize and enact materials is influenced by their beliefs (Nguyen & Huang, 2025; Remillard, 2005). Teachers' beliefs and values are particularly salient when it comes to sustainability issues, yet teachers might not move forward with decisions that align with their beliefs due to a variety of challenges (Cotton, 2006; Nation & Feldman, 2021). We explore how teachers make customizations to incorporate sustainability, how their beliefs and values influence these decisions, and the challenges they navigate when doing so. Our findings suggest that while customizing, participants may lean into aspects of sustainability that are easier to connect to their grade-level content and NGSS-aligned pedagogies. However, these customizations often leave out important aspects pertinent for meaningful sustainability education (International Earth Charter, 2020). Therefore, professional learning facilitators should provide space for teachers to reflect on their beliefs and values and how these beliefs and values might influence teachers' curriculum customization decisions.

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Poster

Early Career STEM Teachers' Access to and Use of Resources Over Three Years

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ABSTRACT

Early career science and mathematics teachers are vulnerable to attrition. Social, material, and personal resources can mitigate teacher turnover. This study describes the resources that early career science and mathematics teachers in high needs schools had access to and used over three academic years. This project was framed by the Conservation of Resources (COR) theory and used quantitative observation methodology. Participants include early

career science ($n = 20$) and mathematics ($n = 4$) teachers in their first five years of teaching. Teachers reported their access to and use of social, material, and personal resources through electronic surveys at multiple time points across academic years. We used Friedman tests to determine if teachers' access and use of resources changed across three years and a hierarchical cluster analysis to identify patterns of resource use among early career science and mathematics teachers. This study contributes towards understanding the resource use of teachers and suggests that additional studies are needed that explore the relationship of resources to one another and their potential connection to the attrition and persistence of teachers.

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Poster

Two Years of Online Professional Learning: Elementary Teachers' Professional Growth in Science and Engineering Teaching

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ABSTRACT

Teacher self-efficacy—an individual's belief in their ability to achieve desired outcomes—is critical for effective science and engineering instruction. However, studies report elementary teachers' low confidence in teaching science and engineering, which may limit student outcomes and classroom innovation. Although professional learning (PL) has shown promise in fostering self-efficacy, most research relies on single-time measurements and single data sources, either surveys or interviews, restricting insights into how efficacy develops over time. This study addresses these gaps through a two-year longitudinal, multi-method design examining elementary teachers' professional growth in teaching NGSS-aligned science and engineering. Four teachers' professional growth was traced using repeated T-STEM surveys (pre-, post-, and end-of-year), end-of-program interviews, and teacher-created confidence graphs. Data were analyzed using framework-based thematic analysis (Braun & Clarke, 2012; Ritchie & Spencer, 1994), guided by Clarke and Hollingsworth's (2002) Interconnected Model of Teacher Professional Growth (IMTPG). Findings reaffirm that professional growth is a complex and individualized process, highlighting the importance of diverse stimuli within PL to support teacher development. Despite its small sample, the study contributes to theoretical understandings of the IMTPG and teacher self-efficacy, emphasizing the value of longitudinal, multi-source research for capturing the evolving nature of teacher growth.

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Poster

Understanding Math and Science Teachers' STEM Epistemologies and Implementations of Integrated STEM

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ABSTRACT

Integrated STEM (iSTEM) initiatives promise relevance and increased student motivation, however, teachers are often prepared to teach in only one discipline. This qualitative interview study examines how math (n=10) and science (n=8) teachers conceive each of the STEM disciplines, how they conceptualize iSTEM, and how they currently integrate STEM disciplines. We sought to understand how teachers' epistemologies relate to their iSTEM enactments as a potential lever for future iSTEM professional development. We conducted semi-structured interviews with the 18 teachers and used a combination of inductive and deductive analyses to identify themes. We found that 1) teachers had more robust understandings of the nature of their "home" discipline than other STEM disciplines, 2) that teachers tended to have a general sense of interconnection among the STEM disciplines, but struggled to articulate an epistemic rationale for their integration, and 3) teachers' conceptions of the disciplines and their interconnections tended to align with their enactment of iSTEM in their own classrooms. Based on these findings, we argue that iSTEM initiatives should move beyond a focus on generic problem-solving or 21st century skills and develop teachers' cross-disciplinary epistemic understandings as a means for developing robust iSTEM instruction.

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Poster

Teacher Perceptions of Authority: Understanding how to Support Generative Learning Environments

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ABSTRACT

The purpose of this study is to explore how a teacher conceptualizes ideas around authority as their epistemic orientation shifts to one that is more generative. Recent work on generative learning and generative learning environments suggests that the role authority plays is crucial to the development of a generative environment. This makes it critical to understand how teachers undergo this orientation change, so that they may be best supported in shifting the dynamics of their classroom environment. The teacher's conceptualization of authority served as the focal point for this study, as it acts as a driver for other classroom components, such as the role of the teacher, language use, and other classroom practices. Through a qualitative case-study analysis of a teacher and her classroom, this study demonstrates how authority is tied to teacher epistemic orientation and the impact that this orientation can have on student participation in dialogue. Alongside this is the exploration and description of what specific barriers and supports exist for teachers trying to reshape their classrooms and undergo this change.

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Poster

Supporting Elementary School Teachers' Computational Thinking Integration in Science: Efforts, and Opportunities

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ABSTRACT

This study examines how elementary teachers integrate computational thinking (CT) into science instruction and how professional learning can support such integration in ways that are both meaningful and sustainable. Drawing on two cohorts of teachers from ethnically and linguistically diverse, high-poverty schools in the Midwest, we analyzed classroom videos of CT and science lessons and transcripts from professional learning meetings. Teachers incorporated CT through practices such as debugging, decomposition, abstraction, and pattern recognition, often embedding them within disciplinary activities like engineering design, scientific modeling, and investigation design. Debugging emerged as a particularly adaptable entry point, supporting iterative refinement, reflection, and collaborative problem solving, even when CT was not explicitly named. Using the 4E Framework, most lessons fell into the Exist or Enhance categories, with fewer examples reaching Extend or Exhibit. Opportunities for deeper integration were shaped by curricular structures, teaching roles, and student needs. Professional learning that fostered collaboration allowed teachers to exchange strategies, adapt lessons, and explore authentic points of connection between CT and science. Sustaining this integration will require flexible PL structures, curricular alignment, and approaches that position CT as a meaningful contributor to disciplinary learning, supporting science and CT learning together, rather than as an add-on.

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Poster

Tracking Science Teacher Leader Ego Networks

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ABSTRACT

This study examines changes in the professional networks of 28 elementary and middle school science teacher leaders (STLs) during the first year of a five-year NSF-funded Noyce fellowship. Using social network analysis of ego networks, participants identified up to ten contacts for pedagogical support across school, district, state, and national contexts in surveys administered at the start and end of the 2024–2025 school year. Preliminary findings show 43% expanded their networks, 11% maintained the same number of connections, and 35% decreased, with qualitative interviews planned to explore these patterns. By integrating quantitative network metrics with teacher reflections, this work provides insight into how

STLs develop and sustain professional relationships, offering implications for designing professional learning and understanding teacher leadership in science education.

Strand 8: In-service Science Teacher Education

Poster

Tracking Change: Evolving Support Practices of District Science Coordinators for Novice Secondary Science Teachers

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Brooke Whitworth, University of South Carolina, USA

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ABSTRACT

Research has documented the support needs of novice teachers, yet the experiences of the professionals who provide that support remain underexplored. Understanding DSCs' perspectives offers insight into how they support novice secondary science teachers and how they perceive their own role in fostering teacher development. The present study focuses on DSCs' experiences, providing a qualitative account of how they perceive and deliver support to novice secondary science teachers using Cobb's (1976) framework of emotional, informational, and instructional support. We conducted interviews with 25 DSCs across diverse U.S. districts at the start and end of the 2023–2024 academic year to explore the types of support provided and how they evolved over time. Findings show that DSCs provide a combination of instructional, informational, and emotional support. Instructional support was most frequent early in the year, shifting toward collaborative strategies such as co-teaching and peer mentoring later. Informational support progressed from onboarding and foundational guidance to individualized office hours and targeted advice. Emotional support focused on building trust, validating feelings, and advocating for their needs. Frequency of reported support decreased, reflecting strategic prioritization as teachers gained independence. Findings highlight multifaceted role of DSCs in bridging district priorities, professional standards, and teacher needs.

Strand 8: In-service Science Teacher Education

Poster

Emotional Labor in Science Teaching: Connecting Resilience and Exhaustion Among Early Career Teachers

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ABSTRACT

Early career science teachers work in emotionally intensive settings where resilience, exhaustion, and emotional labor intersect. This project models the temporal relationships between emotional resilience (ERe), emotional exhaustion (EE), and emotional labor

strategies, and investigates science-specific enactments of emotional labor. We use a longitudinal design with six measurement points across two academic years. Quantitatively, we estimate a two-level random-intercept cross-lagged model with time within teachers to test reciprocal, inverse, and time-varying links between ERe and EE, and to examine how teacher-level emotional labor predicts and moderates those links. Qualitatively, we analyze teachers' "I do" statements to document surface, deep, and authentic acting, and to describe emerging, science-specific strategies that involve changing the teaching situation. Initial evidence suggests substantial between-teacher variance, patterns, and frequent use of surface acting. By integrating qualitative and quantitative data, the study will identify leverage points for targeted professional development that strengthen ERe, mitigate EE, and guide productive emotional labor in science classrooms. Findings will yield insights that programs can adopt to support the well-being and effectiveness of early career science teachers.

Strand 8: In-service Science Teacher Education

Poster

Impacts of collaborative science research on teacher learning in a cohort-based ecology RET program

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ABSTRACT

The need for ecological literacy in the rapidly changing world is urgent (Berkowitz et al. 2005, Jordan et al. 2009, Ardoin et al. 2023). Most teachers have little experience with scientific research resulting in naive and informal ideas about science practices in the classroom (Anderson, 2007; Windschitl, 2004). Supporting teachers' content knowledge and confidence to include robust learning experiences in science practices will be critical to increasing ecological literacy and mitigating global change. Teachers have access to and participate in different types of professional learning experiences, from mandated school-provided in-service learning to optional learning experiences offered by third parties, and perhaps more rarely, to more extensive disciplinary learning experiences such as summer internships. This paper presents results from a study of the cohort-based [Institution] Biology Research Experience for Teachers (BIORETS) program addressing two research questions: What distinctive changes to teacher identity emerged from the experience and do teaching practices appear in the classroom as a result of their team science experience. We found that teachers' experience impacted their thinking and identity as scientists and science teachers and influenced the way they structured learning experiences for their students around research design and science practices.

Strand 8: In-service Science Teacher Education

Poster

Exploring How Instructional Tools Mediate Student Participation and Sensemaking in Science Classrooms

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ABSTRACT

This proposal presents two classroom-based teacher cases from a STEM endorsement program for in-service teachers. As part of their coursework, participants selected and implemented high-quality instructional tools (HQITs) aligned with their science teaching goals. Using a sociocultural lens, this exploratory study investigates how these tools shaped conditions for student participation in classroom science discourse and collaborative sensemaking. The study draws on teacher action research reports and student artifacts to understand how the tools created opportunities for students to contribute ideas, critique peer thinking, and explain phenomena. Findings suggest that HQITs can support more equitable participation when thoughtfully integrated into multi-day science lessons. The study contributes to conversations about how tool-mediated instruction can advance ambitious, inclusive science teaching.

Strand 10: Curriculum and Assessment

Poster

Teachers' Approaches to Fostering Relevance in Localized Storyline Units on Climate Change: Three Examples

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ABSTRACT

Scholars have called for science curriculum materials that reflect relevance and coherence from the student perspective and support students to take local action. Teachers' key knowledge about their students and community can inform curriculum redesign toward these aims; however, teachers need adequate support to design such "localized" curricula. In this paper, I describe three cases of secondary science teachers engaged in a curriculum-based professional learning (CBPL) that supported teachers' curriculum localization of Next Generation Science Standards (NGSS) aligned storyline units on climate change. I attend to approaches teachers used to foster relevance within storyline units through their selection of anchoring phenomena and design of culminating tasks. Interviews with the teachers yielded insights into how each teacher reasoned about their curriculum design decisions in light of their efforts to center relevance within a storylines approach. These cases demonstrate the potential of the unique CBPL design to catalyze teacher-driven curriculum innovations that reflect students' local contexts and deepen the relevance of their science learning.

Strand 10: Curriculum and Assessment

Poster

Analytical Chemistry PBL in Action: Gender-Differentiated Gains in Integrated Quantitative and Analytical Experimentation Skills

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ABSTRACT

This study investigates the impact of a Problem-Based Learning (PBL) curriculum on high school students' integrated quantitative and analytical experimentation skills in analytical chemistry, while examining gender-differentiated development patterns. 22 eleventh-grade students in Shanghai completed a four-task PBL curriculum centered on spectrophotometry, aligned with China's national chemistry standards. Skills were assessed using a validated SOLO-NGSS framework comprising two dimensions—Quantitative Computation (mathematical application) and Experimental Analysis (problem-solving design)—each stratified into four progressive cognitive levels. Parallel pre-post tests analyzed via Rasch analysis and t-tests revealed significant gains in Experimental Analysis ($\Delta M=0.38$ logits, $p=0.028$), with 70.6% achieving Level 4. Quantitative Computation improved marginally ($\Delta M=0.19$ logits, $p=0.267$), suggesting extended practice needs. Gender analysis showed females bridged pre-existing gaps in Experimental Analysis ($\Delta M=0.57$ logits; pre-test male advantage neutralized), excelling in open-ended design, while males progressed more in computation. Findings demonstrate PBL's efficacy in cultivating higher-order experimentation skills and mitigating gender disparities, supporting equitable science education through scaffolded inquiry. Recommendations include low-cost instrumentation adaptations for resource-constrained settings.

Strand 10: Curriculum and Assessment

Poster

Science and Engineering Practices in Kuwait's 10th Grade Biology Curriculum: A Content Analysis

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ABSTRACT

This study explores the integration of Science and Engineering Practices (SEPs) within the 10th-grade biology curriculum of Kuwait, analyzing the extent to which SEPs are incorporated into curriculum materials and their implications for student learning. It employs content analysis to examine textbooks, teachers' books, and workbooks, focusing on the presence and quality of activities designed to support SEPs. Findings reveal a significant underrepresentation of SEPs, with most activities failing to align with inquiry-based, student-centered learning. Practices such as Asking Questions, Planning and Carrying Out Investigations, and Engaging in Arguments from Evidence were notably absent or

inadequately represented. These results highlight the need for curricular revisions to better prepare students for the demands of the 21st century and STEM fields. The study concludes with recommendations for curriculum developers and educators to integrate authentic scientific practices, enhance teacher training, and support a shift toward more interactive, inquiry-driven science education.

Strand 10: Curriculum and Assessment

Poster

Promoting Critical AI Literacy in Informal STEM Education: Community-Centered Curriculum Design

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ABSTRACT

With AI becoming increasingly integrated into STEM education, it's crucial to design educational spaces that build students' critical consciousness and understanding of both the affordances and potential challenges associated with AI. While it's important for curricula to cover the technical and foundational aspects of AI, STEM education experts have noted a lack of focus on its social, cultural, and ethical implications—especially in elementary and informal STEM learning context. This paper addresses that gap by introducing a Critical AI Literacy Program developed through a community-centered, participatory design process. Using participatory design, we collaborated with elementary students and public librarians to co-design curricular modules to promote students' critical AI literacy. These modules not only teach fundamental AI concepts but also explore ethical and environmental concerns that are relevant to students' local communities. This methodological paper contributes to the growing research on informal STEM learning by illustrating how a community-centered and participatory design approach (through the collaboration of youth and librarians) can shape a meaningful and critical AI literacy curriculum.

Strand 10: Curriculum and Assessment

Poster

Document Analysis of SSI-Based Climate Change Educational Resources for Nature of Science Representation

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ABSTRACT

Climate change presents critical societal challenges that require integration of scientific knowledge with social considerations, making it an ideal topic for socioscientific issue (SSI)-based instruction. SSI-based teaching can also promote students' understanding of the nature of science (NOS). This study examined how NOS is represented in freely accessible, NGSS-aligned, SSI-based climate change lesson plans from the Climate Literacy and Energy Awareness Network (CLEAN), a nationally recognized source of high-quality climate change

resources. Using document analysis, 212 CLEAN resources were screened for complete lesson designs, NGSS alignment, and SSI characteristics (real-world problem, controversy, inquiry, argumentation, multiple perspectives). Seventeen lessons met these criteria and were analyzed using a validated 10-aspect NOS rubric, with scores ranging from -3 to +3 per aspect. Results showed low overall NOS representation ($M = 6/30$, $SD = 2.3$), with empirical and inferential aspects most frequently addressed and several aspects (tentative, theory laden, myth of scientific method) absent. High school lessons generally scored higher than those for lower grade bands. Findings suggest that while CLEAN offers SSI-based climate change resources, these lessons require modification to better address NOS aspects. These lessons serve as good starting points for teachers to develop instruction that more thoroughly addresses NOS aspects.

Strand 11: Cultural, Social, and Gender Issues

Poster

Exploring Success Factors for Underserved Graduate Students in STEM

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Wayne Hickman, Augusta University, USA

ABSTRACT

Inequalities in enrollment in STEM persist for those entering higher education as first-generation college students, underserved racial and ethnic groups, females, and those from lower socioeconomic backgrounds. Despite the possibility of upward social and economic mobility, underrepresented students face barriers that inhibit their pursuit of STEM careers. The current study aims to better understand the relationship students have with graduate school success factors by administering the Graduate Student Success Survey+ (GSSS+) at an R2 institution in the southeastern United States. Exploratory factor analysis was used to test the survey's validity, with 242 participants. 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. Item analysis identified perceived barriers (e.g., microaggressions, imposter phenomenon, and financial stress) for underserved students (i.e., females and part-time students). Regression analysis on resilience revealed a positive relationship with mentor support, peer support, and financial support, whereas a negative relationship was associated with imposter phenomenon. Findings from this study underscore the need for additional support from mentors to foster a stronger sense of resilience in students, along with increased opportunities for participation in research, academic writing, and publication.

Strand 11: Cultural, Social, and Gender Issues

Poster

(Un)Becoming-Scientists-With: A Poststructuralist Approach to Understanding Science Identity Development

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ABSTRACT

This paper introduces (un)becoming-scientist-with as a posthumanist rethinking of science identity development, grounded in Karen Barad's agential realism. Moving beyond individualistic and static models of identity, this framework conceptualizes science identity as a relational, emergent, and materially entangled process. Through key concepts such as intra-action, agential cuts, spectral materialism, and more-than-human agency, the paper explores how science identities are continuously assembled and disassembled through affective, discursive, and material engagements. This perspective highlights how educational environments, pedagogical practices, and institutional structures co-constitute students' opportunities to be recognized as scientists, particularly those navigating racialized, gendered, or classed exclusions. Rather than framing identity loss or resistance as failure, (un)becoming attends to the ethical and political stakes of recognition and misrecognition, inviting educators to take seriously the ghosted histories and power-laden arrangements that contour science learning. The paper contributes to growing scholarship that challenges deficit-based models and calls for relational, justice-oriented approaches to science education. By offering a new conceptual vocabulary and analytic orientation, (un)becoming-scientist-with opens possibilities for reconfiguring science learning spaces as more inclusive, affectively responsive, and ethically engaged terrains of becoming, where students are not merely prepared for science, but invited to matter differently within it.

Strand II: Cultural, Social, and Gender Issues

Poster

Inclusive life science curriculum can shift student attitudes and reduce bioessentialism

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ABSTRACT

High school biology or introductory undergraduate courses cover topics such as genetic inheritance, sex determination and development, and reproductive life cycles, that are often taught with outdated material that is influenced by sociocultural bias and doesn't reflect the scientific knowledge of today. Outmoded biology materials can perpetuate alienating gender stereotypes, feed pseudoscientific bioessentialist thinking, and contribute to the underrepresentation of girls and LGBTQ people in STEM. Working with experienced inclusive science educators, we developed and tested inclusive curriculum materials for life science courses. We will present quantitative research on the impact of updated inclusive curriculum content on student attitudes based on pre and postsurveys using previously validated scales. Our findings from presurveys show that students who are LGBTQ or have an LGBTQ family member come in with ideas about the biology of sex that are significantly different than their straight peers, emphasizing the importance of science curriculum that avoids alienating already marginalized students. Further, our findings indicate students who participated in our inclusive biology curriculum significantly increased their attitudes of affirmation for gender and sex diversity and reduced their bioessentialist thinking.

Strand 11: Cultural, Social, and Gender Issues

Poster

First-Generation STEM College Students: Social Capital and Support in Higher Education

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ABSTRACT

First-generation college students (FGCS) are presented with challenges that create potential barriers in educational success. Research suggests that FGCS are often provided less information about the educational and social expectations that aid in the success of obtaining a degree prior to entering higher education, which can lead to disparities in social capital. This study evaluates the variation in development of social capital for FGCS and continuing-generation college students (CGCS) achieving a degree in a STEM related course using a survey and interviews. Our preliminary results indicate that FGCS lean on their social networks more than CGCS and both groups are generally comfortable seeking advice from their college professors or mentors. Implications for research include the need for further interviews with first-generation STEM students to understand their social capital. For practice, educators and staff at universities can use this data to create spaces for social networking and to create a sense of belonging for first-generation college students in STEM majors.

Strand 11: Cultural, Social, and Gender Issues

Poster

Teacher professional development: Heritage and science in engineering thinking

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ABSTRACT

In this paper, we share the value of cultural heritage in teacher development of Nepali teachers to connect cultural heritage, culture, science and engineering. The teachers find cultural heritage an important context to make engineering and science a more sociopolitically conscious activity. A qualitative study based on two teacher development workshops suggests that cultural heritage is a highly valuable area in making engineering more inclusive of local values, ethics, and everyday science, as well as other subjects.

Strand 11: Cultural, Social, and Gender Issues

Poster

Translanguaging as Equity Practice: Supporting Science Identity Development Among Multilingual Students in U.S Science Classrooms

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Julie Brown*, University of Florida, USA

ABSTRACT

Multilingual students possess many strengths that often go untapped in U.S. science classrooms, creating inequity, yet they can contribute by sharing critical thinking, explaining concepts, and contributing to group discussion. However, Science classrooms require active communication and reasoning in English, which can challenge multilingual students, which can challenge multilingual students and affect their ability to express scientific ideas, share reasoning, and fully engage, impacting science identity development. Translanguaging is an equity practice that helps multilingual students use home languages in class in meaningful ways. It helps multilingual students better express scientific thoughts and explain concepts, fostering their science identity. This study reviewed 12 empirical articles between 2018-2025 to explore how translanguaging supports equity and science identity. Thematic analysis revealed two themes: translanguaging (1) promotes equity by expanding participation in science class, and (2) supports science identity development. Findings reveal that translanguaging promotes equity in practice by enabling students to use their home language to explain scientific concepts and reasoning, and to participate in group discussions. Additionally, it strengthens science identity by fostering competence, performance and recognition in multilingual students. These findings suggest that translanguaging can reduce inequity in science learning and foster multilingual students' confidence as scientists.

Strand 11: Cultural, Social, and Gender Issues

Poster

Investigating School STEM Climate and Student Science Attitudes and Interests

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ABSTRACT

This study tested the latent profiles of interests in science, confidence in science, and values of science. In addition, a series of hierarchical mixed-effects models was employed to examine the influence of student-level and school-level factors on students' interests in science, confidence in science, and values of science. The findings suggest that student-level characteristics play a more dominant role. Male students reported higher interest and confidence in science, whereas female students demonstrated a greater perceived value of science. In addition, Asian students exhibited a higher perceived value of science compared to other racial groups. SES and parents' highest education level have a statistically significant correlation with students' perceived value of science.

Strand II: Cultural, Social, and Gender Issues

Poster

Heart of the matter: Epistemic love as pedagogical guidance for culturally relevant STEM pedagogies

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ABSTRACT

This poster proposal introduces epistemic love as a justice-oriented pedagogical orientation for science education, extending and deepening the enactment of culturally relevant pedagogy (CRP) in STEM. While CRP has been widely embraced as a framework for promoting equity, its implementation often overlooks the epistemological foundations of STEM and how dominant norms perpetuate epistemic violence. Epistemic love addresses this need by centering the dignity, well-being, and intellectual legitimacy of students' knowledge systems as essential to science teaching and learning. Drawing on critical and decolonial scholarship, epistemic love is conceptualized through four typologies—tangibility, emotionality, intellectuality, and audacity—that collectively guide educators in sustaining students' cultural personhood while fostering engagement in disciplinary practices. This framework positions love not just as a teacher disposition but as a political and intellectual commitment that informs curriculum design, instructional practice, and classroom relationships. We posit that epistemic love offers a robust theoretical and practical model for transforming science classrooms into spaces of healing, agency, and collective action.

Strand II: Cultural, Social, and Gender Issues

Poster

Containment Listening: Theorizing the Interactional Choreography of Care That Neutralizes Critique in Trust-Based Academic Relationships

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ABSTRACT

Mentoring and collegial relationships are widely regarded as critical to participation, persistence, and advancement in STEMM, particularly for students from marginalized backgrounds. Yet these same high-trust relationships can also reproduce harm in ways that are intimate, confusing, and difficult to name. Drawing on feminist-of-color critiques of allyship and epistemic injustice theory, this paper introduces containment listening: an interactional choreography through which equity-literate, procedurally fluent listeners perform care while redirecting or neutralizing critique. Using analytic autoethnography, I theorize five interlocking components—relational trust leverage, surface validation, epistemic flattening, institutional maintenance, and coerced consensus—that recur within the arc of a single exchange. By naming this mechanism, the framework offers scholars and students of color a vocabulary for recognizing and resisting epistemic harm in mentoring and departmental contexts, reclaiming space for critique and collective solidarity in STEMM education.

Strand 12: Technology for Teaching, Learning, and Research

Poster

How authentic is an AI-based student chatbot? Investigations into the perception of authenticity

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ABSTRACT

Students' conceptions of natural scientific phenomena often lead to misconceptions that significantly impact their understanding and academic learning. Therefore, these conceptions should be explicitly considered in lesson planning, implementation, and reflection. Many alternative conceptions (AC) are persistent despite instructional efforts and remain a continuous challenge for (prospective) teachers. This challenge is partly due to a lack of systematic learning opportunities: academic courses often provide limited interactive engagement with AC, while they arise unsystematically in complex classroom scenarios. Existing assessment tools reduce complexity but lack interactivity.

To address this, we developed an interactive chatbot based on a generative AI model that consistently responds according to a specific AC, simulating a virtual student. This tool aims to support the assessment and training of teachers' diagnostic skills. In this study, nine experienced science teachers interacted with the chatbot and then participated in systematic interviews to assess the perceived authenticity of the interaction, considering linguistic, content-related, and technical aspects. Attitudes toward AI were also evaluated as potential influencing factors.

Results show that most teachers perceived the chatbot as authentic, highlighting its potential to bridge the gap between theory and practice in diagnosing alternative conceptions and to foster teachers' professional competence in science education.

Strand 12: Technology for Teaching, Learning, and Research

Poster

Identifying the Applications of Artificial Intelligence in Educational Entrepreneurship Development: Implications for Science Education

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ABSTRACT

In the rapidly evolving landscape of education, entrepreneurship, and artificial intelligence (AI), understanding AI's applications in developing educational entrepreneurship is essential. This study builds on research that identified the applications of AI in educational entrepreneurship. An applied qualitative approach was employed, combining a systematic

literature review and semi-structured interviews with 14 experts in education, entrepreneurship, and AI. Through thematic analysis, 1,830 basic themes were distilled into 42 first-organizing themes, then grouped into 20 second-organizing themes, and finally consolidated into three global themes: enhancing learning productivity, streamlining instructional methods, and improving educational administration and leadership. Within the context of science education, these themes illustrate AI's potential to transform teaching, learning, and leadership by enabling value creation and fostering innovation. The resulting conceptual framework offers actionable pathways for educators, policymakers, and educational entrepreneurs to integrate AI in ways that respond to current stakeholder needs and highlight the specific dimensions through which AI can transform the educational domain.

Strand 12: Technology for Teaching, Learning, and Research **Stand-Alone Paper**

ISACC II Meets ChatGPT: Enhancing Interdisciplinary Science Learning Through AI-Driven Personalized Feedback

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ABSTRACT

Interdisciplinary (ID) understanding is critical for addressing complex scientific and societal challenges, yet validated tools to assess ID science learning remain scarce. Building on the Interdisciplinary Science Assessment of Carbon Cycling (ISACC I), ISACC II measures students' ability to integrate disciplinary knowledge across biology, chemistry, Physics, and Earth science. This study explored the integration of artificial intelligence, specifically ChatGPT, to generate personalized, rubric-aligned feedback on students' constructed-response (CR) items in ISACC II. We collected responses from 556 undergraduate students across two U.S. universities (2021–2023) and analyzed 10 CR items. Using a Python-based pipeline, ChatGPT produced both diagnostic and holistic feedback aligned with validated scoring rubrics. Examples illustrated how AI-generated feedback identified conceptual strengths, missing disciplinary connections, and opportunities for deeper integration across sciences. Findings indicated that while many students demonstrated strong biological and chemical knowledge, Earth science reasoning and cross-disciplinary synthesis were comparatively weaker. AI-generated feedback offers scalable, individualized support for formative learning, highlighting its potential to enhance interdisciplinary science education. Future work will examine the scalability, validity, and instructional impact of AI-driven personalized feedback in diverse educational contexts.

Strand 12: Technology for Teaching, Learning, and Research

Poster

Scaffolding Teenagers' AI Career Aspirations in a Microelectronics and Edge Intelligence Museum Summer Program

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Woorin Hwang, University of Florida, USA

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Dillon Donihue, Cade Museum, USA

Nicole Dominguez, Cade Museum, USA

Pavlo Antonenko, University of Florida, USA

ABSTRACT

This study explores how a museum-based summer program can scaffold teenagers' career aspirations in microelectronics and Edge Intelligence through hands-on engagement with a AIoT hardware platform. Grounded in Social Cognitive Career Theory (SCCT), the program aimed to foster self-efficacy, reinforce positive outcome expectations, and support goal setting among middle school learners. Twelve participants (ages 11–13), most identifying as girls and representing diverse ethno-cultural backgrounds, engaged in a two-week curriculum comprising five modules: embedded systems, data acquisition, multimodal sensing, AI and Edge AI, and social good applications. Using structured observations and semi-structured interviews, the study employed thematic analysis to examine shifts in learners' motivation and intent to pursue careers in AI hardware. Findings revealed peak engagement during collaborative and cognitively demanding tasks, such as sensor prototyping and final project design. Interview data highlighted increased confidence, curiosity, and connections to future careers, especially among participants who initially felt intimidated by hardware concepts. The program's integration of Edge Intelligence and AIoT technologies helped demystify complex systems and made them accessible to young learners. This research contributes to STEM education by offering a replicable model for inclusive and career-oriented STEM experiences that promote equity and engagement in domains like AI hardware.

Strand 12: Technology for Teaching, Learning, and Research

Poster

Science Academic Self-Efficacy, Learning Engagement, and STEM Aspirations: Urban–Rural Comparisons in Technology-Enhanced Science Education

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Tzung-Jin Lin, National Taiwan Normal University, Taiwan

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ABSTRACT

Addressing persistent inequities in science education requires clarifying how learners' beliefs and participation shape their future trajectories. Drawing on social cognitive career theory and multidimensional accounts of engagement, this study examines the relations among science academic self-efficacy, course learning engagement, and STEM educational and career aspirations in urban and rural elementary contexts. A ten-week technology-enhanced science program incorporated VR human physiology, surgical arm simulation, a simulation-based ecology game, and educational robotics. Participants were upper-grade students (urban $n=79$, rural $n=18$). Validated measures assessed self-efficacy, behavioral, emotional, and cognitive engagement, and science aspirations (educational/career). PLS-SEM was employed to estimate context-specific associations. Results revealed distinct patterns: for urban students, self-efficacy directly predicted both educational and career aspirations, with engagement mediating educational aspirations. For rural students, engagement predicted educational aspirations, whereas self-efficacy predicted career aspirations. These findings implicate complementary levers for equitable design: urban contexts may benefit from competence-supportive, challenge-rich tasks that consolidate self-efficacy, whereas rural contexts call for interactive, hands-on activities that deepen participation and relevance. Theoretically, the study differentiates the roles of self-beliefs and engagement in aspiration formation across contexts; methodologically, it demonstrates the utility of PLS-SEM for prediction-focused modeling with small samples in authentic school settings.

Strand 12: Technology for Teaching, Learning, and Research

Poster

Beyond the Optical Bench: Implementing a VR Interferometer in Physics Education

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André Meyer, Leibniz University Hannover, Germany

Matthias Klassen, Leibniz University Hannover, Germany

ABSTRACT

Subject of this report is an evaluation study about a sophisticated virtual reality (VR) environment in which two different experiments can be conducted using a Michelson interferometer. The VR environment was tested with 45 pre-service teacher students and around 60 upper-secondary students. The result was a high level of immersion in the VR environment and the achievement of high-quality experimental results. The observations and results provided indications of variable use in regular physics lessons.

Strand 12: Technology for Teaching, Learning, and Research

Poster

Mapping Readiness: Developing a Quadrant Analysis Tool to Integrate Advanced Technologies in STEM Lesson Planning

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Liz Whitewolf, edufab, USA

ABSTRACT

Technology is rapidly transforming how students engage with science, engineering, and problem-solving, yet integrating advanced tools into instruction often falls short of intended learning goals. Despite the availability of makerspaces, fabrication equipment, and other high-tech resources, many teachers lack the preparation to connect these tools to rigorous STEM learning that builds both technological fluency and conceptual understanding. This study used a participatory action research approach to design and refine the Quadrant Analysis Tool, an instructional framework for balancing the cognitive demands of lesson content with the complexity of technology while considering students' developmental readiness. The work began in a university science methods course for future elementary teachers and was carried out using collaborative autoethnography, enabling researchers to critically examine and co-construct their experiences from multiple perspectives.

Cogenerative dialogues served as a core process for sharing interpretations, clarifying intentions, and refining the framework in response to authentic classroom challenges. The resulting Quadrant Tool organizes activities into four categories—High-Tech/Low-Content, High-Tech/High-Content, Low-Tech/Low-Content, and Low-Tech/High-Content—and supports lesson planning that scaffolds skills over time, moves students between quadrants as they gain competence, and fosters more intentional, student-centered, and standards-aligned STEM instruction that meaningfully integrates technology to enhance learning outcomes.

Strand 12: Technology for Teaching, Learning, and Research

Poster

Assessing Technology's Role in Correcting Misconceptions of High School Students

Narendra Deshmukh*, Ret from Homi Bhabha Centre for Science Education, TIFR, India

ABSTRACT

The purpose of this study was to examine the effectiveness of integrating technology into the design and development of research-based remedial materials. The ADDIE model was employed to guide the creation and implementation of these materials, which focused on selected topics in life processes for high school biology. Various multimedia technologies were incorporated to enhance engagement and conceptual understanding. Concept-Based Objective Tests (CBOTs) were developed to assess students' understanding of the targeted concepts. A single-group pre-test–post-test quasi-experimental design was adopted, involving 73 Class IX students. Data were analyzed using a t-test to determine the impact of the intervention. Findings indicated that the integration of technology in research-based

remedial materials significantly improved students' understanding and helped address common misconceptions. Moreover, the use of multimedia provided hands-on learning experiences and enabled interaction with simulated environments otherwise inaccessible in a traditional classroom. The study concludes that technology-enhanced remedial instruction not only supports teachers in addressing misconceptions but also enriches students' learning experiences. This approach holds promise as an effective strategy for improving conceptual clarity in biology and can be adapted for other subject areas to promote deeper understanding and retention.

Strand 12: Technology for Teaching, Learning, and Research

Poster

Pilot Testing the Automated Discourse Analysis System (ADAS) for Science Classroom Discourse Feedback

Soon Lee*, Kennesaw State University, USA

ABSTRACT

This pilot study evaluates the Automated Discourse Analysis System (ADAS), a novel platform designed to provide real-time feedback on science classroom discourse quality. The research compares four machine learning approaches—BERT, RoBERTa, GPT-4o, and OpenAI embeddings with neural networks—across TensorFlow and PyTorch frameworks using the established Classroom Discourse Analysis Tool (CDAT) framework. Results from testing with secondary science classroom data demonstrate that RoBERTa-TensorFlow achieved optimal performance (74.34% validation accuracy, F1 = 0.74), while embedding-based neural networks unexpectedly outperformed GPT-4o (75.22% vs. 33.63% accuracy). Expert validation confirmed system alignment with human judgment (Krippendorff's $\alpha > 0.75$), and teacher acceptance testing showed strong usability (SUS = 78.5). The pilot establishes ADAS as a viable tool for transforming discourse analysis from weeks-long processes to same-day feedback cycles, addressing critical gaps in science education professional development.

Strand 12: Technology for Teaching, Learning, and Research

Poster

Teachers, Tasks, and Usability: Interpreting User Experience in Molecular Science Education

Minji Yun*, University of Florida, USA

Kent Crippen*, University of Florida, USA

Charles Xie, Institute for Future Intelligence, USA

Dylan Bulseco, Institute for Future Intelligence, USA

ABSTRACT

Molecular science, an interdisciplinary term for studying molecule-scale phenomena in any science context, is foundational to secondary science education and essential for supporting data-driven reasoning. However, integrating advanced molecular modeling tools, especially those related to cheminformatics concepts and techniques, into secondary classroom

practice presents challenges related to usability and a complex set of teacher-related factors, including unfamiliarity with advanced technology and varying levels of confidence. This study investigates secondary science teachers' user experience (UX) with AIMS (Artificial Intelligence for Molecular Sciences), a web-based platform that brings cheminformatics to life through interactive visual analysis that can illuminate structure-function relationships. Using a convergent mixed-methods design, 11 teachers engaged in guided cheminformatics-driven molecular analysis tasks, recorded their screens, and completed a UX survey. While teachers reported strong perceived value and moderate satisfaction, their usability ratings indicated marginal usability. Participants highlighted difficulties with interface navigation and advanced visualization tasks, alongside positive emotions such as enjoyment and confidence in using the platform. These findings underscore the importance of pairing powerful modeling tools with user-centered design and instructional support. The study offers actionable insights for educational technology developers, science educators, and professional learning providers aiming to promote the meaningful integration of molecular modeling into secondary classrooms.

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

Poster

Investigation of the Inclusion of NOS in the Recent Turkish Science Curriculum

Sevde YERİŞENOĞLU*, Bogazici University, Turkey

Ebru KAYA, Bogazici University, Turkey

ABSTRACT

In recent years, Nature of Science (NOS) studies based on the Reconceptualized Family Resemblance Approach to NOS (RFN) have increased in science education. In this study, the newly implemented 2024 Turkish Science Curriculum is examined with the RFN. The aim of this study is to reveal how and to what extent the 2024 Turkish Science Curriculum includes RFN categories. The science curriculum consists of two sections in total. In this study, only the first section and the 5th grade from the second section were analyzed. Content analysis method was used to analyze the relevant sections of the curriculum. The codes generated for the content analysis are 11 RFN categories in total. The cognitive epistemic categories are included in the curriculum more than the social institutional categories. The category with the highest frequency among the cognitive-epistemic categories is scientific practices. The category with the highest frequency among the social -institutional categories is social certification and dissemination. However, more NOS content should be included in both cognitive-epistemic categories and social-institutional categories. This study provides a comparison between the previous Turkish science curricula and the new science curriculum. It also provides enlightening suggestions for future studies.

Strand 14: Environmental Education and Sustainability

Poster

Assessing students' knowledge regarding green chemistry thinking: test development and evaluation

Laura Freude*, University of Duisburg-Essen, Germany

Mathias Ropohl, University of Duisburg-Essen, Germany

ABSTRACT

In the Anthropocene, society faces challenges like the climate change and other challenges to the ecosystem. One approach to face these challenges from the perspective of chemistry is green chemistry. Green chemistry considers twelve principles that describe how to improve chemical syntheses toward sustainability. The International Green Chemistry Commitment (GCC) was founded to empower a green chemistry community with the ability to provide the transformation needed for a sustainable future. Universities participating in the GCC have started to transform their chemistry courses for a sustainable future. Signing institutions agree on teaching essential green chemistry competencies like working knowledge on the twelve principles, toxicology or laboratory skills. To acknowledge the complexity of the topic, the concept of green chemistry thinking is presented in the educational context. Green chemistry thinking applies the idea of chemical thinking to the principles of green chemistry to describe the learning of green chemistry as a way of thinking. To determine the extent to which the adaptation of chemistry courses leads to students' knowledge regarding green chemistry thinking a test instrument must be developed. Empirical findings indicate that students' green chemistry thinking is influenced by their attitudes towards sustainability and by their chemical prior knowledge.

Strand 14: Environmental Education and Sustainability

Poster

A Systematic Literature Review of Ocean Literacy in Non-formal Education

Lisa Coe*, University of Florida, USA

Hada Herring, University of Florida, USA

Julie Brown, University of Florida, USA

Bryndan Durham, 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 to characterize non-formal ocean science education efforts worldwide and examined 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 are 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

Framework Development of Disaster Justice Education - Disaster Education Integrating Social Justice -

Minkyong Mun*, EWHA Womans University, Korea, Republic of
Donghee Shin, EWHA Womans University, Korea, Republic of

ABSTRACT

The importance of disaster education has grown, and many countries have implemented disaster education programs. However, science education generally focuses on the scientific causes and processes of disasters, as well as strategies for coping with them, while paying little attention to how disasters and society are interconnected. In fact, disasters are not equitable; the consequences of a hazard depend on the social, economic, political, and cultural context. The concept of disaster justice seeks to mitigate inequality during disasters and to ensure fair treatment for all. Science education should implement disaster education aimed at advancing justice. Disaster justice can be best understood at the intersection of environmental, climate, and social justice. This study analyzed the literatures in related fields, and explored elements of disaster education and social justice that can be interpreted within the context of disaster justice. This study conceptualized disaster justice education in three dimensions—cognitive, affective, and praxis—and specified the subcomponents of each dimension. The framework restructures disaster education with the goal of achieving social justice, which has been overlooked in conventional science education. This study will contribute to redefining the relationship between science education and society, thereby fostering a more just, equitable, and safe future.

Strand 14: Environmental Education and Sustainability

Poster

Critical Thinking Mobilization to Assess Information Regarding Climate Change Denial

João Pedro Coutinho*, Programa de Pós-Graduação Interunidades em Ensino de Ciências da USP, Brazil

Lúcia Sasserón, Faculdade de Educação da USP, Brazil

ABSTRACT

Recently, the prevalence of misinformation and disinformation has reached frightening proportions. The urgency of this is intensified as people struggle assessing the reliability of information. In this context, the development of Critical Thinking is considered to equip people to discard false information. Considering Critical Thinking as a dialogic practice, related to argumentation, this study aimed to explore how students mobilized Critical Thinking by epistemically assessing a claim provided by a climate denier stating that climate models are unreliable because they have uncertainty. The research was conducted at a public school in São Paulo (Brazil), in the Chemistry classes, and the participants were 52 first-year high school students (14–18 years old) divided in 10 groups. The results showed that most students don't think that uncertainty necessarily means unreliable, and that the level of epistemic assessment was heterogeneous among the groups. Taking this into consideration, we consider that this activity shows potential for science teaching, and can help develop Critical Thinking, argumentation, and epistemic assessment. Finally, this study adds to the empirical results that relate the constructs of Critical Thinking and argumentation, encouraging future research.

Strand 14: Environmental Education and Sustainability

Poster

Preservice Childhood Teachers, Children's Literature, and Environmental/Climate Justice Education

Leah Master*, NYU, USA

ABSTRACT

As climate change increasingly impacts Earth's inhabitants, it is crucial that preservice childhood educators are equipped with the knowledge to address environmental and climate justice in their classrooms. This study explores a project embedded within a science methods and content course for preservice teachers (PSTs), aimed at fostering climate action through diverse theoretical frameworks and pedagogical approaches. The project emphasized the use of multicultural children's literature to engage PSTs in exploring global inequalities related to deforestation, water access, and water quality. Following the project, PSTs demonstrated a deeper connection to the Earth and an enhanced interest in environmental justice, which influenced both their personal lives and future teaching practices. The findings suggest that integrating environmental and climate justice into teacher preparation can cultivate more informed, action-oriented educators committed to fostering climate awareness in young learners.

Strand 14: Environmental Education and Sustainability

Poster

Students' Beliefs, Perceived Barriers, and the Educational Role in Climate Change Mitigation and Adaptation

Helin Semilariski*, University of Tartu, Estonia

Katrin Vaino, University of Tartu, Estonia

Helen Semilarski, 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' beliefs and planned behaviour towards climate change and its teaching in general education schools. The study sample consists of 90 upper secondary school students whose responses were analysed qualitatively. Results show a strong consensus on the existence of climate change and its long-term impacts, particularly on future generations. However, students express mixed perceptions of its immediate effects on their lives, with some demonstrating psychological distancing, they perceive climate change as a distant threat not directly affecting them. Beliefs in the effectiveness of climate actions are generally positive, though a subset of students perceive their efforts as insignificant, reflecting a need for further empowerment. The findings reveal a moderate sense of readiness to adapt to climate change, with students citing barriers such as a lack of knowledge and rapid environmental changes.

Strand 14: Environmental Education and Sustainability Poster

Testing Cross-National Measurement Invariance of TIMSS 2023 EAB Framework and Implications in Environmental Education Research

Amdad Ahmed Awsaf*, Florida International University, USA

Christopher Irwin*, Florida International University, USA

ABSTRACT

From the energy demands of artificial intelligence to the spread of microplastics and “forever chemicals,” many urgent issues reside at the intersection of the scientific, the social, and the political. IEA, the organization that administers the TIMSS & PIRLS international assessments, emphasizes the need for students to develop both environmental knowledge and enact environmentally responsive values. To advance research in this area, the 2023 administration of TIMSS includes a new Environmental Attitudes and Behaviors Framework (EAB). The types of statistically valid international comparisons with these data depend on the degree of measurement invariance that can be established. Using Multi-Group Confirmatory Factor Analysis (MGCF) across 55 education systems, we found that home and school constructors did not meet configural invariance criteria, precluding international comparison. Student attitudes demonstrated configural but not metric invariance, limiting analyses to within-country patterns, while student behaviors demonstrated metric but not scalar invariance, permitting cross-national comparisons of behavior relationships but not the comparisons of latent means.

Strand 14: Environmental Education and Sustainability

Poster

Empowering Young Changemakers: Children Model Ocean Currents and Design Robots to Address Litter Issues

QINGNA JIN*, Cape Breton University, Canada

Enrique Hernandez*, Cape Breton University, Canada

ABSTRACT

We report a design-based research study that integrated socioscientific issues, systems modeling, and engineering-with-coding to engage Grade 5 students in addressing litter and ocean-bound pollution. Across two coastal classrooms (~40 students; 8–10 weeks), learners mapped local litter pathways, modeled ocean currents, designed and programmed robots to detect, sort, and collect debris, and planned school/community actions. Mixed methods included pre/post concept and ocean-literacy items, systems-thinking and modeling rubrics, robotics performance metrics, design notebooks and code snapshots, group deliberation artifacts, observations, and interviews. Preliminary findings showed (1) improved mechanistic understanding of currents alongside higher modeling-quality scores; (2) growth in systems-thinking skills (identifying components, interactions/feedbacks, boundary conditions); (3) iteration-driven gains in robotic detection/sorting accuracy and collection efficiency; (4) more criteria-based, evidence-attentive SSI reasoning; and (5) increased willingness-to-act and richer ocean-literacy discourse following partner engagement and a public demonstration. The study offers a transferable unit, assessment rubrics, and conjecture-to-practice insights for cultivating action-oriented agency in elementary science.

Strand 15: Policy, Reform, and Program Evaluation

Poster

Fidelity of Implementation to Three-Dimensional Critical Components: A Systematic Review

Lauren Browning*, George Washington University, USA

Haley Lowe, George Washington University, USA

Jonathon Grooms, George Washington University, USA

ABSTRACT

Since their release, the Next Generation Science Standards (NGSS) have redefined science teaching and learning by centering instruction on phenomena and integrating three dimensions—Disciplinary Core Ideas, Science and Engineering Practices, and Crosscutting Concepts. Many researchers describe interventions as “NGSS-aligned,” yet little is known about how publications characterize that alignment. This literature review examines 46 peer-reviewed studies claiming NGSS-design, applying a fidelity of implementation (FOI) lens to NGSS structural components. Using criteria adapted from the EQuIP rubric and an NGSS design coding scheme, studies were examined on their use of phenomena, explicit three-dimensional design, and integration. Sixteen studies were classified as “more NGSS-

designed,” with clear phenomena and full integration of the three dimensions; 22 were “somewhat NGSS-designed,” typically addressing only one or two dimensions; and eight showed minimal NGSS-design features. Findings reveal inconsistencies in how NGSS alignment is described, underscoring the need for common criteria and clearer reporting to strengthen both research and practice. This work offers immediate guidance for researchers in designing and describing NGSS-aligned interventions and raises long-term questions about building consensus on what it means to do NGSS-designed research. Results have implications for supporting teachers, districts, and policymakers in advancing reform goals 13 years after NGSS adoption.

Strand 15: Policy, Reform, and Program Evaluation
Poster

State Politics and Ethical Classroom Tensions: GenAI Initiatives in a Midwestern State

Ali Raza*, Grand Valley State University, USA

Stefanie Marshall*, Michigan State University, USA

Ain Grooms, University of Wisconsin-Madison, USA

ABSTRACT

Educators face a critical crossroads: engage generative AI proactively or await localized implementations. Meanwhile, various stakeholders are lobbying the future of how AI is adopted in K-12 schools. This exploratory case study examines AI education in a Midwestern state using policy network analysis to identify key stakeholders, their relationships, and industry influence on K-12 integration. Drawing on interviews, policy documents, and organizational artifacts, the study reveals tensions between ethical AI use, local agendas, and equitable access. Findings illuminate how power dynamics shape GenAI adoption in schools, highlighting beneficiaries and those marginalized by current educational policy networks.

JRST Dinner (by invitation only)

20-Apr-26, 18:30-20:00

Location: Diamond A (L1)

Social Event

Milagritos of the Heart: A Reflective Craft Session for Building Community and Scholarship in Science Education

20-Apr-26, 19:30-21:00

Location: Willow A (L2)

Social Event

Organizers

María González-Howar¹, The University of Texas at Austin, USA

Enrique Suarez, University of Massachusetts-Amherst, USA

Uma Ganesan, The University of Texas Rio Grande Valley, USA

Angela Chapman, The University of Texas Rio Grande Valley, USA

Miriam Ortiz, The University of Texas Rio Grande Valley, USA

Alejandro Gallard, Georgia Southern University, USA

Alexander Eden, Salem State University, USA

Contributors

Uma Ganesan, The University of Texas Rio Grande Valley, USA

Miriam Ortiz, The University of Texas Rio Grande Valley, USA

Alexander Eden, Salem State University, USA

Angela Chapman, The University of Texas Rio Grande Valley, USA

Alejandro Gallard, Georgia Southern University

María González-Howard, The University of Texas at Austin, USA

Enrique Suarez, University of Massachusetts-Amherst, USA

Abstract

This interactive session, hosted by LARIG, invites all NARST participants into a creative and reflective space grounded in Freire's Pedagogy of the Heart (1997). Through the hands-on crafting of clay hearts inspired by milagrismo traditions in some parts of Latin America, participants will engage in an embodied form of scholarly reflection, exploring their positionality, personal motivations, and commitments in working with and for Latin* students and communities in science education. Following Freire, this session recognizes emotion as a site of critical knowledge, specifically, a way of knowing rooted in love, humility, and solidarity. Engaging with the heart as both a metaphor and method, participants will reflect on the emotional and ethical dimensions of their practice as integral to scholarly rigor and humanizing pedagogy.

Guided reflection prompts will include: What experiences shape your commitment to science education? What does your heart carry into your practice? How does your positionality inform your engagement with and for Latin* students and communities? Such prompts will support participants in connecting culture, emotion, and praxis. The crafting process thus serves as a medium to bridge creativity, reflection, and science education. This session also introduces LARIG's mission and community, offering a space to build relationships, share stories, and imagine collective futures in science education that are rooted in love, liberation, and solidarity. All are welcome, whether you identify as Latin* or are

in solidarity with Latin* communities. Join and reflect, create, and engage in a heart-centered practice of scholarly community-building!

Artificial Intelligence for STEM Education Research: Advanced Methods and Applications

20-Apr-26, 19:30-21:00

Location: Juniper (L2)

Administrative Session

Organizers

Xiaoming Zhai, University of Georgia, Athens, GA, USA

Kent Crippen, University of Florida, USA

Gyeonggeon Lee, Nanyang Technological University, Singapore

Contributors

Shuchen Guo, Nanjing Normal University

Yizhu Gao, University of Georgia, USA

Ehsan Latif, University of Georgia, USA

Lehong Shi, University of Georgia, USA

Matthew Nyaab, University of Georgia, USA

Abstract

This book talk introduces a newly published book from Springer, *Artificial Intelligence for STEM Education Research: Advanced Methods and Applications*. The book features a rich collection of chapters that explore how AI can be harnessed as research methodologies to enhance educational outcomes via applications such as adaptive learning systems, automatic scoring, explainable AI, and intelligent tutoring. The editors of the book (Xiaoming Zhai – University of Georgia; and Gyeonggeon Lee – Nanyang Technological University) invited experts in AI-integrated STEM education research. Authored by leading experts, this book is designed for researchers, educators, and graduate students who are interested in applying AI-driven methods to their research and work. This session will present an overview of the book, introduced by editors and chapter authors. The practical examples, case studies, and methodological details presented throughout the volume make it a valuable resource for those seeking to push the boundaries of traditional research methods and embrace the possibilities offered by AI. Participants will gain in-depth insights into cutting-edge AI applications and their potential to revolutionize STEM education research. This session is ideal for anyone looking to understand and apply AI technology for STEM education research.

Fireside Chat: Networking, Socializing, and Connecting Among the ISK RIG Membership

20-Apr-26, 19:30-21:00

Location: Ravenna AB (L3)

Administrative Session

Organizers

Stacy Potes, University of Hawai'i at Mānoa, USA

Dimitri Smirnoff, University of Minnesota, USA

Julie Robinson, University of North Dakota, USA

Paichi Pat Shein, National Sun Yat-sen University, Taiwan

Contributors

Sharon Nelson-Barber, WestEd, USA

Bhaskar Upadhyay, University of Minnesota, USA

Pauline Chinn, University of Hawai'i at Mānoa, USA

Abstract

The purpose of the ISK RIG Fireside Chat Social Event is to provide a comfortable, informal, and casual setting for the ISK members to connect, meet each other, and exchange ideas. The ISK RIG Fireside Chat will provide a physical space at the 2026 NARST Annual International Conference for current, new, and potential ISK RIG members to learn more about the work, research, and interests of the RIG and to 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 projects and resources, and brainstorming of new ideas and strategies for sustaining the current work and collaborations of the ISK RIG.

Conference Day 3 21 April 2026

Committee Meetings 21-Apr-26, 7:00-8:00

Elections Committee Meeting
Location: Willow B (L2)

Awards Committee Meeting
Location: Aspen (L2)

Equity and Ethics Committee (EEC) Meeting
Location: Cedar AB (L2)

Graduate Student Committee Meeting
Location: Juniper (L2)

International Committee Meeting
Location: Ravenna AB (L3)

Membership Committee Meeting
Location: Ravenna C (L3)

Research Committee Meeting
Location: Issaquah AB (L3)

Scholarships Committee Meeting
Location: Greenwood (L3)

Professional Learning and Institutes Committee (PLIC) Meeting
Location: Capitol Hill (L3)

Social Media, Website, and Communications Committee (SMWCC) Meeting
Location: Ballard (L3)

Program Committee Meeting
Location: Seneca (L4)

Empowering Science Teachers : PCK, Curiosity, and Speculative Approaches

Strand 2: Science Learning: Contexts, Characteristics and Interactions

21-Apr-26, 8:15-9:45

Location: Columbia (L4)

Stand-Alone Paper

Towards a New Vision of PCK for the 21st Century: Knowing How to Teach Science

Vanessa Kind*, University of Leeds, United Kingdom

Jonathan Osborne, Stanford University, USA

ABSTRACT

This theoretical paper argues that the concept of pedagogical content knowledge (PCK) is underdeveloped. While Shulman achieved an important milestone, 40 years later the field has still failed to elaborate his ideas in a form that would make it practically useful. Essentially, all practice has a knowledge component. But what are the elements of knowledge that it might reasonably expect a teacher of science to know at a minimum of three levels – foundational, proficient and expert?

Drawing on research evidence, the paper argues that to define these would establish a set of shared important concepts; enable comparability across sites by providing a common language; and provide structure and control to the field by enabling a common evaluation of teacher competency.

The continued failure to define the elements of professional knowledge required for the specialised work of science teaching undermines our ability to respond to the claim that all that matters is disciplinary knowledge. We advance a framework based around the knowledge required to support the learning of science through talking, writing, reading, experimentation and modelling in science. We offer this as a first step to advancing the concept of PCK and remediating this long-standing weakness.

Stand-Alone Paper

Speculative Designs: Reimagining Teaching and Learning Climate Change in a Middle School Classroom

Kaylee Laub*, University of California, Santa Barbara, USA

Jeanice Trat, University of California, Santa Barbara, USA

ABSTRACT

With the growing call for transformative approaches in science education, especially to address challenges related to climate change, this study explores a middle school science teacher's enactment and her students' experiences during a climate change unit that

incorporated opportunities to design solutions for future climate hazards. Drawing from a futures cone model and eight core competencies, this study conceived possible futures of science education to include opportunities to engage students in such challenges that embraced creative and heterogeneous learning outcomes. This study qualitatively analyzed the holistic and transformative approaches enacted by a middle school teacher to engage her middle school science students in climate change through speculative designs and the resulting student outcomes. The findings illustrated ways the teacher supported students' creative visions to address future climate hazards, imagined actions for climate futures, and student-initiated curiosity of speculative designs. Ultimately, this research contributes to the discourse on climate change education, emphasizing the need for innovative approaches in formal middle school learning environments that position students as imaginative thinkers and creative problem solvers of future climate hazards.

Stand-Alone Paper

Student Epistemic Curiosity and Curiosity-Focused Teacher Training: Enhancing Engagement and Achievement in Middle School Science

Yu Ye*, arizona state University, USA

Carlos Meza-Torres, arizona state University, USA

jongchan park, arizona state University, USA

ying-chih chen, arizona state University, USA

michelle Jordan, arizona state University, USA

ABSTRACT

This study investigated how student epistemic curiosity and curiosity-focused teacher training shape engagement and achievement in middle school science classrooms. Surveys and achievement tests were administered to over 700 middle school students taught by two teacher cohorts with differing levels of professional development (PD). Repeated-measures MANCOVA revealed significant achievement gains across both cohorts, with larger improvements among students whose teachers completed two PD sessions. Engagement patterns were mixed, indicating possible adjustment challenges. Regression analyses revealed that interest-type epistemic curiosity (I-type EC) consistently predicted all dimensions of engagement and achievement, whereas deprivation-type curiosity (D-type EC) showed only limited effects. These results highlight the value of cultivating curiosity-supportive learning environments and equipping teachers with targeted training to strengthen student engagement and achievement.

Supporting Effective STEM and Engineering Instruction in Elementary Classrooms

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

21-Apr-26, 8:15-9:45

Location: Juniper (L2)

Stand-Alone Paper

Impacts of Professional Learning on Rural Elementary School Teachers' Enactment of Student Agency

Rasha Elsayed, WestEd, USA

Meghan Macias*, WestEd, USA

Min Lee, University of North Dakota, USA

Ashley Iveland, WestEd, USA

Ryan Summers, University of North Dakota, USA

ABSTRACT

This study examines how sustained, curriculum-agnostic professional learning (PL) supports grades 3-5 rural teachers in fostering student agency within NGSS-aligned science and engineering instruction. Sixty-nine teachers from four U.S. states participated in a five-day online PL institute followed by ongoing professional learning communities (PLCs). Teachers completed instructional logs at three points during the year, reporting on practices such as eliciting prior knowledge, incorporating student ideas, and modifying instruction based on student performance. Findings indicate modest improvements across all practices, with the largest gains in discussing students' prior knowledge and facilitating classroom discussions that draw on student ideas. While encouraging student interest remained consistently high, modification of instruction showed little change, suggesting targeted support is needed for this particular type of responsive teaching. By positioning students as knowers and doers, these practices advance equitable, three-dimensional learning. This work offers educators, researchers, and policymakers concrete strategies for embedding agency into science instruction and highlights the potential of ongoing, community-based PL to transform classrooms into spaces of student voice, choice, and ownership.

Stand-Alone Paper

Examining rural elementary teachers' planning and implementation of science and engineering practices within engineering lessons

Jenna Gist*, Purdue University, USA

Rebekah Hammack*, Purdue University, USA

Min Lee*, University of North Dakota, USA

Lauren Cabrera, Purdue University, USA

ABSTRACT

This study investigated how rural elementary teachers planned for and implemented science and engineering practices within community-relevant engineering lessons following their participation in an engineering learning community. To conceptually frame this study,

researchers drew from literature on the Next Generation Science Standards and Science and Engineering Practices as well as rural elementary teachers' enactment of the science and engineering practices. This study is a part of a nationally-funded research project that examines how rural elementary teachers' ongoing participation within a larger, professional learning community, and smaller, engineering learning community impacts their science and engineering practice. This study utilized a multiple case study approach and profiled how four teachers who participated in the engineering learning community planned for and enacted the science and engineering practices within community-based engineering lessons. Data were gathered via teachers' lesson plans, teaching videos, and exit interviews. Data were analyzed through a multi-layered coding approach. Findings revealed that there was a complexity of ways rural elementary teachers planned for and implemented science and engineering practices within engineering lessons, and that many teachers experienced conflation between how they planned for and enacted the science and engineering practices. Implications will be discussed for STEM teacher educators and researchers.

Stand-Alone Paper

Storybooks as Bridges: Teaching Nature of Engineering Concepts in Primary Grades

Emine Sahin-Topalcengiz*, Mus Alparslan University, Turkey

Cemile Yalc'n, Ministry of Education, Turkey

ABSTRACT

This qualitative research explores the impact of explicitly teaching the Nature of Engineering (NOE) through children's picture books on elementary students' conceptions. Students' NOE views were measured before and after the intervention using the Views on the Nature of Engineering – Elementary School Version (VNOE-E) questionnaire. The study was conducted with 24 third-grade students (12 girls, 12 boys) from a public elementary school in Türkiye, selected through purposeful sampling. Over seven weeks, the students engaged in four design challenges inspired by picture books. Findings revealed that this literacy-based approach significantly improved students' understanding of NOE and its key components, highlighting children's literature as an engaging and effective tool for NOE instruction at the elementary level.

Engaging Students in Socioscientific Reasoning and Science Practices

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

21-Apr-26, 8:15-9:45

Location: Cedar AB (L2)

Stand-Alone Paper

Convergence Between Responsive Instruction and Science Practices: Insights from Biology Classrooms with Multilingual Learners

Niki Koukoulidis, University of Florida, USA

Rei Taklal*, University of Florida, USA

Julie Brown, University of Florida, USA

ABSTRACT

This study explores the convergence of culturally and linguistically responsive instruction (CLRI) and student participation in science practices within secondary biology classrooms with multilingual learners (MLs). Drawing on 65 systematically coded video-recorded biology lessons from three Southeastern US school districts, we applied a responsive instruction protocol and Chen & Terada's (2021) IONIC framework to identify how specific responsive instructional elements align with core NGSS science practices. Using deductive coding, we found overlaps between several responsive instruction elements and science practices, including multimodal instruction and model-based practices, explicit language supports and scientific argumentation, and structured collaboration with data analysis and investigation. These convergences indicate that responsive instruction not only supports, but often underpins, MLs' engagement in authentic scientific work. Our findings offer actionable insights into which instructional strategies most effectively foster equitable science participation. This research advances the field to contextualize the convergence of equity-driven instruction and discipline-based science practices. Results can inform teacher preparation, curriculum design, and policy for inclusive, practice-rich biology education.

Stand-Alone Paper

Integrating scientific and socio-scientific models in addressing socio-scientific issues: A new pedagogical framework

Zeyu Han*, The University of Hong Kong, China

Chen Chen, The University of Hong Kong, China

Kejian Qiu, University of Warwick, United Kingdom

Qinger Song, Hangzhou Yinhu Experimental School, China

ABSTRACT

Scholars have established Socioscientific Reasoning (SSR) as a distinctive practice in addressing Socioscientific Issues (SSI). Rather, many intervention studies have failed to show detectable SSR learning gains. This highlights the pressing need for effective and efficient pedagogical frameworks. Science educators have attended to the potential of modelling in

SSI learning. While modelling and SSR are distinct practices, both are epistemic in nature. Developing multiple models within the SSI context allows for their respective Epistemic Considerations (ECs) to align coherently, fostering their synergistic development. We first propose a conceptual framework that illustrates this potential alignment, followed by introducing a new pedagogical framework. Finally, we examine the effects of this pedagogy through interviews with thirty 8th-grade students after implementation. We particularly refer to the dimensions of ECs identified in our conceptual framework as potential themes during thematic analysis. Most students demonstrated the ability to thoughtfully engage with a new SSI context and its associated decision-making process from the modelling perspective. We observed significant advancements in students' ECs related to modelling and SSR. This can be attributed to the fact that the modelling pedagogical framework simultaneously serves as a mental framework for students to understand the nature of SSI decision-making and reasoning.

Stand-Alone Paper

Analyzing Grade 6–8 students' socioscientific reasoning and its links to epistemic beliefs

Chengji Luo, Beijing Normal University, China

Hongyan Zhao, Beijing Normal University, China

Jing Lin, Beijing Normal University, China

Mei-Hung Chiu, Taiwan Normal University, Taiwan

ABSTRACT

In this study, we assessed and analyzed socioscientific reasoning and epistemic beliefs, and the relationship between the two variables, among students in grades 6, 7 and 8. The assessment of epistemic beliefs was based on Conley et al.'s (2004) measurement instrument, and focused on two dimensions, i.e., Development and Justification. Socioscientific reasoning was measured using an open-ended questionnaire that we developed, inspired by Zeidler's (2019) framework, encompassing five dimensions, i.e., Complexity, Inquiry, Perspective-Taking, Skepticism, and Science versus Non-Science Considerations. We collected a total of 453 responses. The result indicated that in epistemic beliefs, 6th to 8th grade students showed better performance in Justification. In terms of SSR, students performed better in Inquiry and Complexity, while showing weakness in Perspective-Taking and there was a significant difference among different grades. Epistemic beliefs and SSR showed a significant correlation across all dimensions, with Justification being the most pivotal predictor of overall SSR ability. Meanwhile, Development only had a significant correlation with Perspective-taking. These findings suggest the central role of Justification in promoting socioscientific reasoning and emphasize the importance of incorporating epistemic belief development into socioscientific reasoning instruction.

Representations, Resources, and Participation in STEM Learning

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

21-Apr-26, 8:15-9:45

Location: Willow B (L2)

Stand-Alone Paper

Linking Visual Transition to Mental Model Quality: Coordinating Triple Representations in Chemistry Learning

Sylvia Faustine*, National Taiwan University of Science and Technology, Taiwan

Chia-Yu Wang, National Taiwan University of Science and Technology, Taiwan

Sufen Chen, National Taiwan University of Science and Technology, Taiwan

ABSTRACT

Understanding triple representations (i.e., macroscopic, submicroscopic, and symbolic) in chemistry is essential for developing scientific mental models. Chemical equilibrium was chosen as this topic requires integration across these representations to connect observable changes, molecular kinetics, and symbolic equations. This study aims to examine how students' visual transition patterns during learning a triple representation-based video relate to their mental model quality. Thirty-nine university students participated in the study. Eye-tracking data and lag sequential analysis (LSA) were used to identify transitions between Areas of Interest (AOIs) while learning and solving related problems in the video. Afterwards, open-ended questions were administered to assess mental models. A rubric was developed to assess the mental model. Results showed that nearly half of the participants developed more scientific mental models, while others exhibited partially scientific or less scientific models. Most students struggled to recognize simultaneous increases in forward and reverse reaction rates during temperature changes. The LSA results suggest that integrating submicroscopic and symbolic representations may serve as an effective learning strategy for developing more scientific mental models. Suggestions on how to design digital learning materials with triple representations are provided based on the findings.

Stand-Alone Paper

The Four I's of Resistance: Tracing Resistance Capital Across Physics and Astronomy Classrooms

Reina Howell, San Francisco State University, USA

Khanh Tran*, Utah State University, USA

Kim Coble, San Francisco State University, USA

Alegra Eroy-Reveles, University of California, Santa Cruz, USA

ABSTRACT

This study examines how undergraduate STEM students enact resistance capital across four levels of oppression—internalized, interpersonal, institutional, and ideological—using the Four I's of Resistance framework. Data were drawn from 75 reflective journal entries written by students in introductory physics, astronomy, and supplemental instruction courses at a large, diverse public university. Manifest content analysis identified explicit expressions of

resistance capital, while latent analysis explored underlying meanings and motivations. Individual resistance, characterized by persistence, self-motivation, and rejection of stereotypes, appeared most frequently, followed by ideological resistance aimed at challenging dominant narratives in STEM. Interpersonal and institutional resistance were less common, revealing gaps in opportunities for collaborative and systemic engagement. Latent analysis highlighted resistance as both personal identity affirmation and community-oriented practice, with students framing success through collective advancement and envisioning professional roles as vehicles for systemic transformation. These findings expand understandings of asset-based approaches in postsecondary science education, illustrating how resistance capital can inform equitable and justice-oriented teaching practices. Implications include integrating reflective writing, identity-based projects, peer mentorship, and social justice role models into STEM learning environments. This work invites dialogue on recognizing and amplifying diverse forms of resistance in postsecondary STEM education, advancing conversations on justice and epistemic agency.

Stand-Alone Paper

The Utility of Students' Intuitive Resources: Addressing the Tension of Framing Student Ideas as "Unproductive"

Ryan Bowen*, Michigan State University, USA

Nicole Becker, Michigan State University, USA

ABSTRACT

Traditional undergraduate chemistry education has been characterized by passive pedagogies and direct communication of canonically accepted knowledge. In these classrooms, only a singular way of knowing and doing is emphasized, and the plurality of student resources and experience is not activated for learning. Furthermore, when students' ideas deviate from normative responses or explanations, they have historically been labeled as "misconceptions" and in need of "correction." While undergraduate chemistry education is shifting toward asset-based perspectives, students' intuitive and noncanonical ideas can still be situated in deficit ways. Using the knowledge-in-pieces and resources perspectives alongside preliminary data on graphing representations in undergraduate chemistry courses, this position paper challenges labeling student ideas as "unproductive", even when they are canonically aligned. Instead, we advocate for labeling the contextual activation as productive or unproductive—an original distinction made in the resources perspective. We argue this nuance is significant for the implications of teaching and research and influence how we position student resources and leverage them in practice.

Stand-Alone Paper

Department Cultural Supports and Barriers for Biology Graduate Student Teaching Professional Development: A Delphi Study

Grant Gardner*, Middle Tennessee State U, USA

Eric Akuoko, St. John's U, USA

Cili Marbach-Ad, U of Maryland, USA

Kristen Miller, U of Georgia, USA

Elisabeth Schussler, U Tennessee Knoxville, USA

ABSTRACT

Graduate students (GS) in the STEM fields are critical instructors for supporting the success and retention of undergraduate students. However, these instructors are often unsupported in their efforts to become more effective instructors through Teaching Professional Development (TPD). Although there are various reasons that departments in higher education might choose not to implement high-quality TPD for their graduate students, one area that has been little considered is the department's culture. In this Delphi study, we collected data from a cohort of $n = 49$ experts in GS TPD to reach expert consensus on the critical components of a biology department culture that might support or hinder the implementation of GS TPD. This was done through three iterative rounds that included an initial semi-structured interview followed by two Delphi ranking surveys. Cultural supports and barriers were categorized using the Four Frames taxonomy (Reinholz & Apkarian, 2018). Findings are being used to develop departmental self-assessment tools to support institutional change efforts around GS TPD.

Family Learning & Science at Home

Strand 6: Science Learning in Informal Contexts

21-Apr-26, 8:15-9:45

Location: Seneca (L4)

Stand-Alone Paper

Family STEM conversations as community sustaining pedagogy

Cory Buxton*, Oregon State University, USA

Diana Crespo Camacho*, Oregon State University, USA

ABSTRACT

Broadening participation along STEM pathways has been an important policy initiative in the U.S. since the 1970s but is currently under attack through regressive government initiatives. To continue this work in uncertain times, we recently proposed a framework for community sustaining pedagogies based on four design principles that highlight local STEM connections, multigenerational learning, and listening to diverse stakeholders. This presentation explores initial efforts to study the utility of this framework during family workshops. Using data from family conversations that occurred during these workshops, as well as data from planning done by the teachers who partnered with us to facilitate these workshops, we analyze these conversations for examples of community sustaining practices. Using a two-step analytic process of thematic coding and discourse analysis we found that teacher planning conversations attended well to two of the four design principles (providing families with communication rich learning experiences and supporting ways to listen to each other's voices) but were less focused on making local

connections to the role STEM plays in their communities or in local careers. In contrast, the family conversations more often raised connections to all four design principles, including various STEM connections to the work that family members do.

Stand-Alone Paper

The Family Science Wealth Survey: Development of a Survey to Learn About Families and Science

Julianne Wenner, Clemson University, USA

Christy Brown*, Clemson University, USA

ABSTRACT

Families are children's first teachers and significantly influence their interest, engagement, and aspirations (IEA) in science. This influence is especially vital for students from underrepresented populations in science, where family attitudes, conversations, and values shape children's science pathways. To learn more about the impact families have on children's IEA in science, most studies in the literature rely on retrospective interviews with adults, or surveys/interviews with children; neither of these approaches are accurate. Further most existing instruments present a narrow view of science. To address these gaps, we developed the Family Science Wealth Survey (FSWS), grounded in the constructs of family science habitus, science identity, and Community Cultural Wealth. The FSWS was piloted in Fall 2024; exploratory factor analysis revealed a four-factor structure and internal consistency reliability was strong. In Spring 2025 the survey was administered again; confirmatory factor analysis was also strong in terms of measures of fit, and all but one item had a strong loading. The FSWS is now a validated tool for examining family supports for children's IEA in science. Findings from the survey hold potential to inform targeted interventions that build on family assets, promoting broader participation in science.

Stand-Alone Paper

A Study on the Design Mobile Learning to Promote Family Learning in Botanical Gardens

Xianqing Bao*, Shanghai Normal University, China

Yue Qian, Shanghai Songjiang District She Shan Foreign Language Experimental School, China

ABSTRACT

Botanical gardens are ideal venues for outdoor informal science education and require more research on learning design. This study employs mobile devices as learning tools to explore how to design electronic learning worksheets that can better facilitate family learning. This study adopts the observation ability model as a teaching strategy, designs and develops electronic learning worksheets based on the WeChat.

The two research questions are: 1. How to designed and developed WeChat mobile learning app based on the observation ability model? 2. What are the differences between electronic

worksheets and paper worksheets in terms of promoting children's observational skills and family engagement with nature? This study employs a mixed-methods research approach. Researchers developed the “Bark Observer” mini-program based on design-based research. Subsequently, a quasi-experimental method was used to compare the differences between families using electronic learning sheets and paper-based learning sheets. The experiment found that the electronic worksheets designed and developed in this study effectively enhanced children's scientific knowledge acquisition, observation skills. Both paper-based and electronic worksheets positively influence children's acquisition of scientific knowledge. Children in electronic worksheets group got higher scored in observational ability compared to paper-based worksheets, and parent-child families also engaged more frequently in nature-related activities.

Innovations in Developing Science Teachers' Competencies

Strand 7: Pre-service Science Teacher Education

21-Apr-26, 8:15-9:45

Location: Boren (L4)

Stand-Alone Paper

A novel mind map to reveal what concepts pre-service science teachers associate with “system”

Nazmiye Ertugrul, Bogazici University, Turkey

Beril Genc, Bogazici University, Turkey

Burak Aricioglu, Balikesir University, Turkey

Emre Goktepe, Systems Thinking Association, Turkey

Burcu Gungor Cabbar*, Balikesir University, Turkey

Gaye Ceyhan, Bogazici University, Turkey

ABSTRACT

Systems thinking represents a critical competency for understanding complex scientific phenomena and addressing global challenges like climate change. However, limited research exists on pre-service science teachers' existing conceptual frameworks related to systems thinking. This study examined what concepts pre-service science teachers associate with the term “system” through a novel mind mapping approach. A total of 376 pre-service science teachers from seven public universities participated in a word association task, generating 3,760 conceptual responses. Data were analyzed using mixed deductive-inductive content analysis based on Arnold and Wade's (2015) systems thinking framework. A novel mind map visualization was created to represent conceptual associations. Analysis revealed twelve distinct themes. System structure dominated participants' associations, followed by social systems and biological systems. Advanced systems concepts like non-linear relationships were rarely mentioned, indicating gaps in sophisticated systems thinking. The mind map visualization revealed that pre-service teachers conceptualize systems primarily through structural and contextual lenses rather than dynamic, interconnected

perspectives. The findings inform teacher preparation programs about existing conceptual foundations and highlight areas requiring explicit instruction to develop comprehensive systems thinking competencies essential for effective science education.

Stand-Alone Paper

Advancing Modeling Competence: A Systematic Review of Interventions for Pre-Service and In-Service Science Teachers

Adam Tricomo*, University of Georgia, USA

Daniel Capps, University of Georgia, USA

Jonathan Shemwell, University of Alabama, USA

ABSTRACT

Developing science teachers' competence in using and constructing models is essential for implementing modeling-based teaching, as emphasized by the Next Generation Science Standards. This systematic review synthesizes 13 empirical studies examining interventions in which pre-service and in-service teachers engaged as learners in model- and modeling-based teaching. Using the Model of Modelling framework (Gilbert & Justi, 2016) as a lens, the review categorizes interventions into three approaches: learning to use models, learning to reconstruct models, and learning to construct models de novo. Findings indicate that engaging teachers in reconstructing models and constructing models de novo—thereby participating in all stages of modeling—enhances their conceptual understanding and meta-modeling knowledge, with de novo construction especially facilitating the transfer of modeling experience into effective classroom practice. However, few studies track long-term changes in teachers' meta-modeling knowledge or their ability to enact and sustain modeling-based instruction. This review suggests directions for future research, including longitudinal investigations of how teachers' engagement in modeling activities influences the development of modeling competence and its application in authentic classroom contexts. By identifying effective practices and persistent challenges, this work informs teacher education, professional development, and the design of interventions that cultivate teachers' modeling competence and modeling-based pedagogical content knowledge.

Stand-Alone Paper

From Sprint to Success: Implementing Scrum in Higher Education

Dirk Brockmann-Behnse*, Leibniz University Hannover, Germany

ABSTRACT

This study investigates the implementation of the Scrum framework in a university-level preparatory seminar for pre-service physics teachers. Scrum, originating in agile software development, promotes iterative, team-based, and self-directed learning, qualities aligned with current demands in science education. Across four seminar cohorts (N = 32), students worked in self-organized teams to design physics lessons in three iterative “sprints,” supported by peer and instructor feedback. Data were collected via three surveys administered before the preparatory seminar (T1), after the seminar (T2), and after the

subsequent teaching internship (T3). At T2, students evaluated four Scrum components, with high ratings for teamwork and instructor support, but lower ratings for intra-team retrospectives. Self-assessed professional competencies increased significantly between T1 and T2 across all domains (teaching, educating, assessing, innovating), with the largest effect in teaching; no substantial gains occurred between T2 and T3. Subject-specific didactic knowledge improved markedly between T1 and T2 ($r = .69$). Findings suggest that Scrum can enhance both pedagogical skills and content knowledge in teacher preparation, offering a scalable, transferable model for active learning in science teacher education. The study contributes empirical evidence to the limited literature on agile methods in teacher training, highlighting their potential to foster professionalization.

Stand-Alone Paper

Pre-Service Teachers' Understanding of Systems Thinking Characteristics

Ihsan Ghazal*, Boston University, USA

Hayat Hokayem, Texas Christian University, USA

ABSTRACT

This mixed-methods study examined how explicit instruction of systems thinking (ST) characteristics influenced pre-service teachers' (PSTs) understanding of systems thinking and the nervous system. Sixty-eight PSTs participated, with 50 receiving targeted instruction on eight ST characteristics—boundary, hierarchy, dynamics, feedback, components, interactions, inputs/outputs, and emergence—using visual tangram icons and contextualized examples, while 18 served as a control group. Pre- and post-assessments, weekly reflections, and interviews evaluated PSTs' general systems thinking reasoning and application to biological and non-biological contexts. Quantitative analysis showed significant improvements in PSTs' understanding, with the experimental group outperforming the control group on boundary, hierarchy, emergence, and dynamics. Qualitative analysis revealed that explicit instruction supported coherent identification of system characteristics, cross-level reasoning, and the ability to connect micro-level mechanisms to macro-level phenomena. Reflections and interviews demonstrated PSTs' deeper comprehension of nervous system processes and the capacity to apply ST principles in teaching practice. Findings suggest that integrating ST explicitly into teacher preparation programs enhances conceptual understanding and pedagogical skills, enabling PSTs to adopt more holistic approaches when teaching complex systems.

Understanding the richness of student languages and cultures

Strand 11: Cultural, Social, and Gender Issues

21-Apr-26, 8:15-9:45

Location: Ballard (L3)

Stand-Alone Paper

What Do We Mean by Culture? An Analysis of Teacher Talk

Minjung Ryu*, University of Illinois Chicago, USA

Roshni Bano, University of Illinois Chicago, USA

Mee Na Feng, University of Illinois Chicago, USA

Fatemeh Alipour, University of Illinois Chicago, USA

ABSTRACT

The present study seeks to investigate how high school science teachers conceptualize culture and cultural relevance as it relates to their teaching practices with students from diverse ethnocultural backgrounds. We draw upon theories of culturally oriented pedagogies to frame our analysis of video recordings from teachers' professional learning meetings. Our analysis revealed three conceptualizations of culture: culture as practices tied to ethnicity, determinants of identity and values, and dynamic mediators of everyday actions. Our findings suggest a need for researchers and teachers to establish shared language and frameworks to understand culture, particularly as U.S. K-12 educational reforms continue to trend toward inclusion of culturally oriented pedagogies. Additionally, we argue for a need to move beyond essentialist views of culture to embrace dynamic perspectives that support students from diverse ethnocultural backgrounds.

Stand-Alone Paper

Multilingual Learners' Multimodal Negotiation in College Science Discourse

Adeesha Jayathilaka*, University of Illinois Chicago, USA

Margaret Jeong, University of Illinois Chicago, USA

Minjung Ryu, University of Illinois Chicago, USA

ABSTRACT

As Multilingual Learners (MLs) are increasingly represented throughout all levels of education, recognizing their strengths and leveraging them becomes critical to create inclusive and effective learning environments. Thus, we examined how college MLs draw on multiple semiotic resources—verbal, paraverbal, spatial, and material—to negotiate scientific meaning collaboratively. For the present paper, we analyzed video data collected from task-based paired interviews in which colingual pairs solved science problems together. Our analysis was guided by the framework of translingual negotiation strategies: envoicing, re-contextualization, interactional, and entextualization (Canagarajah, 2013). This paper discusses our preliminary findings, which are organized around three key themes based on the function of MLs' use of semiotic resources in science problem solving: interpret and conceptualize the problem, contextualize relevant knowledge, and maintain the collaborative environment. We present an example event featuring a Burmese and English

speaking pair to demonstrate these practices. Our findings emphasize the importance of diverse semiotic resources in science problem solving, thus indicating the need to design science learning environments that support authentic multimodal engagement.

Stand-Alone Paper

Reimagining Refugee Youth and Parents' STEM Aspirations and College Readiness Through an Enrichment Program.

Mohammed Ibrahim*, Arizona State University, USA

Eugene Judson*, Arizona State University, USA

ABSTRACT

Recognizing the essential role of STEM education in promoting economic empowerment, countries, including the United States, strive to make this education accessible to all residents. Over the years, researchers and other relevant stakeholders have continued to generate various STEM programs and initiatives to support all groups residing in the United States, including refugees. One such program is the NSF-funded program discussed in this study. This mixed-methods study examines the impacts of an NSF-funded enrichment program on STEM aspirations and higher education preparedness among refugee families. The program is a partnership between multiple grassroots ethnic community-based organizations and a large public university. It focuses on relocated families with children in grades 7-12 living in the Southwestern United States. Descriptive statistics and correlation analysis were used to analyze the quantitative data, while thematic analysis was used to interpret the qualitative data. We found that the program had a high positive impact on both the refugee youth and their parents' STEM capital, aspiration, and interest, as well as their college social capital. Additionally, we discovered a positive correlation between STEM attitudes and college preparedness.

Disrupting Essentialism and Advancing Equity in a Time of Rising Authoritarianism

Strand 11: Cultural, Social, and Gender Issues

21-Apr-26, 8:15-9:45

Location: Ravenna C (L3)

Symposium

Disrupting Essentialism and Advancing Equity in a Time of Rising Authoritarianism

Quentin Sedlacek, Southern Methodist University, USA

KT Doerr*, Malmö University, Sweden

Sarah Eddy, University of Minnesota, USA

Gareth Gingell, University of Northern Colorado, USA

Tatiane Russo-Tait, University of Georgia, USA

Daniel Soodjinda, California State University Stanislaus, USA

Brie Tripp, University of California Davis, USA

Taylor Pierce, Gender-Inclusive Biology, USA

ABSTRACT

Science education continues to struggle with biological essentialism—a set of beliefs that social identities such as race and gender are “natural” and informative categories, rather than arbitrary and historically situated social constructs. In recent decades, research and policy has succeeded in identifying and promulgating strategies to disrupt various forms of biological essentialism; however, many of these efforts are now under political and legal attack. In this symposium, a diverse interdisciplinary team of researchers, practitioners, and policymaker/advocates will discuss the current state of efforts to disrupt racial and gender essentialism in K-12, undergraduate, and graduate science education, as well as future directions for research, policy, and practice in this domain in light of rising political authoritarianism.

Teacher AI Use, AI Literacy, & Teacher Reasoning

Strand 12: Technology for Teaching, Learning, and Research

21-Apr-26, 8:15-9:45

Location: Jefferson B (L4)

Stand-Alone Paper

Neuroadaptive AI using Brain Computer Interfaces for Science Text Accessibility

Richard Lamb*, University of Georgia, USA

Danielle Malone, Purdue University, USA

Tosha Owens, East Carolina University, USA

Ikseon Choi, Emory University, USA

Shruti Kundu, University of Georgia, USA

ABSTRACT

This study explores the use of neuroadaptive artificial intelligence (AI) to support students with dyslexia in reading and comprehending science curriculum materials. Using functional near-infrared spectroscopy (fNIRS) and a convolutional neural network (CNN), we classified cognitive demand in real time and dynamically adjusted science text features. Results from 100 students (50 with dyslexia) showed significant gains in reading comprehension and test performance when text was adapted based on neurocognitive feedback. The CNN achieved 86% classification accuracy, enabling personalized support. Findings highlight the potential of neuroadaptive AI to enhance accessibility and learning outcomes for students with reading disabilities, with implications for inclusive science education and future AI design.

Stand-Alone Paper

Applying the PCK Framework to Educators' Analysis of AI-Generated STEM Problems

Stephen Trembath-Reichert*, North Carolina State University, USA

Cesar Delgado, North Carolina State University, USA

Brayan Diaz, Utah State University, USA

ABSTRACT

This qualitative study investigates how STEM educators evaluate Large Language Model (LLM)-generated problems and explanations using the Pedagogical Content Knowledge (PCK) framework. Sixteen pre- and in-service master's students in a STEM education course prompted ChatGPT, Gemini, Claude, and Llama to generate, solve, and explain classroom-appropriate problems. Participants analyzed the outputs for content accuracy (CK) and pedagogical value (PK/PCK). A subsequent deductive content analysis further classified findings within six PCK components, and inductive coding identified emergent themes. Educators reported 120 PK/PCK issues versus 42 CK issues, indicating a greater deficit in pedagogical quality than in factual accuracy. Common issues included explanations inappropriate for the target student level, absence of content-relevant instructional techniques, and problems too simplistic to assess higher-order thinking. Positive findings included curricular alignment, clear procedural explanations, and occasional anticipation of misconceptions. The results suggest that current LLMs may serve as effective generators of problem statements but are less effective in providing instructionally sound explanations for students. Implications include the need for explicit preparation in prompt engineering and systematic evaluation of AI outputs in teacher education.

Stand-Alone Paper

K-12 Science Teachers' GenAI Use as Situated in their School Contexts and Pedagogical Orientations

Drew Nucci*, WestEd, USA

Joshua Rosenberg*, University of Tennessee - Knoxville, USA

Sarah Nielsen, WestEd, USA

ABSTRACT

This qualitative case study examined how 15 K-12 STEM teachers across the Pacific Northwest use generative AI (GenAI) for instructional tasks and how their use is situated within their pedagogical orientations and school contexts. Through 90-minute semi-structured interviews with teachers and 60-minute interviews with their colleagues, we identified 80 distinct GenAI use cases, with 32 focused on science content. Using an ecological perspective on technology adoption and an adapted SAMR framework, we analyzed whether GenAI use was substitutive, amplified, or transformative in providing learning opportunities for students.

Findings revealed that teachers' GenAI adoption patterns aligned closely with their pedagogical orientations and were significantly influenced by social and institutional contexts. Teachers with traditional, teacher-centered approaches in under-resourced, isolated environments primarily used GenAI for efficiency gains. Teachers with student-centered orientations in collaborative, well-supported contexts demonstrated transformative applications, such as having students use GenAI to generate lab procedures for their own research questions. Teachers with student-centered beliefs but limited institutional support showed mixed patterns, including transformative use for professional learning. These findings highlight how contextual factors create differential opportunities for innovative technology integration, potentially exacerbating educational inequities and emphasizing the need for systemic support structures beyond individual teacher training.

Stand-Alone Paper

How Science Teachers Use AI: A Descriptive Portrait from a National Survey

Joshua Rosenberg*, University of Tennessee, Knoxville, USA

Shawon Sarkar, University of Washington, USA

Lief Esbenshade, University of Washington, USA

Drew Nucci, WestEd, USA

Sarah Nielson, WestEd, USA

Ann Edwards, WestEd, USA

Alex Liu, University of Washington, USA

Zewei (Victor) Tian, University of Washington, USA

Zachory Zhang, Colleague.AI, USA

Min Sun, University of Washington, USA

ABSTRACT

Artificial intelligence is reaching science classrooms, but how teachers use it remains unclear. We report results from a national survey of 566 U.S. public-school science teachers (RAND American Educator Panel, 2025). We defined generative AI as tools that create content or automate tasks using large data patterns. About half of teachers reported any use of GenAI; roughly one in four use it weekly or daily. Use concentrates on teacher-facing work—planning lessons (40%) and creating assignments or assessments (32%)—with smaller shares for in-class support, differentiation, and routine paperwork. Only 5% said they teach students to use GenAI as a learning tool. About a quarter said GenAI has changed how they interact with students, most often through more personalization, better support for varied needs, and more ways to explain difficult ideas. Teachers also reported limited student use overall. Taken together, GenAI currently functions more as a planning assistant than a classroom learning tool. We close by outlining implications for professional learning, classroom-ready resources, and policy.

Epistemic practices and socioscientific issues

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

21-Apr-26, 8:15-9:45

Location: Virginia (L4)

Stand-Alone Paper

The way from science education to informed decision-making is paved by epistemic humility

Ayelet Baram-Tsabari*, Technion - Israel Institute of Technology, Israel

Yael Rozenblum, Technion - Israel Institute of Technology, Israel

ABSTRACT

Recent calls emphasize the role of science education in fostering student's awareness of their epistemic dependence, particularly by promoting epistemic humility and epistemic trust as essential components of informed decision-making. Yet, empirical support for this claim is limited. This study addresses the gap by examining the relationships between science education, epistemic dependence, and science-related decision making. Two questionnaires were distributed among two representative adult samples: one with (N=500) and one without (N=800) compulsory science education, during the COVID-19-pandemic. Epistemic trust was defined as judging source credibility, and epistemic humility as awareness of one's limited knowledge. Informed decision-making was measured by (1) accepting experts' guidelines (2) relying on health-related justifications in two COVID-19-related dilemmas.

We found that respondents who expressed higher levels of epistemic trust and humility were more likely to make informed decisions. Second, science education was positively associated with epistemic trust and humility, suggesting that even a small dose can affect awareness of epistemic dependence. Finally, while science education did not directly predict informed decision-making, it did predict epistemic humility, which predicted reliance on health-related justifications. This implies the dual usefulness of science education in both promoting epistemic humility as an end goal and achieving informed decision making.

Stand-Alone Paper

Beyond Building: Teacher Discourse and the Development of Elementary Students' Epistemic Engineering Practices

Zoubeida Dagher*, University of Delaware, USA

Maisha Mouli, University of Delaware, USA

Jennifer Gallo-Fox, University of Delaware, USA

Faezeh Vahdat Nia, University of Delaware, USA

Tyler Van Buren, University of Delaware, USA

ABSTRACT

Teachers play a critical role in supporting the development of students' conceptual understanding and creative problem solving through a variety of productive discourse moves that aim to engage them in engineering design material and discursive practices. This

study analyzes teaching discourse during a pilot implementation of an aquatic soft robotics engineering design curriculum unit, in which elementary students were challenged to design an aquatic robot over 13 instructional sessions. Using a deductive discourse analysis, we analyzed disciplinary teaching discourse in terms of the extent to which it provided opportunities for students to engage with the epistemic practices of engineering (EPE) during the unit's pilot implementation (Cunningham & Kelly, 2017). The results indicate that certain EPE were more prevalent than others in specific lessons, while very few were consistently present across all lessons. When the individual EPE are subsumed under four broad categories, we noted a more consistent representation of these practices across the unit's lessons. This study demonstrates a methodological pathway for capturing provisional EPEs moves in teaching discourse which can be used to evaluate and improve instruction of engineering design curricula.

Stand-Alone Paper

Students' identities as a precursor to accuracy reasoning orientations and evidence evaluation in socioscientific contexts

Jenny Dauer*, University of Nebraska-Lincoln, USA

Rachel Waring-Sparks, Illinois State University, USA

William Romine, Wright State University, USA

Gale Sinatra, University of Southern California, USA

ABSTRACT

Given the importance of helping students navigate a complex information landscape in a post-truth era, we need to understand how individual students interact with evidence in classrooms in the context of controversial socioscientific issues (SSI). Within an undergraduate classroom, we found that students' identities predicted their self-reported accuracy reasoning orientation, though to a greater extent in the controversial, local issue of water conservation in agriculture than in a large-scale issue of plastic pollution, likely as a result of background and identities. In particular, political ideology was a strong driver of self-reported reasoning orientation for the water conservation SSI. Students' directional reasoning did not significantly predict the accuracy of their evidence use in coursework when we analyzed students' reasoning using a rudimentary quantitative comparison of their assignment to experts. However, a qualitative analysis of students' rationales in their written coursework indicated that directional reasoning oriented students were more likely to not refer to any evidence, avoid evidence or be misaligned with experts in their interpretation of the evidence. Instructors need awareness of students' identities to create inclusive and open-classrooms. More extensive studies are needed, along with clear recommendations for instructors on how to navigate politically polarizing topics in the classroom.

Reasoning, Agency, and Inquiry in Socioscientific and Climate Issues

Strand 14: Environmental Education and Sustainability

21-Apr-26, 8:15-9:45

Location: Jefferson A (L4)

Stand-Alone Paper

Integrating Artificial Intelligence into Gene Editing: A Controversy Mapping Approach to Students' Socio-Scientific Reasoning

Yi-Ning Huang*, Graduate Institute of Science Education, National Taiwan Normal University, Taiwan

Shiang-Yao Liu, Graduate Institute of Science Education, National Taiwan Normal University, Taiwan

ABSTRACT

As Artificial Intelligence (AI) increasingly intersects with biotechnology, novel ethical dilemmas arise that demand interdisciplinary educational responses. This study investigates a five-week socio-scientific issue (SSI)-based intervention, integrating AI and gene editing to high school students' learning. A mixed-methods pre/post design assessed students' knowledge, socio-scientific reasoning (SSR), and ethical stances, and included a final controversy mapping task. Results revealed significant gains in both AI and gene editing knowledge and overall SSR skills. The evolution of students' stances showed that: after learning the biological foundations, more students shifted toward opposing embryonic editing; following the introduction of AI concepts, a notable portion of previously opposing students moved to a neutral stance on therapeutic applications, suggesting a more nuanced re-evaluation of risk. Content analysis of the final controversy maps illustrated students' cognitive development through structurally complex representations centered on moral and scientific dimensions. The analysis of connection types showed that students primarily employed causal and influence-based reasoning (57.1%) to explore technological consequences, alongside a notable proportion of ethical/conflictual links (29.3%). These findings underscore the educational potential of integrating AI and gene editing within SSI-based instruction, contributing to emerging interdisciplinary approaches in science education.

Stand-Alone Paper

Knowledge, Reasoning, and Confidence: Developing an Instrument to Assess Understanding of Socioscientific Issues

Melike Hanedar, University of Maryland, USA

Janelle Bailey*, Temple University, USA

ABSTRACT

Students' reasoning about socioscientific issues may be goal-directed toward accuracy (i.e., wanting to be correct in an explanation) or toward a desired conclusion (i.e., wanting to support their existing belief). We have developed the Reasoning About Socioscientific Issues (RASSI) measure, a three-tier instrument to gauge students' knowledge, reasoning, and

confidence in that reasoning around Earth and environmental science topics such as the causes of climate change, impact of climate change on extreme weather events, and the availability of freshwater resources. Using a web-based platform (Prolific) to recruit nearly 500 U.S.-based adults, we split the responses into two groups and conducted first an Exploratory Factor Analysis and then a Confirmatory Factor Analysis on the respective groups. Various fit indices show acceptable to good fit for a single-factor model on each of the three parts of the RASSI (EFA). CFA results are similar, though further refinement of the measure may be warranted. Future efforts will focus on expanding the participants to include middle, high, and college students and to use the instrument to gauge potential changes over instruction.

Stand-Alone Paper

Inquiry-based climate change education: Kindergarten teachers' enactments of scientific, personal and social inquiry

Jingwen Song*, University of Southampton, United Kingdom

Andri Christodoulou, University of Southampton, United Kingdom

Wonyong Park, University of Southampton, United Kingdom

ABSTRACT

Compared with other school stages, climate change education (CCE) for kindergarten-aged children is often insufficient. The main reason for this lies in the complexity of the climate change topics, which challenges their cognitive development level. However, young children have the right to understand the world they live in and to take adaptive actions accordingly. This study is a qualitative case study, which aims to explore how two kindergarten teachers enacted three types of inquiry (personal inquiry, scientific inquiry and social inquiry) of a socioscientific inquiry-based approach, for teaching climate change adaptation in the context of extreme heat in Shanghai, China. Semi-structured interviews, classroom observation and teachers' reflection journals were collected and analyzed qualitatively. The findings indicate that teachers enacted inquiry-based strategies age-appropriately, while considering climate change as a socioscientific issue: (1) Personal inquiry - encouraging students with others' reasoning to express different personal opinions related to climate change controversy; (2) Scientific inquiry - linking students' observed phenomena to scientific explanations as evidence for climate change decision-making; (3) Social inquiry - simulating the democratic participation process to teach about the impacts of climate change, while integrated with early childhood health education.

Sandra K. Abell Institute for Doctoral Students Poster Symposium

21-Apr-26, 8:15-9:45

Location: Redwood AB (L2)

Administrative Session

Organizers

Christa Haverly, Chicago Public Schools, Chicago, IL, USA

Jason Buell, Northwestern University, Evanston, IL, USA

Brian Reiser, Northwestern University, Evanston, IL, USA

Yang Zhang, Northwestern University, Evanston, IL, USA

Contributors

Bolaji Bamidele, Utah State University

Jessica Bautista, University of Michigan

Linsey Brennan, Michigan State University

Brandi Cannon-Force, Stanford University

Bradley Davey, Northwestern University

Genelle Diaz-Silveira, Boston University

Ruth Edri, Technion Israel Institute of Technology

Spencer Eusden, University of Nevada

Sarah Fogelman, Boston College

Alejandra Frausto Aceves, Northwestern University

Leticia Garza, University of Texas at Austin

Loraine Glidewell, University of Colorado Boulder

Daisy Haas, University of Michigan

Nicholas Leonardi, University of Illinois Urbana-Champaign

Josh Modeste, Teachers College, Columbia University

Joshua Mogyoros, University of Toronto

Eva Nelson, University of Minnesota Twin Cities

Kyle Nolting, University of Denver

Adepeju Prince, Kent State University

Muhammad Guntur Purwanto, University of Minnesota Twin Cities

Ester Shinana, Rhodes University

Clara Smith, Brigham Young University

Jamie Steiner, University of North Carolina at Chapel Hill

Matt Stewart, University of Washington

Stephanie Tracey, Clemson University

Grace Tukurah, Michigan State

Jasmyne Yeldell, University of North Carolina at Chapel Hill

Hannah Ziegler, Vanderbilt University

Jill Zipperer, Texas State University

Faith Zondi, Witwatersrand University

Abstract

The Sandra K. Abell Institute for Doctoral Students was established to support the professional development and education of doctoral students involved in the study of science education. Over the years, the Abell Institute has provided a space for doctoral students to establish a community within and to build long-lasting relationships with peers and mentors. will present posters that highlight how their work developed over the course of the intensive week-long institute. In this session, Emerging Scholars from the 2025 Abell Institute hosted by Northwestern University will present their research.

Quality Peer Review: Training with the Journal of Ethnographic and Qualitative Research

21-Apr-26, 8:15-9:45

Location: Willow A (L2)

Administrative Session

Organizers

Brock Couch, Baltimore County Public Schools, USA

Sabrina Stanley, University of Northern Alabama, USA

Contributors

Amy Barry, University of Nebraska-Lincoln, USA

Justin Andersson, University of Nebraska at Omaha, USA

Le Kang, Gardner-Webb University, USA

Paige Hespe, University of Nebraska-Lincoln, USA

Abstract

High-quality peer reviews are crucial to academic discourse in literature, particularly among the constellation of qualitative methodologies in educational research and across other disciplines. Abundant literature supports the effectiveness of training programs on peer reviewers': development of skills; increases in self-efficacy to reviewing manuscripts; and developing reviewer's own writing skills. Despite benefits of training programs, many graduate programs neglect to include formal peer review training. This point is critical given that most doctoral students will engage in review work at some point post graduation. Participants of this workshop will be better positioned to provide actionable feedback necessary to increase rigor in qualitative literature while developing their own skills. Peer review is essential quality-control for the scholarly discussion that takes place through academic publications. Peer review leads to better understanding of the publication process, connectedness to one's field of expertise, and collaborations with editorial boards (Sage, 2025). Peer review training programs can be effective for increasing the rigor of published

research manuscripts across numerous disciplines (Andersson et al., 2022; Bruce et al., 2016; Buser et al., 2023; Schroter et al., 2008), particularly for preparing graduate students to excel in academia, thereby potentially strengthening research capacity. Peer reviewer training can be effective in enhancing reviewers' own writing skills (Lundstrom et al., 2009; Janke et al., 2017). Training that develops capacity for supportive and productive revision of manuscripts will help address the unfortunate, sometimes harsh treatment of author, especially those who are not writing in their native language (Buser et al., 2023).

Advancing AI in Science Education (AASE): Envisioning Responsible and Ethical Practice

21-Apr-26, 8:15-9:45

Location: Aspen (L2)

Administrative Session

Organizers

Xiaoming Zhai, University of Georgia, USA

Joe Krajcik, Michigan State University

Kent Crippen, University of Florida, USA

Contributors

Lei Liu, ETS, USA

Ross Nehm, Stony Brook University, USA

Cyeong-Geon Lee, Nanyang Technological University

Jamie Mikeska, ETS, USA

Xiufeng Liu, University of Macao, China

Marcus Kubsch, Free University Berlin, Germany

Kevin Haudek, Michigan State University, USA

Knut Nuemann, Leibniz Institute for Science and Mathematics Education

Okhee Lee, New York University, USA

Yizhu Gao, University of Georgia, USA

Abstract

This session explores how artificial intelligence (AI) can be thoughtfully and responsibly integrated into science education to promote high-quality learning opportunities for all students. Supported by NSF (2332964), the RAISE co-chairs convened an international committee of experts in AI and science education to collaboratively envision the future of AI in K–12 contexts. The committee's early findings highlight both the transformative potential of AI—such as generative tools like ChatGPT—and the ethical considerations required to ensure its use upholds fairness, academic integrity, and accessibility. Presenters will introduce a conceptual

framework that aligns 3-dimensional learning with responsible and ethical principles for AI integration. This session invites educators, researchers, policymakers, and technology developers to engage in dialogue around opportunities, challenges, and pathways for shaping a trustworthy and ethically grounded future of AI in science education.

What is in a Name? Problematizing Terminology in Educational Research and Praxis

21-Apr-26, 8:15-9:45

Location: Issaquah AB (L3)

Administrative Session

Organizers

Miriam Ortiz, The University of Texas Rio Grande Valley, USA

Alejandro Gallard, Georgia Southern University, USA

Enrique Suarez, University of Massachusetts, Amherst, USA

Alexander Eden, Salem State University, USA

Uma Ganesan, The University of Texas Rio Grande Valley, USA

María González-Howard, The University of Texas at Austin, USA

Angela Chapman, The University of Texas Rio Grande Valley, USA

Contributors

Uma Ganesan, The University of Texas Rio Grande Valley, USA

Angela Chapman, The University of Texas Rio Grande Valley, USA

María González-Howard, The University of Texas at Austin, USA

Enrique Suarez, University of Massachusetts, Amherst, USA

Alejandro Gallard, Georgia Southern University, USA

Miriam Ortiz, The University of Texas Rio Grande Valley, USA

Alexander Eden, Salem State University, USA

Abstract

Language is never neutral. The terms that educational researchers and educators assign and/or use to describe learners, communities, and practices are deeply connected to power, identity, and equity. This administrative session brings together scholars who intentionally interrogate and navigate the language of educational research. Panelists will share the underlying positionalities, identities, dispositions, and how rationales that guide their use or rejection of particular terms in their scholarship. They will also discuss the impact of terminology on their methodological approaches, data analysis, and interpretations, as well as on the communities with whom they partner. Attendees will be invited to reflect on their own use of terminology and engage in a plática about the tensions, possibilities, and responsibilities that come with classifying, designating, or labeling their research and praxis.

This session will nurture collaborative insight and critical reflection into how scholars can move toward more just practices in educational research.

Interdisciplinary Thinking and the Development of STEM Identity

Strand 2: Science Learning: Contexts, Characteristics and Interactions

21-Apr-26, 10:00-11:30

Location: Columbia (L4)

Stand-Alone Paper

Students' Interest in Physics - An Exploratory Quantitative Study

Hermann Lidberg*, Institute for Physics Didactics - Goethe University Frankfurt am Main, Germany

Roger Erb, Institute for Physics Didactics - Goethe University Frankfurt am Main, Germany

ABSTRACT

Young people's interest in scientific topics has been investigated in large-scale studies (IPN Interest Study (1998), ROSE Study (2010)). According to Zoechling (2023), contexts can be classified into several levels based on the proportion of students who find them interesting. This suggests that young people only find physics interesting when it is embedded in specific contexts that they perceive as relevant. According to Krapp & Prenzel (1992), interest can develop when a person repeatedly engages with an object of interest in learning situations. If a learning situation is appealing, situational interest in the object of interest arises. Through repetition, this interest becomes increasingly internalized and turns into an individual interest.

To determine the reasons why certain topics are perceived as interesting by young people, a questionnaire was designed based on interview results to provide a quantitative assessment of the relevance of certain situations described by the interviewed students. Topics that generally interest young people are compared with those from the fields of physics, history, and biology that they also consider interesting. PCA and regression analyses were conducted to examine the questionnaire data. The results of the survey are presented in this article.

Stand-Alone Paper

STEM identity and STEM career intention: A meta-analysis

Zhimeng Jiang*, University of Macau, Macao

Xiaowei Tang, University of Macau, Macao

Lihua Tan, University of Macau, Macao

Bing Wei, University of Macau, Macao

ABSTRACT

STEM identity is increasingly recognized as an important factor shaping students' intention to pursue careers in science, technology, engineering, and mathematics (STEM). However, empirical studies have reported inconsistent effect sizes, raising uncertainty about the strength and generalizability of this relationship. This meta-analysis synthesizes findings from 35 quantitative studies (75 effect sizes) covering secondary to postgraduate populations across various STEM disciplines. Using a random-effects, three-level meta-analysis in R, we estimated an average weighted correlation of $r = .47$ ($SE = .04$, $p < .001$) between STEM identity and STEM career intention. Moderator analyses revealed significant variation by identity type (i.e., science identity and physics identity), gender, and interactions between identity type and some demographic characteristics, while other factors such as score calculation and temporal design were non-significant. These findings suggest that STEM identity is a meaningful but not uniformly strong predictor of career intention, and its impact depends on disciplinary, gendered, and contextual factors. This nuanced understanding highlights the need for targeted, identity-based interventions to strengthen and diversify STEM career pipelines.

Stand-Alone Paper

A Study on Cultivating Students' Interdisciplinary Thinking in Chemistry Teaching

Shaoke ZHANG, Shandong Normal University, China

Shanshan LU*, Shandong Normal University, China

ABSTRACT

This study investigates the constitutive elements of interdisciplinary thinking and analyzes the characteristics of learning activities that foster its development. Four key elements were identified: (1) identifying relevant knowledge from other disciplines based on a problem; (2) organizing knowledge to form an interdisciplinary consensus; (3) synthesizing disciplinary differences to develop an interdisciplinary understanding; and (4) applying this understanding to solve new problems. Using a quasi-experimental design, the study involved 227 tenth-grade students from a key high school, with intervention effects assessed via independent-samples t-tests comparing post-test scores between groups. Results revealed variations in both overall levels and developmental patterns across the elements. Students performed best in identifying relevant knowledge but struggled most with organizing interdisciplinary consensus. Notably, instruction incorporating interdisciplinary learning activities significantly enhanced student performance in three elements: organizing interdisciplinary consensus, synthesizing disciplinary differences, and applying interdisciplinary understanding.

Stand-Alone Paper

Influence of Disposition toward Scientific Uncertainty Navigation and Epistemic Curiosity on Students' Learning Engagement

Bukola Akinbadewa*, Arizona State University, USA

Ying-Chih Chen, Arizona State University, USA

Michelle Jordan, Arizona State University, USA

Jongchan Park, University of Georgia, USA

Carlos Meza-Torres, Arizona State University, USA

ABSTRACT

This study investigated how students' dispositions toward scientific uncertainty navigating (DSUN) and epistemic curiosity (EC) influence learning engagement in an inquiry-based science unit on solar energy, using the Students' Uncertainty as a Pedagogical Resource approach. Survey data were collected from 786 middle and high school students taught by 16 science teachers with varying professional development exposure. Polynomial multiple regression with teacher-clustered robust standard errors showed that DSUN had a positive linear ($b = 0.695$, $p < 0.001$) and quadratic effect ($b = 0.193$, $p < 0.001$), indicating accelerated engagement at higher levels. EC had a steady positive linear effect but no quadratic effect. A significant interaction revealed that the benefits of DSUN were greatest among students with lower EC ($b = -0.002$, $p < 0.001$). Dimension-level analysis further revealed that epistemic orientation, positive affect, self-efficacy, and uncertainty strategies predicted higher learning engagement, while negative affect did not. The findings underscore the importance of designing learning environments that normalize ambiguity, encourage reflection, and provide space for exploration and feedback during scientific inquiry.

Young Learners, Big Questions: Multiple Lenses for Understanding Early Science Education within a Single Program

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

21-Apr-26, 10:00-11:30

Location: Juniper (L2)

Related Paper Set

From Nature Walks to Bloomz Posts: How Preschool Educators Communicate about Science with Families

Tamara Turski*, University of Delaware, USA

ABSTRACT

This qualitative case study explores how preschool educators communicate with families about children's inquiry-based science learning. Drawing on Bronfenbrenner's Ecological Model (1979), the study examines how communication within the home-school mesosystem supports early science development. Interviews with three educators from a nature-based program were thematically analyzed, revealing four themes, (1) types of communication, (2) science-specific communication, (3) challenges in communication, and (4) efforts to build home-school science connections. Educators used varied methods (e.g., including face-to-face, emails, and Bloomz app) to share updates and encourage family engagement. Communication often focused on nature and included prompts to extend learning at home.

Despite efforts to foster collaboration, time constraints and one-way exchanges remained barriers. Findings highlight the importance of supporting educators in developing reciprocal communication practices that strengthen science learning across contexts.

Related Paper Set

Engaging Two- and Three-year-olds in Science and Engineering: A Case-Study

Subrina Niranjana*, University of Delaware, USA

Jennifer Gallo-Fox, University of Delaware, USA

Maisha Mouli, University of Delaware, USA

Ariadni Kouzeli, University of Delaware, USA

ABSTRACT

Addressing equity in early childhood requires comprehensive approaches, including quality STEM instruction. This case study of how one teacher addressed the NGSS Disciplines in her half-day two- and three-year-old classrooms' science curricula. The curriculum was developmentally appropriate, child-centered, play-based, place-based, and holistic. Findings and developmentally appropriate teaching practices will be shared.

Related Paper Set

Splash, splash, squish, crack: Young children explore water concepts through play-based learning

Maisha Farzana Mouli*, University of Delaware, USA

Subrina Niranjana, University of Delaware, USA

Jennifer Gallo-Fox, University of Delaware, USA

Ariadni Kouzeli, University of Delaware, USA

ABSTRACT

Looking across year-long data sets of teacher communications with families from the five classrooms, researchers examine how teachers supported young children ages 2-6 years-old to explore water-related concepts. Findings present the multiple ways teachers explored water concepts with young children through water play, studies of ice and mud, and creek exploration thus illustrating developmentally appropriate play-based science learning across a trajectory of early years. Analysis utilizes a NGSS three-dimensional learning framework including all science practices, cross-cutting concepts, and disciplinary core ideas.

Related Paper Set

Interdisciplinary science and creative arts instruction in a nature-based preschool classroom

Ariadni Kouzeli*, University of Delaware, USA

Jennifer Gallo-Fox, University of Delaware, USA

ABSTRACT

This case study investigates how a high-quality preschool teacher incorporates science and creative arts into her nature-based year-long curriculum. The goal of this study is to explore how an exemplary nature-based preschool teacher integrated STEAM activities into her nature-based year-long curriculum. Findings present activities for music, drama, and visual arts, which include science in a nature-based preschool classroom.

AI and Computational Tools Transforming Science Learning

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

21-Apr-26, 10:00-11:30

Location: Cedar AB (L2)

Stand-Alone Paper

ChatGPT-Generated Socioscientific Issues in the Context of Systems Thinking: Affordances and Limitations

Wardell Powell*, Framingham State University, USA

Steven Courchesne*, Framingham State University, USA

Dana Zeidler*, University of South Florida, USA

ABSTRACT

Teaching high school students to engage with socioscientific issues (SSI) using systems thinking provides them with opportunities to search for solutions to ill-structured problems. Teachers face challenges in developing curriculum for students to engage in systems thinking. This study investigated whether generative AI can assist educators with creating meaningful learning experiences, exploring the affordances and limitations of using ChatGPT to design a high school instructional unit on the Environmental Protection Agency's Good Neighbor Plan. Using document analysis, researchers evaluated a ChatGPT-generated unit plan, including revisions in response to follow-up prompts, utilizing a systems thinking taxonomy with a high degree of consensus that encompasses seven critical components (Stave & Hopper, 2007). Although ChatGPT produced a structured, standards-aligned unit plan with opportunities for basic systems thinking, it lacked specificity, included inaccuracies, and failed to support intermediate or advanced systems thinking without substantial human intervention. Follow-up prompting improved the depth of some activities but did not elevate them beyond a basic surface structure level of systems thinking. The study highlights the potential of generative AI as a starting point for lesson planning, while emphasizing the need for teacher expertise to ensure pedagogical rigor and accuracy.

Stand-Alone Paper

Potential of ChatGPT to promote health and assessment literacy among students with regard to e-cigarettes

Helena Aptyka*, Institute for Biology Education, Faculty of Mathematics and Natural Sciences, University of Cologne, Germany

Alessio Ciaccia, Institute for Biology Education, Faculty of Mathematics and Natural Sciences, University of Cologne, Germany

Kirsten Schlüter, Institute for Biology Education, Faculty of Mathematics and Natural Sciences, University of Cologne, Germany

Jörg Großschedl, Institute for Biology Education, Faculty of Mathematics and Natural Sciences, University of Cologne, Germany

ABSTRACT

Health literacy (i.e., the ability to critically evaluate and apply health-related information) is a key science competency, particularly urgent amid rising e-cigarette use among teenagers and limited prevention-oriented teaching materials. This mixed-method experimental study examined whether AI-supported learning via ChatGPT could enhance secondary students' health and assessment literacy on e-cigarettes compared to traditional worksheets.

Participants (N = 27, grades 7–9) were randomly assigned to a ChatGPT group (EG) or worksheet group (CG). The intervention involved: acquisition of scientific knowledge on vaping, and application to a moral–ethical peer-pressure dilemma using the WAAGER-model. Pre-post-test measures assessed knowledge, assessment literacy, self-efficacy, motivation, and risk perception; qualitative data from transcripts and worksheets documented students' assessments. No significant pre-post-test gains emerged for most variables; only risk perception increased significantly in the EG. Moderate-to-large effect sizes suggest possible Type II errors due to the small sample. Qualitatively, both groups engaged with the content and identified health risks. ChatGPT prompted richer technical detail but less structured reasoning; worksheets yielded more organized responses. Findings provide empirical insight into integrating AI-supported learning on health-related issues, highlighting that ChatGPT's potential is maximized when paired with explicit WAAGER-model scaffolds fostering structured dilemma assessments.

Culturally Informed STEM Instruction

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

21-Apr-26, 10:00-11:30

Location: Willow B (L2)

Stand-Alone Paper

When Stories Belong, Students Belong: A Quantitative Study of Culturally Responsive Teaching in Introductory Biology

Hannah Gill*, California State University, Fresno, USA

Emily Walter, California State University, Fresno, USA

ABSTRACT

Persistence in STEM remains uneven across historically minoritized groups, with underrepresented minority (URM) students experiencing disproportionately high attrition in high-stakes “weed-out” STEM courses. Culturally responsive teaching (CRT) is one strategy to change this narrative by centering students’ cultural knowledge in course content. This approach has shown promise in qualitative studies, but quantitative research on CRT in postsecondary STEM classrooms is limited. In this project, we conducted a quantitative pre/post study across two sequential semesters (N = 296) to examine the impact of a 50-minute CRT lesson in an introductory cell and molecular biology course on science identity at a Hispanic-Serving and AANAPISI institution. We measured impacts using the valid and reliable 24-item Student Science Identity instrument (SSI; Chen & Wei, 2020; Cronbach’s $\alpha = 0.95$). Analyses showed that students who attended the lesson scored significantly higher on multiple science identity competence and recognition items than non-attenders. Pre-intervention gaps between URM and non-URM students in performance, recognition, and interest domains were also no longer significant post-intervention, suggesting the lesson helped narrow identity disparities. These findings provide empirical evidence for the potential of CRT to promote equity in postsecondary STEM contexts and can offer actionable lesson strategies for educators.

Stand-Alone Paper

A Meta-Analysis of Culturally Relevant, Responsive, and Sustaining Pedagogies in Higher Education Classrooms

Vivian Nguyen*, California State University, Fresno, USA

Alexa Valdez*, California State University, Fresno, USA

Allison Vang*, California State University, Fresno, USA

Danielle Vu*, California State University, Fresno, USA

Anna Lee, California State University, Fresno, USA

Emily Walter, California State University, Fresno, USA

ABSTRACT

This qualitative meta-analysis synthesizes nearly three decades (1996–2024) of research on culturally sustaining, relevant, and responsive (CSRR) pedagogies in postsecondary education, with a particular focus on STEM disciplines. While prior meta-analyses have

demonstrated the benefits of CSRR in K–12 contexts, this is the first synthesis in almost a decade, and the only one focused exclusively on higher education. We analyzed 57 empirical studies using an integrative mixed-methods review approach, coding for methodology, disciplinary context, implementation level, and the benefits and barriers of CSRR. Most studies were qualitative ($n = 43$), with STEM disciplines underrepresented ($n = 14$). Benefits included authentic learning environments, collaborative learning, and empowerment through instruction, yet few studies connected CSRR to STEM identity formation or career pathways. Challenges included tokenism, culturally disconnected examples, and faculty resistance or lack of CSRR knowledge. Underexamined areas include linguistic diversity, Indigenous Knowledge integration, and race/ethnicity-specific impacts. Findings reveal a gap between institutional rhetoric and course-level implementation, highlighting missed opportunities for discipline-specific faculty development and curricula. By situating results in relation to prior K–12 syntheses, this study offers evidence-based strategies for embedding CSRR in STEM higher education, advancing science identity theory, and supporting the equity-focused transformation at NARST.

Stand-Alone Paper

The Conceptualizations and Enactments of Culturally-Informed Pedagogies among Higher Education Biology Instructors

Angelita Rivera*, Stanford University, USA

Shima Salehi, Stanford University, USA

ABSTRACT

STEM instructors face increasing calls to adopt culturally-informed pedagogies to improve inclusion and retention, yet many struggle to translate theory into practice. Drawing on the ecological model of faculty decision-making (Sansom et al., 2023), this qualitative study explores how biology instructors conceptualize and implement culturally-informed pedagogy. Through thematic coding and narrative inquiry on semi-structured, individual interviews with 15 instructors, we identify barriers and affordances at different ecological levels. We highlight one instructor, Elsa, whose rich narrative illustrates key tensions: inclusive pedagogy as a gateway, its integration into everyday practice, and the limits of such efforts in isolation. Findings underscore the need for multi-level support to sustain culturally-informed pedagogies in STEM, and offer insights for future professional development and institutional change.

Learning Through Play, Games & Immersive Experiences

Strand 6: Science Learning in Informal Contexts

21-Apr-26, 10:00-11:30

Location: Seneca (L4)

Stand-Alone Paper

Adult gamers' problem-solving, science, and mathematics experiences when playing Baldur's Gate 3 – a recreational game

Gina Childers*, Texas Tech University, USA

ABSTRACT

This proposal focuses on STEM problem-solving experiences embedded within Baldur's Gate 3's (a recreational video game) storylines and activities as an informal learning space for adults. The STEM Integrated Framework of Problem-Solving is a concept that was created to identify problem-solving domains in science, mathematics, engineering, technology, and computer science to guide the research design. Semi-structured interviews collected narrative stories of adult gaming experiences focused on documenting two facets of the gamers' (n=7) experiences: general gaming history and Baldur's Gate 3 gaming experiences. A qualitative thematic analysis was performed deductively (a priori) using a framework related to how problem-solving, science, and mathematics were experienced in Baldur's Gate 3 by adult gamers. The findings suggest that gaming experiences in Baldur's Gate 3 enable players to encounter STEM problem-solving experiences and utilize science and mathematical practices to advance in the game by identifying and explaining the observation skills, trial and error occurrences, mathematical thinking, using experiential data to revise models, and use existing information to make game-based decisions to address challenges. This provides insight in exploring how unique spaces, such as recreational gaming experiences for adults, may support the strengthening of science and mathematical thinking.

Stand-Alone Paper

Students' development of understanding of SEPs and STEM-related behaviors: An exploratory study

Su Gao*, University of Central Florida, USA

Shiva Jahani, University of Central Florida, USA

ABSTRACT

Science fairs have long been promoted as educational resources. As new standards provide an updated vision of science learning through actively engaging students in science and engineering practices (SEPs), research is needed to understand the impact of science fairs on students' learning. 168 students who participated in a state science and engineering fair responded to a survey in this study. Results from paired samples t-tests indicate that participation in the fair positively associated with students' gains in understanding of SEPs and engagement in STEM-related behaviors. Results from two multiple regression analyses show that: 1) Students internal motives for participating the state fair was positively

associated with their gains in understanding of SEPs and engagement in STEM-related behaviors; 2) Students who participated for external rewards were less likely to experience positive change in their understanding of SEPs and engagement in STEM-related behaviors ; 3) All other variables, such as grade level, ethnicity, parental education, and science class type that students took were not statistically significant related to students development in their understanding of SEPs and STEM-related behaviors.

Stand-Alone Paper

Reasoning in Levels: Facilitating Systems Thinking Skills in Science through Embodiment

Yetunde Mabadeje*, University of Iowa, USA

Kay Ramey, University of Iowa, USA

ABSTRACT

In recent years, science education has evolved from a focus solely on preparing future scientists to developing science literate citizens. A key strategy in achieving this is through the development of conceptual understanding of scientific phenomena. Although, research has demonstrated a strong correlation between conceptual understanding and the cultivation of systems thinking, fewer studies have engaged in the idea of systems thinking specifically at the elementary level. Therefore, this study takes on a playful embodied design framework to facilitate systems thinking regarding the circulatory system among elementary school children. Nine learners (ages 8-10) from a STEAM afterschool club in the Midwestern United States consented and participated in the study. An analysis of their words, actions, and drawings, utilizing interaction analysis and reflexive thematic analysis, reveals how these young learners demonstrated an understanding of different levels within a system, including micro, meso, and macro levels. The findings underscore that children are capable of engaging in systems thinking and makes a call towards engaging young people in systems thinking using embodied learning. Furthermore, it offers recommendations for designing learning environments that enhance systems thinking among young learners in line with their academic and developmental stages.

Noticing, Talk, and Discourse in Preservice Preparation

Strand 7: Pre-service Science Teacher Education

21-Apr-26, 10:00-11:30

Location: Boren (L4)

Stand-Alone Paper

Becoming a Caring Mentor: An Evolution of One Pre-Service Teacher's Perceptions of Science Classroom Discourse

Emelia Pelliccio*, Teachers College, Columbia University, USA

Felicia Mensah, Teachers College, Columbia University, USA

ABSTRACT

Productive and equitable discourse in science classrooms is essential not just for student learning but for supporting students' feelings of belonging and fostering interest in science. Facilitating this type of discourse is complex and therefore must be considered as an important component of the teacher education experience for prospective teachers. In this study, a rich description of one pre-service teacher's experience through the scope of their teacher education program is provided to understand how they make sense of student discourse in the science classroom and how their teacher education experiences contribute to that sensemaking. This study adds to this important literature around discourse in the science classroom by drawing on a positioning lens to understand how the role of the teacher and the students are conceptualized and navigated throughout the teacher education experience. Engaging in this from the perspective of preservice teachers is important in how it uncovers how the novice teacher grapples with this incredibly complex phenomenon of classroom discourse via their teacher education experiences. This will have important implications for the design of teacher education programs as well as for ways in which new teachers can be further supported once they enter the field as teachers.

Stand-Alone Paper

A Digital Video Ethnography Exploring Teacher Candidates' Radical Listening to Understand and Value Learners' Standpoints

Adam Devitt*, California State university, Stanislaus, USA

ABSTRACT

By including learners' standpoints in science teaching, radical listening shifts the emphasis of speaking and listening from simply understanding to genuinely valuing what students say. This study uses digital video ethnography to examine how beginning teachers enact radical listening and how it positions learners for science learning. Grounded in hermeneutics, feminist standpoint theory, and critical psychology, radical listening is conceptualized as creating space for learners to express their ideas with agency, actively working to understand without imposing bias, and engaging with those ideas as resources for shared meaning-making. Video clips from an afterschool science program were analyzed with teacher candidates three years after their participation, generating "thick interpretations" through multiple perspectives. The analysis focused on four components: Create a Safe Learning Environment, Understand and Expand the Learner's Standpoint, Value Learners' Standpoints by Testing and Evaluating, and Recognize Learning as Process and Product. Findings illustrate that when teacher candidates engaged in these components, they fostered equitable participation, deeper conceptual engagement, and student agency. This work highlights radical listening as both a pedagogical practice and an ethical stance, offering implications for education programs to intentionally develop radical listening practices that position students as capable contributors to their own ontological development as scientists.

Stand-Alone Paper

Putting Noticing Into Practice - Pre-Service Teachers' Efforts to Enact Instruction Centered Around Students

Heather Johnson*, Vanderbilt University, USA

Tara Barnhart*, Chapman University, USA

Miray Tekkumru-Kisa*, University of Illinois, USA

ABSTRACT

This study examines how three pre-service science teachers (PSTs) connected their developing noticing skills to instructional practice during the semester before student teaching. Using Bautista and Davis' Expansive Sensemaking framework, researchers analyzed PSTs' written work from video analysis tasks involving videos from their own and others' teaching episodes through typological analysis.

When analyzing accomplished teachers' videos, PSTs demonstrated critical evaluation skills, focusing on collaborative culture-building and student participation patterns. During their own teaching, PSTs designed inclusive participation structures and aimed to position students as epistemic agents. They encountered three primary challenges: asset-oriented (students did not engage as anticipated), equity-oriented (assumptions about student familiarity were incorrect), and participation-oriented (limited student-to-student interaction). However, PSTs located these challenges in their own instructional choices rather than student deficits, demonstrating an asset-based approach towards students and their thinking.

Findings reveal that while PSTs successfully planned student-centered instruction, enacting such teaching requires ongoing navigation of institutional pressures, student expectations, and developing facilitation skills. This research contributes to teacher education by highlighting the complexity of translating noticing skills into responsive practice and emphasizing the importance of reflective learning in preparing teachers for diverse classroom contexts.

Stand-Alone Paper

Teacher Candidate Noticing during a Video Analysis Task within Science Methods Courses Across Four Universities

Anna Arias*, Kennesaw State University, USA

Emilia Pelliccio*, Teachers' College, USA

Heather Johnson, Vanderbilt University, USA

Jessica Riccio, Teachers' College, USA

Lawrence Escalada, University of Northern Iowa, USA

Brett Criswell, West Chester University, USA

Michelle Forsythe, Texas State University, USA

Joshua Ellis, Louisiana State University, USA

ABSTRACT

Video analysis of a teacher practice can support the development of more effective and responsive teaching through the refinement of professional noticing. However, research on noticing that supports responsive teaching has commonly been studied in a single context. As part of this multi-site collaborative research focused on developing professional vision through video analysis tasks, this study uses a qualitative case study design to explore the links between responsive teaching and noticing in TCs' analyses of video records of teaching practice. At four different universities, teacher educators implemented the same series of video analysis tasks at the beginning of their science methods course. Using TCs' written analyses of the same video clips, this study investigates what secondary preservice science teachers notice at the start of their science methods coursework. The analyses revealed that TCs' attention and framing in their noticing varied both within and across universities. For example, at one university, nearly all TCs used an anti-deficit framing in their noticing, whereas at two others, most used a deficit or neutral framing. These findings provide new insights into how teachers develop professional noticing for responsive teaching within teacher education and beyond, having implications for teacher educators and researchers.

Exploring science teacher change across multiple dimensions

Strand 8: In-service Science Teacher Education

21-Apr-26, 10:00-11:30

Location: Issaquah AB (L3)

Stand-Alone Paper

Exploring Science Teachers' Attribution for Student Performance, Self-Evaluation, and Sources and Justification of Pedagogical Decision-Making

Grace Wan-Yue Zhan, National Taiwan Normal University, Taiwan

Fang-Ying Yang*, National Taiwan Normal University, Taiwan

ABSTRACT

This study explores how secondary science teachers attribute student performance, evaluate their teaching knowledge, and justify pedagogical decisions within Taiwan's educational context. Building on Ferguson and Bråten's (2022) framework, we developed three questionnaires with scenario-based and open-ended questions to explore science teachers' attribution for student performance, self-evaluation, and sources and justification of pedagogical decision-making. Five hundred secondary science teachers from varying backgrounds and experience participated in an online survey. Exploratory factor analysis and ANOVA were conducted to identify key elements in teachers' belief systems and examine differences across teaching experience and backgrounds. The results revealed that science teachers' perceptions and experiences were shaped by both personal-level factors (teaching experience) and communal-level factors (school type and size). Different school contexts placed varying demands on teachers regarding labor, responsibilities, and skills. These findings highlight the need for differentiated support in teacher education and

professional development, with early-career teachers requiring different guidance than those in large or full secondary schools. This study advances theoretical constructs in science education by moving beyond individualistic lenses to incorporate communal, social, and ideological layers, responding to calls for frameworks that account for structural factors in educational research.

Stand-Alone Paper

Noticing Inclusion in Argumentation: New Science Teachers' Perspectives on Classroom Discourse

Althea Roy*, Clemson University, USA

Meredith Schwendemann*, Binghamton University, USA

Xinyu He, University of Georgia, USA

Ella Yonai, Auburn University, USA

Julie Luft, University of Georgia, USA

Brooke Whitworth, University of South Carolina, USA

ABSTRACT

Teachers have many challenges in their early years of teaching. One such challenge is engaging students in Science and Engineering Practices (SEPs). The Framework for K-12 Science Education emphasizes an inclusive vision where all students are able to understand, interact with, and utilize science knowledge and practices in their everyday lives. Yet, teachers often find incorporating inclusive practices into their instructional routine challenging. This qualitative study utilizes a video of classroom instruction to examine new science teacher noticing around how teachers position students as knowledge generators—one element of an inclusive approach—when engaging in argumentation. Initial findings suggest that new teachers are beginning to build their views of argumentation and inclusive instruction. It was evident that many teachers could see an element of inclusion alongside argumentation; however, providing teachers with more opportunities to explore and discuss instruction in inclusive approaches to teaching science will further develop their reasoning about the SEPs as they were originally envisioned. The findings from this study help science teacher educators differentiate professional learning to further support the development of all teachers valuing and shifting their perspective of how students can and do engage with science and its applications in their lived realities.

Stand-Alone Paper

Leveraging Scientific Resources to Empower Teacher Professional Development in China

Fangfang Zhao*, East China Normal University, China

ABSTRACT

There is a growing emphasis on integrating scientific resources into K-12 science education to improve teaching quality and student outcomes. This study explores the impact of a national teacher professional development (PD) program designed for this purpose in China,

using a mixed-methods approach. Data from post-training and follow-up questionnaires were analyzed through the lens of boundary-crossing theory (Akkerman & Bakker, 2011) and Guskey's (2002) framework for evaluating PD effectiveness. Results indicated that while teachers reported positive experiences, enhanced knowledge, challenges remained in classroom application. Teachers' needs include exemplar lesson examples or teaching examples and engagement in real scientific research. The study highlights the crucial role of science education researchers at normal universities in facilitate the boundary crossing of scientific and educational communities to each other's world. And exemplar practical examples can serve as boundary objects to engage collaborative practices. Suggestions on the design and implementation of teacher PD programs featuring integration of scientific resources are provided.

Stand-Alone Paper

Comparative Case Study of Resource Use by Newly Hired Science Teachers Across Linguistic Classroom Settings

Paulo Augusto Carneiro Loureiro*, University of Georgia, USA

Emily Adah Miller, University of Georgia, USA

Ella Yonai, Auburn University, USA

Julie A. Luft, University of Georgia, USA

Shannon L. Navy, Kent State University, USA

ABSTRACT

This study examines how newly hired high school science teachers select and evaluate resources in varied linguistic classroom contexts, guided by van Lier's (2008) constructs of agency, affordance, and action. Two research questions were addressed: (1) How do newly hired science teachers explain their choice of resources, and what similarities and differences emerge across distinct linguistic settings? (2) How do shifts in linguistic setting influence a teacher's explanation about resource choice and quality? Using a comparative case study design, we analyzed three teachers over three years: one consistently in a multilingual setting, one in a monolingual setting, and one who transitioned from monolingual to multilingual. Data included surveys, classroom observations, and interviews coded for van Lier's constructs. Findings reveal that across contexts, social resources, as mentors and instructional coaches were most valued when they offered context-relevant affordances. In multilingual settings, teachers emphasized material resources that balanced content with linguistic accessibility, while human/personal resources often required adaptation to new student needs. For the transitioning teacher, previously ancillary resources became essential, and linguistic accessibility emerged as a central evaluative criterion. These results contribute to science teacher education by illustrating how agency, affordance recognition, and purposeful action shape early-career teachers' resource decisions.

Transgressing Boundaries Between Engineering Education, Multilingual Learners, and Community: Lessons from a Project's Creative Solutions

Strand 8: In-service Science Teacher Education

21-Apr-26, 10:00-11:30

Location: Willow A (L2)

Symposium

Transgressing Boundaries Between Engineering Education, Multilingual Learners, and Community: Lessons from a Project's Creative Solutions

Jerome Shaw, University of California, Santa Cruz, USA

Kirsten Daehler, WestEd, USA

Okhee Lee*, New York University, USA

Ashley Iveland, WestEd, USA

Nico Janik, WestEd, USA

Meghan Macias, WestEd, USA

Tanya Warren, WestEd, USA

Diana Aquilizan, San Diego Unified School District, USA

Paola Paz Soldan, Capistrano Unified School District, USA

ABSTRACT

The Next Generation Science Standards call for educators to incorporate the teaching of engineering with science instruction in K-12 classrooms in the United States. A sizable portion of students in those classrooms come from backgrounds in which English is not the first or native language; i.e., Multilingual Learners (MLs). However, studies have documented (a) the lack of engineering teaching occurring in elementary classrooms, (b) elementary teachers' expressed lack of preparation for teaching engineering, and (c) teachers' expressed lack of preparation for teaching MLs. Our project has developed and studied a model of professional learning designed to enhance elementary teachers' understanding of and capacity to effectively engage in teaching engineering, teaching MLs in general, and teaching engineering to MLs in particular. In this symposium, we present the model along with results from both quantitative and qualitative analyses of its implementation with a cohort of fourth grade teachers of MLs during the 2024-25 school year. The symposium is designed to engage participants in small group discussions about issues related to this subject from a variety of perspectives — practitioners, professional learning providers, researchers, and policy makers. Contributors (including teachers, facilitators, researchers) will seed the conversations by giving brief presentations about our project.

Design Approaches for the Crossroads of STEM and the NGSS

Strand 10: Curriculum and Assessment

21-Apr-26, 10:00-11:30

Location: Capitol Hill (L3)

Related Paper Set

“Thinking Like a Kid” in STEM Curriculum Design: A Framework for Student Hat for Design

Daniel Voss*, Northwestern University, USA

ABSTRACT

In this paper, the author explores how “student hat”—positioning adults as grade school students during an enactment of a lesson—can be used in design of integrated STEM units. Student hat has been studied as a tool in professional learning contexts but there is little literature on its use in design, despite the fact that it is used by many designers of NGSS-aligned materials. The author discusses prior work on student hat and provides an overview of how it typically plays out in design contexts. This paper also draws on literature on student hat, rehearsals in professional learning contexts, equity, and the discourse concept of stylisation to develop a framework for further study of how student hat is used in a system where designers test, receive feedback on, and revise instructional materials.

Related Paper Set

Using Student Voice to Develop an Integrated STEM End-of-Unit Activity

Nicole Vick*, Northwestern University, USA

Michael Novak, Northwestern University, USA

ABSTRACT

A Framework for K–12 Science Education and the Next Generation Science Standards (NGSS) advocate for centering instruction on real-world phenomena and problems, yet educators face challenges in selecting contexts that meaningfully engage students. This study investigates how student voice—defined as students’ inclusion and empowerment in school decision-making—can inform curriculum design, particularly in integrated STEM instruction. We developed and field-tested a sound-focused STEM unit employing the storyline instructional model. The culminating activity involved students designing hearing-protection devices using micro:bits, but teacher feedback identified implementation barriers. To balance teacher feasibility and student engagement, we surveyed students from the field test cohort to choose among three potential culminating activities. Contrary to our predictions, students preferred an investigation of animal sounds to explore bioacoustics and endangered species protection. The publicly available unit incorporated flexible end-of-unit pathways based on in-class polls, enabling either extended inquiry into animals or closure. Findings highlight that student surveys can challenge designers’ assumptions, promote equitable decision-making, and enhance curricular relevance. We argue that structured, transparent integration of student voice—beyond teacher perceptions—supports authentic

engagement, strengthens science learning, and models democratic practices in the classroom.

Related Paper Set

Designing for Meaningful Integration of Computer Science in Storyline-Based Science Units

Tiffany Neill*, University of Central Oklahoma, USA

Brian Reiser*, Northwestern University, USA

ABSTRACT

Integrated STEM instruction remains inconsistently defined and implemented and can be challenging to describe within units of instruction. In this paper, we argue that developing and investigating design strategies for STEM integration requires a way to characterize the various types of integration of the individual STEM disciplines that can occur in an instructional unit. We consider two questions: (1) Which of the STEM disciplines are present, and to what depth, in each of the lessons in a unit? and (2) What is the reason, as experienced by the student, that multiple disciplinary practices and ideas are brought together in a particular task or lesson? We then apply these two analytical lenses to examine the varied combinations of STEM disciplines represented in lessons across two integrated STEM units and how computer science serves as an amplifier of STEM integration, authentically leveraged for science sensemaking.

Related Paper Set

What is a model in an integrated STEM and NGSS space?

Michael Novak*, Northwestern University, USA

Daniel Voss, Northwestern University, USA

ABSTRACT

In this paper, the authors examine the differences in the modeling practice between STEM disciplines, specifically science and computer science, and the challenges these differences pose for designing integrated instructional materials. They then propose ways in which the NGSS crosscutting concept of Systems and System Models can provide a bridge across these disciplines. Finally, this paper explores how a middle school contact forces unit can leverage a common input-process(ing)-output model to support student sensemaking across physical science and computer science ideas. This approach is used in the context of explaining, repurposing, and designing sensor systems without sacrificing science learning.

Exploring science teaching through language ideological lenses

Strand 11: Cultural, Social, and Gender Issues

21-Apr-26, 10:00-11:30

Location: Ballard (L3)

Stand-Alone Paper

Toward a culturally sustaining Third Space for Chinese international students

Ying Yeung (preferred name: Yeung) Tang*, Vanderbilt University, USA

Jessica Watkins, Vanderbilt University, USA

ABSTRACT

Given that science classrooms have often marginalized students' diverse cultural and linguistic assets, there has been continual push for culturally sustaining pedagogies in science. By culturally sustaining, it means that students' cultural and linguistic assets are not only honored but also be integrated and built upon in learning. However, attempts to incorporate students' culture into science learning have often been superficial and are not truly culturally sustaining. The idea of culturally sustaining pedagogies is congruent with Kris Gutiérrez's "Third Spaces," which are culturally sustaining spaces where students' home and communal knowledge intersect with traditional school practices of science to give rise to new tools, practices, and meanings. In this paper, we explored what a Third Space in which Chinese international students (CIS)'s Chinese linguistic and cultural resources are integrated into science learning may look like in a preservice teacher education course. This is particularly because CIS are often positioned as linguistic and culturally deficient individuals, whose rich Chinese linguistic and cultural resources are often overlooked as resources to negotiate new ways of learning. Through video and interaction analysis, we explored how the course functioned as a Third Space for our focal CIS and what may have supported its emergence.

Stand-Alone Paper

Science Teachers' Language Ideologies: Initiating Spaces for Linguistically Responsive Teaching and Teacher Education

Sara Salloum*, Ohio University, USA

Saouma BouJaoude*, American University of Beirut, Lebanon

Rana Baddour*, American University of Beirut, Lebanon

Danielle Dani, Ohio University, USA

ABSTRACT

Science teachers' language ideologies influence interpretations of curricula, professional learning, language awareness, and practices. Studies are needed across world contexts to explore how ideologies affect teaching in multilingual settings and attitudes toward linguistic diversity. This study investigates science teachers' language ideologies and examines the perceived opportunities and challenges teachers encounter in multilingual contexts. Seventeen science teachers from linguistically diverse schools in two Middle Eastern (ME) countries and the US were interviewed. Learners in one of the ME countries

share an Arabic background, while teachers in the second country serve diverse expatriate communities using English. US participants taught in public schools with diverse multilingual learners. Qualitative interviews explored teachers' language ideologies and how they characterize their science teaching in multilingual classrooms. Reflexive thematic analysis was used to analyze the data. Results showed that teachers' language ideologies were internally consistent yet dynamic, typically exhibiting instrumental awareness centered on exam success, while holding limited views on the dialogic nature of science. Science teachers noted both opportunities and challenges in teaching multilingual learners, especially difficulties navigating science concepts with diverse home languages in the classroom. Notwithstanding, teachers' dynamic ideologies were not 'simple,' reflecting a commitment to serve multilingual learners with resources available to them.

Stand-Alone Paper

Exploring notions of language and language-in-use in science teacher noticing

Nazia Tasnim*, University of Texas at Austin, USA

María González-Howard*, University of Texas at Austin, USA

Leticia Garza*, University of Texas at Austin, USA

ABSTRACT

The field of science education has had a rise of research focused on teacher noticing since the release of the NGSS. This area of inquiry is important because reform-oriented science instruction requires teachers to ongoingly notice how students construct knowledge to enact pedagogical practices that uplift students' evolving ideas and questions. However, we argue that to realize this vision of science education in ways that are just for all students, and particularly for multilingual learners, teachers must notice not only students' ideas, but also the diverse ways students use their full language repertoire to engage in and communicate their sensemaking. In this study we used a translinguaging lens to conduct a content analysis of teacher noticing research, exploring whether and how researchers attend to language in their work. 18 studies were examined as they fit the criteria of focusing on science teacher noticing, including data of teacher noticing and were published since the release of the NGSS. Our analysis revealed that researchers' conceptualizations of teacher noticing attend to language to varying degrees. Findings suggest there are opportunities for researchers to integrate language-expansive noticing into their work to better support teachers in noticing multilingual learners' language rich practices when sensemaking.

Stand-Alone Paper

From Monoglossic to Heteroglossic: A Teacher-Specialist Ideological Shifts with Translinguaging in a Dual-Language Science Classroom

Yernat Mnuar*, University of Houston, USA

Jie Zhang*, University of Houston, USA

ABSTRACT

While dual language programs (DLPs) are expanding, a tension persists between their rigid language separation policies and the asset-based pedagogy of translanguaging. This qualitative case study explored the ideological and pedagogical shifts of a sixth-grade science teacher and specialist dyad following a year-long, co-design professional development (PD) focused on translanguaging in a two-way Spanish/English science classroom. Data sources included pre/post-interviews, classroom observations, and co-design meeting notes, which were analyzed thematically.

Findings highlight four themes: (1) participants' shift from monoglossic to heteroglossic language ideologies; (2) a move from deficit-oriented to asset-based, inquiry-driven pedagogy; (3) teacher collaboration as a key driver of professional growth; and (4) persistent challenges rooted in institutional policies and a lack of systemic support. This study refines the understanding of translanguaging in DLP contexts and underscores the need for systemic adjustments to support equitable science instruction for multilingual learners.

AI in support of developing, using and scoring 3D assessments

Strand 12: Technology for Teaching, Learning, and Research

21-Apr-26, 10:00-11:30

Location: Jefferson B (L4)

Related Paper Set

Leveraging Generative AI to Detect Uncertainty

Namsoo Shin*, Michigan State University, USA

Xunlei Qian, Michigan State University, USA

Cory Miller, Michigan State University, USA

Joseph Krajcik, Michigan State University, USA

Yue Xing, Michigan State University, USA

ABSTRACT

This study develops and tests a Large Language Model-based AI assessment framework using multi-agent systems for analyzing written responses, generating scoring reasoning, and identifying response uncertainties to assign final scores and provide feedback on weaknesses to support learning. This paper illustrates the framework through a case study: assessing Earth science written responses from 330 elementary school students using a polytomous holistic rubric. Using prompting and aggregation methods, the proposed multi-agent systems achieved an overall accuracy of 88% for elementary school responses. Compared to a single-agent model, the accuracy increased by 20% for elementary school data. These findings demonstrate the framework's potential to enhance the rationale of classroom assessments by providing timely feedback to improve teaching and learning. The future direction to further improve scoring accuracy include retrieval-augmented generation, human-in-the-loop, and fine-tuning with synthetic data.

Related Paper Set

Exploring Object Recognition Approaches to Analyze Students' Draw Models

Mao-Ren Zeng*, Michigan State University, CREATE for STEM Institute, USA

Kevin Haudek, Michigan State University, CREATE for STEM Institute, USA

Leonora Kaldaras, University of Houston College of Education, USA

Joseph Krajcik, Michigan State University, CREATE for STEM Institute, USA

ABSTRACT

Knowledge-in-Use is a crucial educational goal where students actively apply their knowledge to interpret real-world phenomena. Students' draw models are an effective way for them to show this, as they reveal how students integrate disciplinary core ideas, scientific practices, and crosscutting concepts. However, manually analyzing these models is challenging for educators and researchers. This study proposes and explores a novel approach to evaluate students' draw models using object detection, rather than the classification task used by AI. Our approach treats the evaluation as a task of finding and identifying specific symbols and conceptual components within a students' draw models. This approach provides a more detailed and interpretable view of a student's understanding. We used the YOLOv9 model on a custom dataset of students' draw models from a physical science curriculum. Our results show that this method accurately and consistently detects meaningful elements, which boosts the accuracy and trustworthiness of AI-based assessments in science education. This new approach helps researchers track student learning with more precision and consistency, supporting the development of a strong validity argument for AI scores. Ultimately, this integration of object detection aims to give educators powerful tools to better assess and improve student learning.

Related Paper Set

Optimizing AI Scoring of Scientific Explanations: Exploring Augmentation Strategies with Fine-Tuned Transformers

Prudence Djabga*, Michigan State University, USA

Kevin Haudek, Michigan State University, USA

Clare G.-C Franovic, Michigan State University, USA

Leonora Kaldaras, Texas Tech University College of Education, USA

ABSTRACT

Automated scoring of students' scientific explanations offers the potential for immediate, accurate feedback, yet class imbalance in rubric categories—particularly those capturing advanced reasoning—remains a challenge. This study investigates augmentation strategies to improve transformer-based text classification of student responses to a physics assessment based on an NGSS-aligned learning progression. The dataset consists of 1,466 high school responses scored on 11 binary-coded analytic categories. We focus on Categories 5 and 6, which represent sophisticated energy and Coulombic reasoning but are highly imbalanced (3.9% and 1.2% positive cases, respectively). Using SciBERT as a baseline, we

applied fine-tuning and test two augmentation strategies: (1) GPT-4-generated synthetic responses, and (2) EASE, a word-level extraction and filtering approach. While fine-tuning SciBERT improved recall over baseline, augmentation substantially enhanced performance, with GPT-4 data boosting both precision and recall, and EASE achieving perfect precision, recall, and F1 scores. We selected augmentation over traditional over/undersampling to avoid overfitting and retain novice-level data critical for learning progression alignment. Findings demonstrate that targeted augmentation can address severe imbalance while preserving conceptual coverage, offering a scalable solution for automated learning progression-aligned scoring in science education.

Related Paper Set

Using generative AI to score students' quantitative knowledge-in-use about energy

Knut Neumann*, IPN-Leibniz-Institute for Science and Mathematics Education, Germany

Weiwei He, Michigan State University, USA

Yucheng Chu, Michigan State University, USA

Jiliang Tang, Michigan State University, USA

ABSTRACT

In order to be prepared for the challenges of the 21st-century students must develop knowledge-in-use (KIU). Assessing KIU, however, demands open-ended performance tasks that generate complex student artifacts, which are time-consuming to score reliably. While machine learning has been applied to automate scoring, it typically requires extensive human labeling, which is also time-consuming. With recent advances in generative AI (genAI), particularly large language models, there is growing potential to score student responses with less human effort while maintaining accuracy. This study explores the use of genAI to score assessments of students' KIU about energy. Building on prior work in task and rubric design, we administered 16 tasks to 524 students across the U.S. and compared genAI scoring, using the GradeOpt multi-agent grading framework, with human raters. Initial human-AI agreement was comparable to human-human reliability. Further analyses tested strategies for improving agreement, including rubric revisions, enhanced instructions, and AI clarification prompts, with task-specific effectiveness. Findings highlight the potential of genAI to reduce scoring burdens and provide scalable, high-quality assessment of KIU.

Understanding Science in the Age of AI: Interfaces Between Epistemology, Ethics, and NOS Education

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

21-Apr-26, 10:00-11:30

Location: Virginia (L4)

Symposium

Understanding Science in the Age of AI: Interfaces Between Epistemology, Ethics, and NOS Education

Kerstin Kremer, Justus Liebig University, Germany

Wonyong Park, University of Southampton, United Kingdom

Douglas Allchin, University of Minnesota, USA

Marcus Kubsch*, Freie Universität Berlin, Germany

Tingting Li*, Washington State University, USA

Peng He, Washington State University, USA

Elvira Schmidt, Justus Liebig University, Germany

Sara Satanassi, University of Bologna, Italy

Olivia Levrini, University of Bologna, Italy

Sibel Erduran, University of Oxford, United Kingdom

Martina Caramaschi, University of Bologna, Italy

Emily Reigh, University of California, USA

Xinyu He, University of Georgia, USA

Holly Amerman, University of Georgia, USA

Emily Adah Miller, University of Georgia,

ABSTRACT

This symposium addresses how artificial intelligence (AI) is transforming the Nature of Science (NOS), challenging established epistemic, methodological, and ethical foundations. AI increasingly acts as an active epistemic agent—detecting patterns, generating hypotheses, and supporting decision-making—across science, technology, and medicine. While enabling new forms of discovery, AI also raises concerns over transparency, reproducibility, and the reinforcement of biases, potentially shifting emphasis from theory-driven inquiry to data-driven correlations. The “black-box” nature of many models complicates scrutiny, and the potential for dual use amplifies risks. Traditional NOS frameworks, largely developed before AI’s rise. Historically, NOS education has relied on past scientific episodes, but today’s rapidly evolving scientific landscape demands a focus on “what science is becoming.” AI’s integration across the research pipeline calls for updated curricula that prepare learners to navigate epistemic uncertainty and ethical complexities. The symposium explores three themes: (1) shifting epistemic cores as AI reshapes fundamental practices; (2) redefining authorship, responsibility, and equity in human–AI collaboration; and (3) reimagining NOS education for an AI-infused world. Drawing on frameworks like the Family Resemblance Approach, it aims to position NOS as a dynamic construct, aligning science education with emerging realities in AI-driven research

Youth and Teacher Agency in Designing Just and Sustainable Futures

Strand 14: Environmental Education and Sustainability

21-Apr-26, 10:00-11:30

Location: Jefferson A (L4)

Stand-Alone Paper

Exploring Science Teachers' Agency in SSI instruction: Focusing on Tensions and Praxis

Jiwon Kong*, Ewha Womans University, Korea, Republic of

Sohyun Jeon, Ewha Womans University, Korea, Republic of

Hyunju Lee, Ewha Womans University, Korea, Republic of

ABSTRACT

This qualitative case study explores how science teachers exercise their agency in implementing socioscientific issues instruction, with a focus on tensions with conventional science education paradigms and their translation into educational praxis. Guided by Priestley et al.'s (2015) ecological model of teacher agency, the study examines the experiences of two in-service science teachers—one elementary and one middle school—who sustained SSI teaching despite structural constraints. Data were collected through two rounds of semi-structured interviews, analyzed thematically across iterative, practical-evaluative, and projective dimensions. Findings reveal that both teachers critically reflected on the limitations of correct-answer-oriented science education, recognizing the socially unequal impacts of science and technology. Sophia sought to reflect the power dynamics in real-world decision-making processes within classroom SSI discussions, aiming to bridge the gap between idealized discourse and societal realities. Emily extended SSI learning into local communities to promote authentic application of scientific knowledge. This study emphasizes the need for support systems that enable agentic teachers to create spaces for teaching SSI and ensure that their critical reflection on education can be translated into classroom practice. This study suggests that cases of teachers can serve as practical models for other teachers seeking to explore directions for SSI.

Stand-Alone Paper

Examining Youth Authority Throughout Community Interview in the Co-Design of an Environmental Engineering Curriculum

Yuxi Huang*, University of California, Irvine, USA

Aakriti Bisht, University of California, Irvine, USA

Rossella Santagata, University of California, Irvine, USA

Symone Gyles, University of California, Irvine, USA

Taryn Williams, University of California, Irvine, USA

Teresa Hackey, University of California, Irvine, USA

Hosun Kang, University of California, Irvine, USA

Jennifer Long, University of California, Irvine, USA

Sara Ludovise, Orange County Department of Education, USA

Erick Valdez, Orange County Department of Education, USA

ABSTRACT

This study examines youth authority in interviews with community members during an environmental engineering curriculum co-design. Seven high school students, together with university researchers and informal environmental educators, co-developed interview questions and identified potential interviewees, then independently conducted interviews with community members in pairs. The study aimed to understand how youth demonstrate and exercise authority within this activity. Through qualitative analysis of audio recordings from group discussions, interviews, and reflections, we found that youth authority emerged through authority in virtue of specific competence and authority in virtue of office, and was realized via both epistemic and deontic dimensions. Youth most often demonstrated epistemic authority when designing questions and deontic authority when leading interview conversations. Logistical arrangements, however, were largely controlled by university researchers. These findings extend micro-level analyses of power dynamics and suggest that intentional facilitation can expand opportunities for youth to exercise both epistemic and deontic authority in co-design. It also contributes to broader literature on power, authority, and equitable youth engagement in curriculum design.

Climate Justice Education Designed and Sustained Through Large-Scale Networked Transformation Communities

Strand 15: Policy, Reform, and Program Evaluation

21-Apr-26, 10:00-11:30

Location: Greenwood (L3)

Related Paper Set

Teacher Preparation for What Worlds? A Review of Climate Change Education in Pre-service Teacher Learning

Kelsie Fowler*, University of Washington, USA

Ximena Gallegos*, University of Washington, USA

Bud Bong*, University of Washington, USA

Philip Bell, University of Washington, USA

ABSTRACT

Education is a crucial lever in shifting how we collectively understand and respond to climate change and the injustices it presents. However, how the field of pre-service teacher (PT) education improves preparation around the climate crisis and integrates climate learning within formal teacher education programs (TEPs) is underreported and therefore poorly understood. To address this gap, we conducted a systematic literature review of peer-reviewed articles published between 2014 and 2024 to help us understand (1) under what contexts climate change education occurs in teacher education? and (2) how do teacher

educators frame the eco-politics of climate change, and how are matters of equity and justice engaged? 132 articles met the inclusion criteria. These included literature reviews (n = 1), theoretical and conceptual manuscripts (n = 17), and empirical studies (n = 116), spanning 36 different countries, and reported varied pedagogical approaches and challenges. Considering that over two-thirds (n = 91) of the articles were published within the last five years, we anticipated more to focus on climate justice education, program-wide approaches, and climate-relevant pedagogies. However, the collection was dominated by conceptual arguments for better PT climate change education or measuring PTs' climate literacy and readiness to teach about climate change.

Related Paper Set

Understanding the Critical and Political Frames in a Co-Designed State-level Climate Justice Teacher Educator Network

Philip Bell*, University of Washington, USA

Kelsie Fowler, University of Washington, USA

Deb Morrison*, University of Washington, USA

ABSTRACT

The unfolding climate and environmental crises of today demand that teachers be better prepared to disrupt whiteness, anthropocentrism, and extractive logics in human-nature relations, and in their place seed a transdisciplinary, multi- onto-epistemic and just social and multispecies response. To address this reality, we started a networked improvement community (NIC) of faculty and instructors from 12 different teacher education programs across Washington State to learn about climate justice education and engage in the transformation of teacher education. Fourth generation cultural historical activity theory (CHAT) guides the network's efforts as it engages in dialogue, relationship building, and material/intellectual/social designing and infrastructuring across significant scale. In this study we aim to understand how artifacts collaboratively constructed by the NIC mobilized epistemological, ideological, and political frames. Our analysis of network artifacts (1) identified varied substantive, pedagogical, and critical and political clarity frames and (2) used inductive and iterative coding to note variation in how these dimensions were represented. The findings provide examples of different critical and political frames and elements of justice activated through the work. Additionally, this research offers a conceptual framework to guide state-level NICs working to integrate climate and environmental justice into teacher education.

Related Paper Set

Mapping Climate Change Education: Reflections from an Education Design-Based Research Project from Northern British Columbia, Canada

Hartley Banack*, University of Northern British Columbia, Canada

ABSTRACT

K–12 teachers in northern British Columbia (BC) face significant challenges in delivering climate change education due to limited curricular integration, resources, and professional learning. These issues are heightened in a region experiencing warming two to three times faster than in southern BC. The Climate Education in Teacher Education (CETE) project, launched at the University of Northern British Columbia in 2022, addresses these gaps by supporting preand in-service teachers with localized, justice-oriented approaches.

Related Paper Set

Re Envisioning Climate and Environmental Education in California for Thriving Futures

Asli Sezen-Barrie*, University of California, USA

Bailey McCraner*, University of California, USA

ABSTRACT

Education is an important social lever that needs to be transformed to build capacity across society to disrupt the devastating effects of climate change and more justly respond to the related socio-ecological crises. Unfortunately, teacher preparation related to the climate emergency remains inconsistent and sparse, lacking the well-organized and diligent effort that this moment necessitates. Therefore, this session explores the possibilities and complexities of designing and then engaging geographically far-flung networks of educators, teacher educators, and/or researchers to transform education through design-based implementation research, focused on climate justice using kin-centric, transdisciplinary, place-based, anti-colonial, and anti-racist approaches. To contextualize these efforts, we open with a systematic literature review outlining the varied contexts climate change education occurs with pre-service teachers, and emphasize ways matters of justice and eco-politics were woven into this work. We then present empirical findings from four widespread networked teacher initiatives, proposing a more relationship and futurity-centric model of implementation called networked transformation communities. These efforts include a range of social actors working in solidarity through systems of collaboration and relational accountability to radically (re)envision and (re)build the structural conditions needed to prepare educators to take up climate justice in critically conscious and transformative ways.

Related Paper Set

Co-Designing Communities for Place-Responsive Science and Collective Changemaking: Reflections from a Multi-Year Professional Learning Model

Jordan Sherry-Wagner*, University of Washington Bothell, USA

ABSTRACT

This paper examines the Learning in Places project's model for co-designing and sustaining large-scale networked transformation communities that reimagine professional learning in science education as a site of socio-ecological change-making. In contrast to short-term,

fidelity-focused professional development, the project has engaged over 350 educators and 10,000 students across diverse contexts through interwoven pathways of professional learning, community building, and educator agency. Grounded in participatory design research (Bang & Vossoughi, 2016) and place- and land-based traditions (Bang & Marin, 2015; Tuck et al., 2014), the model integrates classroom implementation with layered structures such as summer summits, co-design gatherings, framework sessions, and ongoing coaching. Findings from case study interviews and documentation highlight four key shifts: (1) pedagogical reorientation toward teaching with place and learners, (2) nurturing possibility and trust through routine engagement, (3) storying implementation data to navigate complexity and inequity, and (4) local adaptation and diffusion. Together, these shifts demonstrate how layered, proleptic forms of pedagogical mediation cultivate educators' identities, agency, and efficacy as changemakers. This work contributes an empirically grounded framework for responsive, justice-oriented science teacher learning with significance for broad educational transformation.

Jhumki Basu Scholars Poster Symposium

21-Apr-26, 10:00-11:30

Location: Redwood AB (L2)

Administrative Session

Organizers

Khanh Tran, Utah State University, Logan, UT, USA

Iliana De La Cruz, Texas Higher Education Coordinating Board, Texas

Regina McCurdy, University of North Carolina Charlotte, NC, USA

Basu Scholars

Arya Karumanthra, Indiana University

Grace Tukurah, Michigan State University

Destinee Cooper, Clemson University

Safron Milne, University of Michigan

Joshua Modeste, Columbia University

Jasmyne Yeldell, University of North Carolina

Melinda Lopez, University of Colorado Boulder

Karin Mason, Georgia State University

John Ojeogwu, Texas State University

Katarzyna Pomian Bogdanov, Northwestern University

Mahati Kopparla, University of Pittsburg

Jill Zipperer, Texas State University

Maximilan (Max) Sherard, University of North Texas

Victor Leos, University of Colorado Boulder

DeNae Kizys, University of South Carolina

Abstract

Jhumki Basu Poster Symposium highlights thought-provoking and compelling work of the 2024 Basu Scholars. This will be an interactive poster session with the 2024 Basu Scholar awardees. These emerging scholars bring diverse educational perspectives and reflect a range of research interests in scholarship addressing equity and justice in science education. During this symposium, the following Basu Scholars will present ideas and research focused on examining, shaping, improving and expanding science education across places and contexts.

NARST Connects

21-Apr-26, 10:00-11:30

Location: Kirkland (L3)

Discussion Session

Abstract

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 (see <https://narst.org/conferences/2026-annual-conference>).

Sample discussion topics include: What recent challenges are you facing? How might NARST be able to help? Easels with flipchart pads and markers will be available for folks to record information or messages that they wish to share with the NARST Board of Directors.

Developing Modeling and Computational Thinking

Strand 1: Science Learning: Development of student understanding

21-Apr-26, 12:45-14:15

Location: Ravenna C (L3)

Stand-Alone Paper

Developing and evaluating meta-modeling knowledge in 7th graders: A Mixed Methods study

Manav Sharma*, University of Miami, USA

Ji Shen, University of Miami, USA

Valeria Quintero, University of Miami, USA

Arlette Perry, University of Miami, USA

David Xiong, University of Miami, USA

Amylia Wiesner, University of Miami, USA

ABSTRACT

This mixed-methods study examined how 7th graders' understanding of scientific models developed when explicit meta-modeling instruction was embedded in a model-based STEM curriculum. Over a semester, 29 students explored human anatomy, thermoregulation, and nutrition through physical, digital, and embodied modeling activities. Core meta-modeling knowledge constructs (their nature, purpose, form, and function) were introduced and revisited after each activity. Surveys showed a significant medium improvement in overall meta-modeling knowledge (Cohen's $d = 0.63$; $t(28) = 3.4$, $p = .002$), with the largest gains in recognizing that multiple models can represent aspects of the same phenomenon and serve different purposes. Interviews with six students (selected from pre-post gains tertiles) revealed a progression from focusing on visual or tactile features toward appreciating models' explanatory and functional roles. The idea that models can change and be revised remained less developed, likely due to limited opportunities for revision. Findings highlight the value of combining explicit instruction with diverse modeling experiences and including the full cycle of model creation, use, and revision. Integrating quantitative and qualitative evidence in a mixed methods design offered a richer understanding of students' meta-modeling knowledge than either method alone.

Stand-Alone Paper

T/E Design Based Biotechnical Learning: Inherent and Imposed Cognitive Demands

John Wells*, Virginia Tech, USA

ABSTRACT

Cognitive demands increase along a continuum of higher order thinking from declarative, procedural, schematic, and finally strategic (decision making). The integration of science, technology, engineering, and mathematics (STEM) content and practices employing T/E DBBL approaches is believed to inherently impose the type of cognitive demands that will undoubtedly confront tomorrow's problem-solvers. The research presented was designed to evidence the potential of T/E DBBL for improving a student's capacity for responding to higher order cognitive demands inherently imposed by T/E design challenges. This research took place over multiple years involving mixed-discipline (STEM) groups of graduate students enrolled in a Design Based Biotechnical Learning course. Following a multiple-case, one-group pretest-posttest design students were assessed on their abilities to respond to the continuum of cognitive demands imposed by two increasingly complex DBBL Problem Scenarios. Data were analyzed to assess students' ability to respond to questions aligned with the inherent imposed cognitive demands along a continuum of higher order thinking from declarative to strategic. Findings indicate strong connections between the T/E DBBL instructional strategies used to intentionally teach specific STEM content and practices, and improved capacity of students to respond to imposed cognitive demands inherent within T/E design challenges.

Stand-Alone Paper

From Code to Chloroplasts: Speaking About Photosynthesis through Computational Modeling

Tamar Fuhrmann, Teachers College Columbia University, USA

Brendan Henrique*, University of California, Berkeley, USA

Adelmo Eloy, Teachers College, Columbia University, USA

Leah Rosenbaum, Teachers College, Columbia University, USA

Aditi Wagh, Massachusetts Institute of Technology, USA

Paulo Blikstein, Teachers College, Columbia University, USA

Michelle Wilkerson, University of California, Berkeley, USA

ABSTRACT

This paper examines how students use coding as a language to express scientific concepts and, in turn, use scientific concepts to inform their coding, enhancing their understanding of photosynthesis through MoDa, a computational modeling platform. We analyze student-pair conversations as they design and construct photosynthesis models, focusing on how coding practices—such as breaking down complex processes, identifying relationships and ratios, and defining steps and conditions—help students make sense of the stages and components of photosynthesis. Our findings indicate that as students modeled photosynthesis, they fluidly transitioned between scientific concepts and coding practices, building interconnected knowledge across both domains. This study contributes to the growing body of research showing that integrating coding into science education allows students to use computational thinking to make sense of challenging science concepts.

Stand-Alone Paper

LLM-based Agents in Virtual Scientific Inquiry: Effects on Concepts, Motivation and Learning Strategies, and Thinking

Yanling Zhao*, School of Educational Technology, Beijing Normal University, China

Yafeng Zheng, Center for Educational Technology, Beijing Normal University, China

ABSTRACT

Abstract: Virtual scientific inquiry learning provides important opportunities for deepening students' conceptual understanding and inquiry practices, yet it often suffers from fragmented support, delayed feedback, and insufficient personalized guidance that limit student engagement and learning outcomes. This study examines how large language model (LLM)-based intelligent tutoring agents can transform virtual science learning environments. We developed an agent-integrated platform implementing Predict-Observe-Explain pedagogy and conducted a pre-post experimental study with elementary students exploring energy concepts over five weeks. The LLM-powered agents provided dynamic cognitive scaffolding, bidirectional interactive feedback, and real-time process support throughout inquiry activities. Results revealed significant improvements across multiple dimensions: scientific concept understanding increased substantially, all four measures of learning motivation and strategies showed significant gains, and higher-order thinking skills

including problem-solving, critical thinking, and creativity demonstrated marked improvement. The agents successfully addressed traditional limitations by offering personalized, immediate support that adapted to individual student needs during complex inquiry processes. Findings suggest that LLM-based tutoring agents can serve as effective partners in science education, moving beyond static scaffolding to create responsive, engaging learning environments that promote both conceptual mastery and cognitive skill development.

Transforming Teaching and Learning through Pedagogical Interventions

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

21-Apr-26, 12:45-14:15

Location: Willow B (L2)

Stand-Alone Paper

Faculty-Learning Assistant Partnerships as a Catalyst for Pedagogical Change

Monsour Zakariyah*, Middle Tennessee State University, USA

Tomi Mafe, Middle Tennessee State University, USA

Kathryn Hosbein, Middle Tennessee State University, USA

ABSTRACT

Transforming undergraduate STEM instruction requires approaches that connect pedagogical change with shifts in teaching identity and classroom relationships. This qualitative case study examines how faculty-Learning Assistant (LA) partnerships can drive such change by combining collaborative instruction with structured reflective practice.

Seven STEM instructors from general chemistry, general biology, and remedial mathematics at a large research-intensive university participated across two semesters (Fall 2024-Spring 2025). Data from monthly faculty reflection meetings, classroom observations, and interviews with 14 LAs were analyzed using reflexive thematic analysis, guided by Communities of Practice (Wenger, 1998) and Reflective Practice (Schön, 1983).

Five themes captured the transformation process: shared presence and accountability fostering engagement; co-developed strategies expanding instructional repertoires; collective responsibility reshaping the teaching enterprise; LAs as communication bridges enhancing student access; and reflection meetings enabling role negotiation and responsive teaching.

Findings suggest that faculty-LA collaborations can foster inclusive, student-centered pedagogy and disrupt traditional authority structures. By embedding professional learning in relational and reflective contexts, this work offers further support for the LA model as a catalyst for instructional transformation in STEM classrooms, aligning with NARST's mission to advance meaningful, systemic change.

Stand-Alone Paper

Intentional Teaching Gestures Increase Student Outcomes in Anatomy and Physiology

Stephanie Wallace*, Texas Christian University, USA

Hayat Hokayem, Texas Christian University, USA

ABSTRACT

Some undergraduate science courses earn a reputation as “gatekeeping” courses due to their nature as prerequisite courses with a high drop/fail/withdraw rate. One such course is Anatomy and Physiology for nursing and kinesiology students. Students often struggle with this material due to the volume and complexity of the content. Mastering the content in this foundational course is important for success in upper-level coursework.

Gestures are commonly used by teachers and students when teaching and learning, but limited work has been done examining their effect on student outcomes in the classroom, especially at the postsecondary level. This study examines the role of gestures in teaching and learning in an undergraduate anatomy and physiology course on a unit covering the muscular and nervous tissues. Incorporation of gestures helped students score significantly higher in a multiple-choice and free response posttest compared to the non-gestures section.

Stand-Alone Paper

Incorporation of Real-World Experiences in Faculty's Instructional Planning in Context of a Professional Development Institute

S. M. Mushfiqur Rahman Ashique*, University of Massachusetts Dartmouth, USA

Stephen Witzig*, University of Massachusetts Dartmouth, USA

ABSTRACT

The demand for higher education institutions to prepare graduates as not only theoretically competent but also practically skilled has led to greater emphasis on incorporating real-world experiences into faculty's instruction. While substantial research has demonstrated the importance and outcome of incorporating real-world experiences, there is a notable gap in exploring how faculty plan such practices in their instruction. Our research addresses this critical need in the context of a professional development institute aimed at enhancing faculty instructional practices. This qualitative research guided by narrative inquiry, grounded in social-constructivism framework with transformative lens, investigated the question: In what ways (if any) do faculty incorporate real-world experiences into their instructional planning? We collected data through surveys, implementation templates, instructional materials shared by participants and transcripts from the video-recorded sessions. Our analysis led to four key assertions: 1) Faculty incorporate real-world experiences into their instructional planning through real-world data collection strategies; 2) Faculty incorporate real-world experiences into their instructional planning through technology integration;

3) Faculty incorporate real-world experiences into their instructional planning through embedding social, environmental, ethical and skeptical aspects; 4) Faculty incorporate real-world experiences into their instructional planning through collaboration among stakeholders. We hope these findings spark discussion and welcome feedback.

Stand-Alone Paper

Labor-Based Grading in Physics: Perceptions of Control, Value, and Engagement

Thanh Le*, Western Washington University, USA

J. Speirs, University of North Florida, USA

Vicki Retzer, Western Washington University, USA

Gracie Deerwester, Western Washington University, USA

ABSTRACT

Traditional grading dominates STEM college courses but can undermine learning outcomes, motivation, equity, creativity, and other aspects of learning. Labor-based grading contracts (LBGC) offer an alternative but have limited documented use in STEM education. LBGC shifts assessment from content mastery to effort and time, centering feedback to promote engagement. This study examines how students experience LBGC in an undergraduate physics course and how it shapes motivation and engagement. We interviewed 29 pre-service teachers enrolled in different sections of a student-centered, research-based physics course aligned with NGSS, all of which used LBGC and were taught by different instructors over two academic years. Using a comparative case study of two focal students (Sandra and Faye) who expressed strong emotional responses to LBGC, we applied Control-Value Theory (CVT) to code for perceived control and value and conducted a cross-case comparison. Both students highly valued grades but differed in perceived control: Sandra reported low control, while Faye maintained high control. These appraisals align with CVT predictions — high value with high control supports engagement, whereas high value with low control is linked to lower engagement. Findings highlight the need for clear communication about grading expectations to align instructor intentions with student perceptions and enhance equity.

Youth Identity Development in STEM

Strand 6: Science Learning in Informal Contexts

21-Apr-26, 12:45-14:15

Location: Seneca (L4)

Stand-Alone Paper

Exploring STEM Identity through Informal STEM Activities and Culturally Relevant Literature

Karen Collier*, Augusta University, USA

Wayne Hickman, Augusta University, USA

Elizabeth VanDeusen, Augusta University, USA

Katherine Barker, Augusta University, USA

ABSTRACT

Out-of-school activities have the potential to broaden participation in science, technology, engineering, and mathematics (STEM) fields, especially for groups with less access to school-based opportunities. Incorporating culturally relevant literature can also encourage students who feel adjacent to STEM. This pilot project aims to engage local families in STEM-based activities and culturally relevant books, to positively impact their STEM identity. Local families were provided the opportunity to participate in STEM activities and receive culturally relevant books about STEM individuals at a local farmers market. The books were also made accessible to patrons of the literary center throughout the Spring semester. Elementary and middle school-aged students also participated in a summer program at a local university, interacting with STEM activities and receiving culturally relevant books to add to their family libraries. Participants of these events were invited to take two surveys: 1) Justice-centered STEM and 2) STEM Identity. The Justice-centered STEM Framework guided the data analysis, providing insight into the project's impact. The research questions guiding this project include: 1) How did students respond to the survey items?, and 2) What themes emerged from open-response questions? Findings support informal STEM education and the positive impact of culturally relevant books.

Stand-Alone Paper

Reimagining CT and STEM Learning with Neurodivergent Youth Through Rightful Presence and Pedagogies of Play

K. Mendoza*, University of Nebraska at Omaha, USA

Yupei Duan*, University of Missouri, USA

Tanya Churaman*, University of Missouri, USA

David Ogundairo*, University of Georgia, USA

Noah Glaser*, University of Missouri, USA

Lucas Jensen*, Georgia Southern University, USA

Amanda Olsen, University of Missouri, USA

Matthew Schmidt*, University of Georgia, USA

Erica Carlson-Moudry, University of Nebraska at Omaha, USA

ABSTRACT

Youth with neurodevelopmental conditions (e.g., autism, ADHD, and dyslexia) remain persistently underrepresented in advanced STEM courses, in part because traditional environments privilege linear, rule-bound forms of participation that undervalue their strengths. This qualitative study examines the pilot implementation of a flexible, community-based program in which neurodivergent middle school youth designed original video games using Nintendo's Game Builder Garage. Guided by abolitionist pedagogies of play and the principle of rightful presence, the analysis focuses on moments of divergence, improvisation, and off-script engagement as indicators of agency and epistemic legitimacy in computational thinking (CT). Data were collected across five sites in two states and included field notes, audio recordings, curriculum artifacts, and interviews. Findings highlight how

participants engaged CT through nonlinear exploration, multimodal creation (e.g., coding, art, narrative, music), and collaborative problem-solving—often through off-script and unexpected approaches—to develop complex, identity-driven games. These results challenge normative definitions of CT competence, reframing divergence as a strengths-based expression of learning. This paper contributes a grounded example of how inclusive, play-based environments can expand what “counts” as participation in informal STEM and computing spaces.

Stand-Alone Paper

Let-Me-See, Can-I-Be, and This-is-Me: Identity Play Versus Identity Work in Informal Science Learning Settings

Heidi Carlone*, Vanderbilt University, USA

Hannah Ziegler, Vanderbilt University, USA

Lauren Connelly, Vanderbilt University, USA

Gabriel Carlone, Vanderbilt University, USA

Alison Mercier, University of Wyoming, USA

ABSTRACT

This paper advances identity theory in science education by analytically distinguishing identity play from identity work. Using the “let-me-see/can-I-be/this-is-me” framework, we reframe how informal science programs can define relevance beyond simple alignment, legitimizing “relevance-as-expansion” by valuing moments of discovery and reinvention. By showing how recognition and competence norms can sometimes narrow exploration, we provide a lens to identify subtle gatekeeping and foreground agency, imagination, and affect. Our cross-case analysis of two middle school girls clarifies how the same design moves can lead to different outcomes—stabilizing identities (this-is-me), funneling youth into aspirational work (can-I-be), or opening exploratory play (let-me-see). Methodologically, we introduce pragmatic tools that make identity play visible in practice: a novelty-by-change card sort, identi-bead identity landscapes, and micro-analytic markers of play. Taken together, the framework enables informal science programs to claim and assess outcomes beyond “more/stronger” affiliation or pipeline movement, valuing moments of trying out, provisional narrations, and safe departures from comfort zones.

Stand-Alone Paper

Youth Translating the STEM Bikes and Biking Ecosystem Through Friendship, Ownership, History, and Joyful Play

Noemi Waight*, University at Buffalo, USA

Ryan Rish, University at Buffalo, USA

Jennifer Tripp, SUNY Geneseo, USA

Stacy Scheunemann, University at Buffalo, USA

Fatemeh Mozaffari, University at Buffalo, USA

Finn Goehrig, University at Buffalo, USA

David Jackson, School, USA

Darryl Rodam Marks, East Side Bike Club, USA

ABSTRACT

The bicycle is a “very good seed” a powerful, critical, and transparent technology—a cultural ecosystem that engages with and for youth and fosters opportunities for the multiplicity of science and engineering learning in real world contexts. This study documented the voices of, their experiences, and how youth translated what and how they learned in a STEM bike and biking summer camp. Youth translated their experiences and focused on the following thematic components: tearing apart and rebuilding bikes; ownership; bike rides and uncovering history; friendships; full sensorial experiences on the bike; and joyful play. This study has implications for understanding how youth translate and make sense of science education and STEM teaching and learning ecosystems. Specifically, this work offers a unique and novel context—that is the bike and biking ecosystem via an out of school summer camp—to understand how bike rebuild and problem solving, ownership, friendship, community bike rides and history, and play and joy inform how students engage with science and engineering phenomena. The findings also inform on High Impact Practices with youth experiences and programming.

Understanding How Instructional Vision, Attitudes, and Beliefs Shift Through Preservice Science Teacher Preparation

Strand 7: Pre-service Science Teacher Education

21-Apr-26, 12:45-14:15

Location: Boren (L4)

Stand-Alone Paper

Drawing Science Teaching: Tracing Shifts in Preservice Teachers’ Instructional Visions

Kristin Chisholm*, University of Delaware, USA

ABSTRACT

Preparing preservice elementary teachers for ambitious science instruction requires addressing both pedagogical skills and the beliefs that shape instructional decisions. This study examines how preservice teachers’ visions of science teaching evolved during a methods course through iterative drawing. Twenty participants completed drawings in Weeks 1, 7, and 15 in response to the prompt, “What should teaching and learning science look like?” Drawings were analyzed using both qualitative and quantitative methods to provide a full picture of change. Qualitative content analysis identified and interpreted instructional features and shifts in framing, while Wilcoxon signed-rank tests and exact binomial tests examined changes in the number and presence of these features over time.

Instructional complexity—defined here as the number of distinct instructional practices depicted—increased significantly over time (3.2 → 5.1 practices per drawing, $p = .0003$).

Depictions of student discourse, writing, and real-world connections—key elements of Ambitious Science Teaching—became more prevalent by semester's end. While many participants shifted toward more interactive, inquiry-based depictions, others showed conceptual growth without increased complexity, and some remained unchanged.

Drawing can serve as a formative assessment tool for teacher educators, providing insight into evolving instructional visions and supporting the development of equitable, student-centered science teaching.

Stand-Alone Paper

Changes in Pre-service Science Teachers' Attitudes toward Science Teaching through a Laboratory Microteaching Experience

Betul Ekiz Kiran*, Tokat Gaziosmanpasa University, Turkey

Dekant Kiran, Tokat Gaziosmanpasa University, Turkey

ABSTRACT

Teachers' attitudes and beliefs play an important role in their decisions and teaching acts throughout their careers. The teacher preparation period is critical to alter beliefs, attitudes, and behaviors, despite the resistance of settled beliefs and attitudes to change. Thus, the current study aims to reveal how pre-service science teachers' (PSTs') attitudes toward science teaching change after participating in a science laboratory course that includes microteaching sessions. The participants consisted of three PSTs who are currently juniors in the science teacher training program. We collected the data through semi-structured interviews before and after each teaching session. Two science educators, holding PhD degrees, analyzed the transcripts and conducted a thematic analysis. Results showed increased confidence, improved preparation habits, and deeper awareness of science teaching as a layered process involving planning, materials, and engagement with student questions. By the end of the course, their appreciation for science evolved into an ability to articulate its value in education. Findings suggest that integrating inquiry-based microteaching into laboratory courses can foster confidence and reflective practices in PSTs.

Stand-Alone Paper

Re-designed Science Methods Courses' Impacts on Elementary Pre-service Teachers' Beliefs and Attitudes for Multilingual Learners

HIEN THI Tran*, University of Houston, USA

Sissy Wong*, University of Houston, USA

Zhenjie Hou*, University of Houston, USA

Jie Zhang*, University of Houston, USA

Samuel Katende, University of Houston, USA

Maria Alexandra Walsh, University of Houston, USA

Laveria Hutchison, University of Houston, USA

ABSTRACT

This mixed-methods study explores the impacts of the two re-designed science methods courses on elementary preservice teachers' (PSTs) beliefs, attitudes and pedagogical practice for multilingual learners (MLs). The courses integrated asset-based beliefs, language, literacy and contextualization for preparing PSTs for a more engaging and equitable science instruction. 74 PSTs completed the validated pre/post surveys measuring their beliefs and attitudes toward linguistic diversity, language and culture-integrated science practices. 15 were interviewed for more in-depth perspectives. Quantitative analysis revealed statistically significant improvements in overall beliefs and linguistic diversity sub-scale across all participant demographics, though changes in beliefs about research-based practices for teaching academic content and language to MLs in science sub-scale was not significant. Qualitative findings highlighted PSTs' growth from initial uncertainty to increased confidence and readiness to work with MLs, citing the use of students' home languages, cultures and lived experiences as resources for science instruction. The convergence of quantitative and qualitative findings suggests that incorporating asset-based beliefs, language, literacy and contextualization in science methods courses effectively prepared PSTs for linguistically and culturally diverse classrooms.

Stand-Alone Paper

Preservice Science Teachers' Self-Efficacy Beliefs Regarding NGSS-Aligned Instructional Practices

Saed Sabah*, The Hashemite University, Jordan

ABSTRACT

This study investigated preservice science teachers' self-efficacy regarding NGSS-aligned instructional practices in Jordan. Guided by Bandura's self-efficacy theory, the research aimed to examine overall self-efficacy levels, potential gender differences, and comparisons between NGSS-aligned and traditional instructional practices. Participants included 85 preservice teachers who completed the Higher Diploma in Teacher Preparation at the Hashemite University. A modified self-efficacy scale, adapted from Hayes et al. (2016), was used, demonstrating strong reliability ($r > .88$) and validated through expert review. Results indicated high self-efficacy levels for both NGSS-aligned and traditional instruction, with means exceeding 4.00 on a 5-point scale. No significant gender differences were found, while paired comparisons revealed significantly higher self-efficacy toward traditional instruction than NGSS-aligned practices. Findings suggest that positive program experiences, mentoring, and structured pedagogical support contribute to high self-efficacy, but highlight the need for further emphasis on translating NGSS-aligned confidence into classroom practice. Implications for teacher education and future research are discussed.

Leveraging a Research-Practice Partnership to Support Systemic Change in a Large School District

Strand 8: In-service Science Teacher Education

21-Apr-26, 12:45-14:15

Location: Greenwood (L3)

Related Paper Set

Perspectives on Teachers' Changing Views for Earth Science Integration Into Biology, Chemistry, and Physics

Lauren Browning*, George Washington University, USA

Annie Caires, University of Montana, USA

Beth Covitt, University of Montana, USA

Jonathon Grooms*, George Washington University, USA

Alan Berkowitz, Cary Institute of Ecosystem Studies, USA

Angie Hood, Cary Institute of Ecosystem Studies, USA

Kevin Garner, Baltimore City Public Schools, USA

Ed Mitzel, Baltimore City Public Schools, USA

ABSTRACT

Current U.S. science education reform, guided by the Framework for K–12 Science Education and the Next Generation Science Standards (NGSS), calls for equitable treatment of life, physical, and Earth and space sciences. Yet, Earth science remains underrepresented in many high school programs. Meeting NGSS expectations often requires integrating Earth science into existing courses without additional time, resources, or teacher specialization. This qualitative study, part of an ongoing Research–Practice Partnership (RPP), examines the experiences of 13 science teachers tasked with embedding Earth science in biology, chemistry, and physics instruction. Guided by Clarke and Hollingsworth’s Interconnected Model of Teacher Professional Growth, we explore teachers’ evolving confidence, successes, and challenges. Semi-structured interview data show all participants reported greater comfort with integration, crediting collaborative professional learning as a key factor. Teachers leveraged Earth science as a central phenomenon to anchor unit storylines, reporting increased student engagement. Persistent challenges included students’ limited prior knowledge and content-heavy curricula. These findings, drawn from teacher leaders at the forefront of reform, provide actionable insights for sustaining Earth science integration and shaping future professional learning and curriculum development as the RPP enters its final phase.

Related Paper Set

Evolution of Teacher Leadership within a Research-Practice Partnership

Edmund Mitzel, Jr.*, Baltimore City Public Schools, USA

Angela Hood, Cary Institute of Ecosystem Studies, USA

Alan Berkowitz, Cary Institute of Ecosystem Studies, USA

Lauren Browning, George Washington University, USA

Beth Covitt, University of Montana, USA

Kevin Garner, Baltimore City Public Schools, USA

Jonathon Grooms, George Washington University, USA

Carolyn Parker, American University, USA

ABSTRACT

In 2013 the state board of education adopted the Next Generation Science Standards which includes disciplinary core ideas for Earth and space science in grades K-12. State graduation requirements specify that students will complete three credits in science including “one credit in Earth/space science or a course with the topics of Earth/space science integrated.” The District has elected the latter and subsequently developed a research-practice partnership to support the integration of Earth science concepts in the current courses for biology, chemistry, and physics. District leadership identified a cadre of 20 science teachers to learn how to design integrated Earth science lessons and assessments, pilot and revise the materials in their classroom, and engage in activities designed to build their teacher leadership capacity to serve as school based science ambassadors and systemic facilitators to advance the work district wide. This paper reports on the successes of those efforts and the necessary components for building teacher leaders’ capacity to contribute to a sustainable district-wide reform effort.

Related Paper Set

Aligning District assessment resources with teachers’ assessment practices and priorities to support responsive teaching

Alan Berkowitz*, Cary Institute of Ecosystem Studies, USA

Beth Covitt, University of Montana, USA

Kevin Garner, Baltimore City Public Schools, USA

Edmund Mitzel, Baltimore City Public Schools, USA

Angela Hood, Cary Institute of Ecosystem Studies, USA

Jonathon Grooms, George Washington University, USA

Lauren Browning, George Washington University, USA

Annie Caires, University of Montana, USA

David Fischer, Cary Institute of Ecosystem Studies, USA

Karen Draney, University of California at Berkeley, USA

ABSTRACT

This paper utilizes a learning sciences lens concerning high-quality assessment to examine strengths, challenges, and opportunities for a District’s high school science assessment system and practices. Drawing on researcher and teacher perspectives of effective assessment, this paper explores (1) what sources of evidence do District teacher leaders use and/or are they interested in using to inform responsive instruction?; (2) what issues do these teachers encounter as they seek to use sources of student evidence to inform enactment of responsive instruction?; and (3) what are the implications for providing District-level systems, resources, and professional learning (PL) to support teachers in effective use of student evidence for responsive teaching. With data from 24 District teachers, most of whom are teacher leaders, findings suggest that while the teachers more regularly rely on proximal (in

classroom) sources as evidence of their students' learning, they are also interested in and well-able to apply insightful approaches to exploring systemic level student data to inform responsive instruction. Teachers also noted common assessment challenges that they encounter, informing the design of District resources to support responsive instruction that is sensitive to particulars of the District context.

Related Paper Set

Using the Interconnected Model of Teacher Professional Growth to Understand Changes in Classroom Practice

Jonathon Grooms*, George Washington University, USA

Lauren Browning, George Washington University, USA

Beth Covitt, University of Montana, USA

Annie Caires, University of Montana, USA

Angela Hood, Cary Institute of Ecosystem Studies, USA

Edmund Mitzel, Baltimore City Public Schools, USA

Kevin Garner, Baltimore City Public Schools, 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. Using the Interconnected Model of Teacher Professional Growth, this paper explores the relationship between teacher beliefs and knowledge about reform, their professional learning experiences, and the influence of student learning outcomes on teachers' instructional practices. Semi-structured interviews and classroom observations come together to illustrate the important role of student learning and engagement in driving teachers' decisions to take up new instructional approaches, such as three-dimensional teaching, and embrace new integrated science curricula. We also share implications related to teacher professional learning within the context of research practice partnerships.

Science identity, discourse, and ambitious teaching practices

Strand 8: In-service Science Teacher Education

21-Apr-26, 12:45-14:15

Location: Issaquah AB (L3)

Stand-Alone Paper

Strengthening Students' Science Identity: The Impact of Teacher Immersion in Defensible Learning Theories and Practices

Samantha Nevado*, Wayne State University, USA

Jazlin Ebenezer, Wayne State University, USA

ABSTRACT

Pre-pandemic science education faced challenges in engaging students, fostering scientific identity, and curricular application to global scenarios. The COVID-19 pandemic caused science education reform to shift to virtual teaching and learning, student engagement, and mental health crises. Post-pandemic there is a need to fill in gaps of varied student readiness while remaining aligned to science standards and continuing to foster scientific identity. This study examines the integration of the Common Knowledge Construct Model-Social Justice stitched frameworks as a means to increase students' scientific identity and overall success. Conducted across two public charter schools in marginalized communities, this multi-method study analyzed discourse of a thirteen-week professional learning community, teacher translation of the stitched framework reflection interviews, and student responses through interviews and surveys. The findings support the implementation of the CKCM-SJ stitched framework in PLCs and learning sequences provided effective teacher development and improved student engagement through socio-scientific issues with equitable participation.

Stand-Alone Paper

Network Science for Sensemaking: Exploration of Discourse Analysis in a Middle Grades Science Classroom

Sierra Morandi*, Florida State University Schools, USA

Alexander Cairns*, Florida State University, USA

ABSTRACT

Supporting student sensemaking has never been more imperative in the current age of K-12 science education reform efforts. Productive science discourse, or productive talk, is one pedagogical tool that fosters sensemaking and supports students in engaging in science disciplinary practices and content. This study uses network analysis to understand the productive talk that took place in Mr. Jerry's middle grades biology classroom. Audio and video across four lessons were coded and assembled into weighted and directed adjacency matrices to provide a complete accounting of the productive dialogic ties between actors in the classroom. Student artifacts from individual assignments and group-constructed posters were used and leveraged to provide insight into student achievement across the lessons. The analysis used centrality, reciprocity, and degree measures to garner a preliminary characterization of each lesson's discourse. Temporal analysis was then conducted to understand key patterns between students and illuminate the influence of discourse on achievement. Findings suggest that group roles, classroom dynamics, and influential key students are important in achievement at the group and individual levels. Future work seeks to explore this data through a fine-grained epistemic network analysis.

Stand-Alone Paper

Culturally Ambitious Science Teaching as Joyful Transgression: Conceptual Change Across Novice and Experienced Elementary Educators

Christopher Mangogna*, University of Washington, USA

ABSTRACT

This study investigates how teacher learning environments can cultivate both the disciplinary rigor and critical consciousness essential for transformative science education as a site of justice and joy. Using a qualitative case study of the Conceptual Infrastructure Model, an integration of culturally ambitious curriculum, communities of practice, and intentional cultivation of teacher agency, we traced the learning development of two novice teachers and four veteran elementary teachers. Focusing on their development of resistant practices: the capacity to notice inequities, dismantle structures that sustain them, and replace these with more just approaches. The analyses combined thematic coding, critical discourse analysis, and interaction analysis to uncover how educators moved from surface-level adoption of equity principles toward sustained, justice-centered enactment.

Findings show that novice teachers used the infrastructures to accelerate their entry into justice-centered work, while veteran teachers employed them to interrogate long-standing routines and influence institutional practices. By embedding agency as a design principle rather than a byproduct, this work extends ambitious science teaching scholarship and offers a durable, evidence-based model for positioning teachers as sustainable agents of transformation, capable of joyful transgressions that redefine what counts as science and who participates in it.

Stand-Alone Paper

Novice teachers' in-field and out-of-field noticing: examining the influence of professional knowledge and teaching experiences

Lu Wang*, Indiana University Kokomo, USA

ABSTRACT

This study explores how novice science and math teachers' professional knowledge and practical teaching experience influence the two facets of noticing: identification and interpretation of classroom situations. Through a qualitative comparison of the same teachers' noticing of instructional videos aligned with their content area (In-field, INF) and videos outside their content area (Out-of-field, OOF), this design explores how teachers' integrated professional knowledge impacts their noticing without directly measuring diverse domains of teacher knowledge. By recruiting teachers with 0-3 years of full-time teaching experience, this study also investigates how practical experience shapes teachers' identification and interpretation skills. Findings reveal that professional knowledge plays a more critical role in identifying noteworthy events for teachers with limited classroom experience. For knowledge-based reasoning, teachers with more than one year of teaching experience demonstrated greater differentiation between INF and OOF analyses,

highlighting the subject-specific nature of reasoning. These findings contribute to the literature by illuminating the different roles professional knowledge plays in novice teachers' identification and knowledge-based reasoning of classroom situations while also highlighting the significance of full-time teaching experience in shaping teachers' noticing and knowledge development, particularly in the early years of their careers.

Transgressing Decontextualized Science: Asset-Based Approaches to Cultural Responsiveness in Diverse Learning Environments

Strand 11: Cultural, Social, and Gender Issues

21-Apr-26, 12:45-14:15

Location: Ballard (L3)

Symposium

Transgressing Decontextualized Science: Asset-Based Approaches to Cultural Responsiveness in Diverse Learning Environments

Clausell Mathis*, Michigan State University, USA

Ehud Aviran*, Michigan State University, USA

William Van Luven, Michigan State University, USA

Ozlem Akcil Okan*, Michigan State University, USA

Lucky Nonyelum*, Michigan State University, USA

John Kelly, Tennessee State University, USA

Ian Neuhart, Michigan State University, USA

Hiba Assi, University of Detroit Mercy, USA

Collette Periard, Michigan State University, USA

Joseph Krajcik, Michigan State University, USA

Barbara Schneider, Michigan State University, USA

ABSTRACT

This symposium presents a comprehensive examination of asset-based approaches to science education that transgresses traditional instructional boundaries by positioning students' lived experiences and cultural assets as foundational to learning. The session unpacks a "challenges → solutions → implementation → outcomes" progression through four interconnected studies. Beginning with an examination of how Nigerian physics teachers navigate systemic educational constraints while attempting to incorporate culturally relevant practices. Following this, a professional learning study illustrates how structured support through learning communities and educative resources enables teachers to integrate students' cultural resources into three-dimensional project-based instruction. The third paper explores a university physics pilot study addressing practical implementation of context-rich problems that leverage students' cultural resources for enhanced engagement with physics ideas. Finally, empirical evidence from high school implementations documents impact on student achievement when curriculum modules integrate cultural resources while maintaining academic rigor. Aligned with NARST's theme, this collection directly

addresses Strand 11's equity focus by providing concrete frameworks and evidence for inclusive practices. The symposium offers actionable insights for researchers, teacher educators, and practitioners committed to transforming science education to serve all learners effectively while demonstrating that equity and excellence are mutually reinforcing outcomes.

Illuminating intersectional experiences in STEM

Strand 11: Cultural, Social, and Gender Issues

21-Apr-26, 12:45-14:15

Location: Ravenna AB (L3)

Stand-Alone Paper

Intersectionality and Positioning Theory Analyses in Essays on Race

Felicia Mensah*, Teachers College, Columbia University, USA

ABSTRACT

Using data collected from six women science educators of diverse racial, cultural, and linguistic backgrounds, I examine how they position race, themselves, and others in their Race Essay assignment. The women were asked to write about the first time they realized that race mattered in teaching and learning as students and teachers. The themes communicate: (1) the similarities and differences in positioning of race based on intersectional identities; (2) the positioning of others in shaping their identities and views of race in education; and (3) the pedagogical considerations made due to racial understanding. The essays exemplify a small step toward uncovering the processes of cultural transmission of racialized discourses and storylines and the implications of their past and current educational experiences as learners and science teachers. Engaging in conversations about race and racism is needed in science teacher education, which often neglects to acknowledge the impact of race and racism in science education.

Stand-Alone Paper

"We listen and don't judge": How Sustained Support Fostered STEM Persistence in One Participant's Journey

Jasmyne Yeldell*, University of North Carolina, Chapel Hill, USA

Anina Mahmud*, University of North Carolina, Chapel Hill, USA

Simone Wilson, University of North Carolina, Chapel Hill, USA

Dionne Cross Francis, University of North Carolina, Chapel Hill, USA

ABSTRACT

Women of Color (WoC) in STEM often face isolation, discrimination, and limited access to sustained support. Using a Communities of Care framework, this single-case study examines Caia, a woman of Nepalese descent, and her participation in a multigenerational

counterspace providing academic, professional, and psychosocial resources for WoC in STEM. The study explores how the Initiative supported her persistence, highlighting its most impactful elements and the ways it addressed institutional gaps. Findings show that relational care, mental health support, and identity-affirming spaces reframed wellness as integral to achievement, challenging the competitive culture of STEM. However, Caia's difficulty maintaining self-care within high-pressure academic environments points to the limits of relatively short-term interventions. This study calls for restructuring STEM pathways to extend timelines and embed culturally responsive, community-oriented practices, ensuring that student well-being and academic success are mutually reinforcing.

Stand-Alone Paper

"When things get hard, I'm not going to back down": Women of Color navigating STEM

Anina Mahmud*, University of North Carolina at Chapel Hill, USA

Jasmyne Yeldell*, University of North Carolina at Chapel Hill, USA

Dionne Cross Francis*, University of North Carolina at Chapel Hill, USA

ABSTRACT

Women of Color (WoC) in STEM navigate male- and white-dominated spaces that often impose isolation, microaggressions, and structural barriers to persistence. While existing literature tends to emphasize deficit-based narratives, this study adopts a strength-based approach, centering the agency and resilience WoC activate in leveraging navigational capital to thrive in STEM. Guided by Yosso's (2005) Community Cultural Wealth framework, we examine the narratives of two Black undergraduate biology majors at a Predominantly White Institution in the U.S. We found that WoC, navigated challenges in their STEM programs by utilizing navigational capital by drawing on external support and personal strength through practicing remarkable agency in the form of seeking out affinity groups for belongingness, challenging dominant narrative around STEM commitment and findings joy in STEM to navigate challenges. These findings illuminate the power of agency and external supports in WoC's navigation of STEM spaces and persisting in STEM, offering actionable insights for institutions aiming to foster inclusive, supportive STEM environments.

AI for PBL, Teacher Support, & Classroom Simulation

Strand 12: Technology for Teaching, Learning, and Research

21-Apr-26, 12:45-14:15

Location: Jefferson B (L4)

Stand-Alone Paper

Building Teacher Confidence With AI: Scaffolding Affordable, Hands-On Experimentation

Travis Ray*, University of Nebraska-Lincoln, USA

Elizabeth Hasseler*, University of Nebraska-Lincoln, USA

ABSTRACT

This study investigates how generative artificial intelligence (AI) can support core components of science education: designing and conducting experiments. While most current discourse around AI in education centers on administrative applications, its role in supporting science-specific pedagogical practices remains underexplored. We conducted a series of professional development workshops with pre-service and in-service secondary science teachers to explore how AI tools—specifically ChatGPT—can scaffold experimental design and coding tasks using the low-cost Arduino microcontroller platform. Preservice teachers completed an AI-designed lab, while in-service teachers later reviewed its structure and classroom relevance. Pre/post survey data revealed gains in technical confidence and reductions in perceived programming difficulty, even among those who only engaged in lesson critique rather than direct implementation. Qualitative reflections suggest that participants viewed AI not as a replacement for teacher expertise, but as a collaborative design partner. Our findings highlight how brief, targeted experiences with AI-supported experimentation can build teacher confidence and foster creativity, particularly for those with limited technical backgrounds or financial resources. This work contributes to growing conversations around equitable, discipline-specific AI integration in science education, offering a practical and affordable model for NGSS-aligned, AI-enhanced instruction.

Stand-Alone Paper

Development of a Generative AI Agent for Supporting Project-Based Learning Curriculum Design— Integrating Procedural Methodology

jìn shēn*, beijing normal university, China

xíngshū jī, beijing normal university, China

shūwén yú, beijing normal university, China

rui wēi, beijing normal university, China

ABSTRACT

Project-Based Learning (PBL) enhances students' critical thinking, creativity, collaboration, and problem-solving, yet designing high-quality PBL curriculum remains time-intensive and demands advanced teacher expertise. This study explores how Generative Artificial Intelligence (GAI) can support PBL curriculum design by integrating procedural methodologies into AI prompts and varying the granularity of input materials. Using a 2x4 quasi-experimental design, ten middle school engineering projects generated 80 curriculum texts under two AI agent conditions—Agent A, embedding only PBL evaluation criteria, and Agent B, embedding both evaluation criteria and procedural methodologies—and four types of input materials ranging from topic-only to teacher-written drafts. Curriculum texts were evaluated across seven quality dimensions using double-blind ratings. Results indicate that Agent B significantly outperformed Agent A in most dimensions, especially those requiring structured design, confirming that procedural methodologies provide effective scaffolding for complex educational tasks. Input material type also influenced outcomes: teacher-written

drafts yielded the highest overall quality, but open-ended topics occasionally promoted stronger performance in creative dimensions. Findings highlight the importance of aligning prompt strategies and input granularity with task demands, suggesting that embedding procedural methodologies into GAI prompts can efficiently guide teachers in producing high-quality PBL curriculum.

Stand-Alone Paper

Using Multi-Student, Generative AI Teaching Simulations as Practice Spaces for Facilitating Science Discussions

Jamie Mikeska*, ETS, USA

Catherine Flynn, ETS, USA

Devon Fetrow, ETS, USA

Shreyashi Halder, ETS, USA

Tricia Maxwell, ETS, USA

Rutuja Ubale, ETS, USA

Beata Beigman Klebanov, ETS, USA

Abhilash Sarnad, ETS, USA

Sanat Singh, ETS, USA

Mengxuan Zhao, ETS, Canada

ABSTRACT

This study investigated how participants engaged in the practice of using student ideas when facilitating a science discussion in a generative artificial intelligence (GenAI) teaching simulation and participants' perceptions of the simulation's authenticity and usability. In this study, a convenience sample of 13 participants facilitated a total of 17 Mystery Powder science discussions with three GenAI elementary students. We used convergent parallel mixed methods to analyze participants' discussion transcripts and their survey responses. Findings suggest that the GenAI simulation provided opportunities for participants to practice making use of student ideas as they facilitated a science discussion, with many simulation features perceived as authentically representing how elementary students respond. However, results also point to areas that need additional refinement, such as increasing the realism and variation of the student responses and the GenAI students' responsiveness to the questions asked during the discussion. The study shows how GenAI can be used to power simulated student agents that provide opportunities for participants to engage in a core science teaching practice, providing an innovative potential solution to the scalability and access challenges when using human-powered digital teaching simulations.

Stand-Alone Paper

Classroom Text Analytics for Math Anxiety: K-12 Evidence from Expressive Writing

Yiru Wang*, Mount Holyoke College, USA

Ruobing Zhou*, Mount Holyoke College, USA

Yiyuan Li, Reed College, USA

La Li, Mount Holyoke College, USA

Xingcen Liu, Mount Holyoke College, USA
Qinglang Liao, Mount Holyoke College, USA
Ainsley Gruener, Mount Holyoke College, USA
Katherine Binder, Mount Holyoke College, USA

ABSTRACT

Math anxiety is common in adolescence and drains the working memory needed for mathematics. Expressive writing shows promise in lab studies, but its classroom value, especially in international K–12 settings, remains unclear. We combined a brief pre-exam writing activity with an interpretable, privacy-aware text analytics workflow to test whether students' language reflects anxiety mechanisms and relates to performance.

In a quasi-experimental study of 359 Grade 6–8 students, two routine exams were administered. Before testing, students wrote for five minutes about exam thoughts and feelings or responded to a neutral prompt. Linguistic Inquiry and Word Count (LIWC) features profiled cognitive and emotional language.

Four results stand out. (1) Math anxiety was strongly associated with lower exam scores ($r = -0.476$). (2) A single five-minute session showed no detectable average score change (non-significant Time $\times$ Condition). (3) Fast-track and regular classes displayed distinct linguistic profiles (fast-track used more analytic language and showed more positive tone). (4) Exploratory analyses suggested anxiety may partially link gender and performance.

We contribute a lightweight, reproducible workflow for classroom research and program monitoring, and argue that journaling analytics, not only pre-exam writing, can illuminate group-level psychological and cognitive patterns to inform equitable science education support.

How is “ancestry” conceptualized? An exploratory study
Strand 13: History, Philosophy, Sociology, and Nature of Science
21-Apr-26, 12:45-14:15
Location: Virginia (L4)

Related Paper Set

What is “ancestry”?

Kostas Kampourakis*, University of Geneva, Switzerland

ABSTRACT

This paper clarifies the concept “ancestry”, distinguishing between two notions often confused: genealogical ancestry and genetic ancestry. Genealogical ancestry refers to the identifiable ancestors in a person's family tree. Usually, these are one's parents, grandparents, and great-grandparents, but it is possible that someone finds information about ancestors

further back in time through written records or other sources. In contrast, genetic ancestry does not refer to one's family tree, but to the paths through which one's DNA was inherited from one's ancestors. In doing so, it provides the theoretical background for the empirical papers in this related paper set.

Related Paper Set

How is ancestry conceptualized in the journal PLoS Genetics?

Lucie Tournayre*, University of Geneva, Switzerland

Nikolaos Tsourakis, University of Geneva, Switzerland

Nuno Galheto, University of Geneva, Switzerland

Kostas Kampourakis, University of Geneva, Switzerland

ABSTRACT

In recent decades, computational approaches to linguistics have enabled large-scale text mining. In this exploratory study we used ChatGPT to analyze around 25,000 PLoS Genetics excerpts containing references to ancestry. Using four predefined criteria, we distinguished genealogical framings (cultural, ethnic, geographic, or historical lineage) from genetic framings (quantitative estimates or DNA-based evidence). After validating the framework on 91 manually coded excerpts, we scaled the analysis across the full corpus. Results show that genealogical ancestry is more consistently reported, while genetic ancestry appears less coherently and rarely alone. Roughly 40% of excerpts combined both framings, 36% were genealogical only, 15% genetic only, and 9% neither. These findings indicate that PLoS Genetics articles tend to contextualize genetic ancestry with genealogical information. However, the high variability observed across runs indicates that ChatGPT cannot yet be used reliably for this type of analysis. To address this, the next step is to implement the method via the OpenAI API, allowing finer control over model parameters. This study highlights both the promise and the limitations of large language models for large-scale content analysis.

Related Paper Set

"How is 'ancestry' conceptualized by pre-service biology teachers?"

Florian Stern*, University of Geneva, Switzerland

Kostas Kampourakis, University of Geneva, Switzerland

ABSTRACT

Our study explores how pre-service biology teachers construe the idea of "ancestry," a concept at the intersection of genetics, evolution, and cultural identity. Using the repertory grid method (RG), we conducted interviews with six secondary-level pre-service teachers to investigate both individual and general conceptualizations. Participants generated constructs through triadic elicitation, contrasting genealogical, cultural, and historical understandings with genetic and scientific framings. Principal component analysis (PCA) of the grids identified two main dimensions. The first contrasts ancestry represented in scientific and genetic terms (e.g., "mitochondrial Eve") with ancestry framed in genealogical

and cultural terms (e.g., “grandparent,” “Genghis Khan”). The second highlights a distinction between ancestries perceived as African and human origins (e.g., “African ancestry in DNA tests”) and those construed as non-African, non-human, or ancient (e.g., “LUCA”). These findings suggest that pre-service teachers’ construal of ancestry is organized around two axes: genetic versus cultural framings, and African/human versus broader evolutionary perspectives. While the limited sample constrains generalizability, our study demonstrates the potential of the RG method for analyzing how ancestry is conceptualized by future educators. Further research with a larger sample aims to validate these preliminary results and deepen understanding of ancestry in teacher education.

Rethinking Science Teacher Education for Climate and Ecological Responsibility

Strand 14: Environmental Education and Sustainability

21-Apr-26, 12:45-14:15

Location: Jefferson A (L4)

Stand-Alone Paper

Climate Change Educator Identity: A Multidimensional Framework for Transformative Teacher Development

Amal Ibourk*, Florida State University, USA

Sukanya Chakraborty*, Florida State University, USA

Patrick Sonde*, Florida State University, USA

ABSTRACT

Despite growing recognition of climate literacy as essential for twenty-first-century citizenship, teacher preparation programs lack comprehensive frameworks to support the development of climate-change educators’ identities. Existing approaches focus narrowly on beliefs, content knowledge, or emotional regulation, neglecting the complex, multidimensional nature of identity formation. Drawing on sociocultural theories of identity, climate education research, emotional learning scholarship, justice-oriented pedagogy, and decolonial approaches to environmental education, we propose a five-dimensional framework that conceptualizes climate change educator identity as comprising interconnected cognitive, emotional, behavioral, social, and professional dimensions. This theoretical contribution advances the field by: (a) synthesizing fragmented literatures into an integrated identity development model; (b) introducing novel constructs including productive emotional ambiguity, pedagogical emotional purposing, and justice-integrated climate cognition; (c) theorizing how political contestation shapes identity development; and (d) providing research propositions and practical implications for teacher preparation reform. The framework positions climate educator identity as requiring not only scientific understanding but also epistemic justice—recognizing diverse knowledge systems, including Indigenous and relational ways of knowing about human-nature connections. We argue that comprehensive, identity-focused approaches offer greater promise for preparing teachers

capable of sustained engagement in climate education than isolated interventions targeting single dimensions.

Stand-Alone Paper

Navigating Epistemological Plurality: A Theoretical Framework for Interweaving Indigenous and Western Scientific Pedagogies in Climate Change Education

Amal Ibourk*, Florida State University, USA

Lore Nix, E.O. Wilson Biophilia Center, USA

Patrick Sonde, Florida State University, USA

Deb Morrison, University of Washington, USA

ABSTRACT

Learning sciences have inadequately theorized how educators navigate epistemological plurality—particularly in integrating Indigenous and Western scientific knowledge systems in climate education. This paper proposes a three-dimensional framework for educator sensemaking: epistemological navigation, contextual adaptation, and pedagogical confidence-building- with cultural humility positioned as foundational. Grounded in Indigenous pedagogical principles, we argue that cultural humility, not cultural competence, must be foundational to this work. Drawing on principles articulated in First Nations higher education contexts, we engage critically with “both-and” approaches that obscure power dynamics and epistemological incommensurabilities, while acknowledging that our framework does not escape these tensions. We theorize the limits of what non-Indigenous educators can authentically implement without Indigenous partnership and argue that some aspects require structural transformation rather than just individual sensemaking. The paper challenges learning sciences to reconceptualize teacher learning as navigation of colonial histories and cultural positionality, positioning knowledge integration as explicitly political work that may require material changes—to institutions, land relations, and power structures—that frameworks alone cannot accomplish.

Stand-Alone Paper

The Role of Conceptual Learning in Biology Education for Sustainability

Ilona Södervik*, University of Helsinki, Finland

Antti Laherto*, University of Helsinki, Finland

ABSTRACT

Global sustainability challenges necessitate a transformative approach to science education. In this paper, we propose that strengthening sustainability competence requires numerous experiences of conceptual change at the individual level and in societies. It emphasizes the need to rethink the teaching of scientific concepts, especially in biology, to align with emerging educational paradigms that promote agency and transformation. The ecological crisis has revealed that traditional definitions and interpretations of certain key concepts are often inadequate or misleading, necessitating a re-evaluation of these concepts within educational curricula. By drawing on the conceptual change research tradition, we argue

that as scientific paradigms evolve, so too must the meanings of established concepts, prompting a shift in how they are taught. This process involves multiple experiences of conceptual change at both individual and societal levels, enabling learners to develop a deeper understanding of essential concepts. Ultimately, equipping children and adolescents with robust conceptual frameworks will empower them to act as agents of change, fostering a more sustainable future in line with contemporary science education visions.

Dilemmas in Queering STEM education research

21-Apr-26, 12:45-14:15

Location: Redwood AB (L2)

Administrative Session

Organizers

Sara Porter, UNCG, Greensboro, NC, USA

Contributors

Khanh Tran, Utah State University, Logan, UT, USA

Charlie Blake, Southern Illinois University Edwardsville, Edwardsville, IL

Aramati Casper, Colorado State University, USA

Colby Tofel-Grehl, Columbia University, New York City, NY, USA

Ronan Rock, University of Illinois Chicago, Chicago, IL, USA

Mario Suarez, Utah State University, Logan, UT, USA

Alexander Paulchell, University of Arizona, Tucson, AZ, USA

Abstract

In this structured poster session, researchers at different stages of their work on Queering STEM education will share insights and challenges related to their work. The session includes work that brings queer perspectives to the research and design of learning settings, as well as work that centers queer experiences in STEM education research. Bringing queer perspectives into STEM education is relatively new, which makes it more difficult for researchers working in this field to connect with each other and build upon each other's work. Furthermore, attacks on queerness, including legal attacks at the state and federal level regarding the right of queer people to exist publicly in society, defunding of research that engages with queerness, and decreasing societal acceptance of queerness, create additional barriers and demonstrate the vital need for this work and spaces for researchers engaging in it to connect. Participants will be led through a structured protocol to hear about presenters work, challenges they experience and have discussions with colleagues about those challenges in small groups. The session will end with a whole group reflection. Participants will also have time to informally engage with presenters' work at the beginning of the presentation.

Getting Into Good Trouble: Equity and Ethics Considerations When Centering Joyful Transgression and Radical Imagination

21-Apr-26, 12:45-14:15

Location: Willow A (L2)

Administrative Session

Organizers

Scott Cohen, Lamar University, Beaumont, TX, USA

Maria Rivera Maulucci, Barnard College, New York, NY, USA

Laura Peña-Telfer, Purpose Built Schools Atlanta, Atlanta, GA, USA

Alexandria Muller, Rowan University, Glassboro, NJ, USA

Contributors

Deana Scipio, IslandWood, Bainbridge Island, WA, USA

Okhee Lee, New York University, USA

Natalie King, Georgia State University, USA

Sam Lee, California State University Long Beach, USA

Shawn Rowe, Exploratorium, USA

Jessica Hernandez, G3I Enterprises, USA

Abstract

From an equity and ethics perspective, what does it mean to teach science or to conduct research in science education in ways that center joyful transgression and radical imagination? How can we bring together scholars from various disciplines to learn from and strengthen our approach to joyful transgressions within science education? What are some examples of joyful transgression that help us create better futures for science education? How can we engage in a practice of radical imagination to ground research in equity and ethics and push toward better futures in science education for all students and teachers? How do we conduct science education and scientific research in ways that are ethically true and honest despite the pressures to deceive for short-term gain? In this session, an interdisciplinary set of panelists will engage with these questions and share stories of joyful transgression and radical imagination. Session participants will explore ways they, as scholars, can continue to get into good trouble as they navigate the current political climate and work to restructure classrooms, curricula, projects, and programs to support engagement with science for all.

Integrating Skills, Epistemologies, and Inquiry for Critical Thinking

Strand 2: Science Learning: Contexts, Characteristics and Interactions

21-Apr-26, 14:30-16:00

Location: Columbia (L4)

Stand-Alone Paper

Analyzing Core Idea-Practice Integration in Chinese High School Chemistry Classrooms Through Chemical Thinking Perspectives

Honglu Liu*, Beijing Normal University, China

Jiuhua Hu, Beijing Normal University, China

Peng He, Washington State University, USA

Lei Wang, Beijing Normal University, China

ABSTRACT

Core idea-practice integration constitutes a critical pathway for developing students' scientific literacy. Yet few studies have discussed integrated instruction through the lens of chemical thinking. This study posits that chemical thinking perspectives bridge core ideas and scientific practices, arguing the essence of integrated instruction lies in cultivating chemical thinking grounded in chemical thinking perspectives. This study first analyzes integrated manifestations of 21 instructional units from dimensions of core ideas, scientific practices and integration. And it summarizes six integrated categories of Core Idea-Practice Integrated Instruction, including (1) knowledge-practice isolation; (2) structured question-response integration; (3) concrete problem-solving integration; (4) perspective-construction-oriented integration; (5) perspective-construction-application-oriented integration; (6) reflection-oriented integration. Then the study identifies that the engagement in scientific practices, chemical thinking demand based on chemical thinking perspectives and metacognitive reflection are the key factors influencing integration, and proposes a new framework to analyze Core Idea-Practice Integrated Instruction.

Stand-Alone Paper

Exploring Structural Relationships among High School Students' Critical Thinking, Epistemological Beliefs, and Science Process Skills

Feral Ogan-Bekiroglu*, Marmara University, Turkey

Erol Suzuk, Marmara University, Turkey

Cansu Sivgin, Marmara University, Turkey

ABSTRACT

The purpose of this study was to examine the relationships among epistemological beliefs, critical thinking, and science process skills in high school students by comparing two alternative structural models representing different directional pathways of influence. The participants of the study were 1043 students from three different high schools. The Critical Thinking Disposition Assessment, the Epistemological Beliefs in Science Scale, and Science Process Skills Test were the instruments used for the data collection. The results exposed a substantial linear interaction between the constructs (EB, CT, and SPS). Some of the

conclusions derived from the SEM analysis results are as follows: There is a reciprocal relationship between epistemological beliefs in science and critical thinking. Epistemological beliefs and critical thinking have direct and substantial effects on science process skills. And, epistemological beliefs exert a stronger mediating effect than critical thinking on science process skills. This study suggests that raising epistemological awareness should be prioritized in science curricula and activities such as debates on scientific controversies and historical case studies should be encouraged.

Stand-Alone Paper

Reflective Refinement Through Iterative Model Building

Idris Solola*, Utah State University, USA

Hillary Swanson, Utah State University, USA

Sarah Schwartz, Utah State University, USA

Rida Munir, Utah State University, USA

Jared Arnell, Utah State University, USA

Ravi Sinha, Utah State University, USA

ABSTRACT

While research has emphasized the role of classroom discourse, hands-on demonstrations, and carefully crafted prompts in eliciting and responding to students' ideas, there's a need to investigate how the design of instructional activities can support eliciting and refining students' thinking in a structured manner. Drawing on the knowledge in pieces (KiP) epistemology and the concept of responsive teaching, we present an instructional approach called guided reflective refinement (GRR), which guides students to articulate and examine their thinking through building and evaluating models. We analyzed middle school students' model drafts over a 7-day unit on conservation of energy to understand the impact of our approach. Specifically, we provide a case study of one student to illustrate the processes by which guided reflection, scenario-based comparison, and iterative revision supported conceptual growth. By operationalizing GRR through the construction and iterative refinement of models, we position GRR as a pedagogical anchor for responsive teaching and an assessment strategy for capturing conceptual growth. Our study extends current model-based instructional strategies by demonstrating how structured reflection, embedded into modeling cycles, facilitates scientific reasoning across different contexts

Stand-Alone Paper

Ontoepistemologies in College-Level Socioscientific Issue Learning: A Systematic Review of Contexts and Interactions

Eric Nolan*, California State University, East Bay, USA

Syahrul Amin, Texas A&M University, USA

Jennifer Marisi, NESST, USA

Caitlyn Dixon, NESST, USA

Brandi Stroecker, NESST, USA

Kathryn Strom, California State University, East Bay, USA

ABSTRACT

Socioscientific Issues (SSIs) provide college students with opportunities to connect science with ethical, social, and environmental issues when addressing complex, real-world problems. Although research has studied SSI teaching and learning in K–12 settings, little is known about how college-level SSI studies consider students' ontological and epistemological perspectives (i.e., ontoepistemology). This systematic literature review synthesizes 79 peer-reviewed empirical publications between 2005–2025 that use SSI in college classrooms outside of teacher education programs and schools of education (e.g., non-education majors). Our review is guided by established protocols to examine how these studies speak to students' ways-of-being (ontology) and ways-of-knowing (epistemology) within SSI frameworks. In our findings we show that although various studies include aspects of ontoepistemology, often through decision-making frameworks, tradeoff analyses, or perspective-taking measures, college students' experiential elements are typically implied and presented as cognitive skills rather than relational practices grounded in their identities, values, and being in the world. We suggest that intentionally integrating ontoepistemology into research design and classroom practice can help teachers deepen students' engagement with complex issues, promote inclusivity, and increase the authenticity of learning. We also offer implications for designing college-level SSI experiences that emphasize diverse perspectives and strengthen links between science and society.

Interdisciplinary Approaches to STEM and Nature-Based Learning

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

21-Apr-26, 14:30-16:00

Location: Juniper (L2)

Stand-Alone Paper

Designing and Implementing Play-Based Methods in Science: In-Service Teachers' Profiles and Views on Conceptual Playworlds

Argyris Nipyrakis*, University of Crete, Greece

Eleni Stavropoulou, Aristotle University, Greece

Iro Zachariadi, Aristotle University, Greece

Glykeria Fragkiadaki, Aristotle University, Greece

ABSTRACT

Despite the importance of play in preschool education, we have limited knowledge on concrete play-based models for science teaching. This study implemented Fler's Conceptual PlayWorlds (CPW) in a Professional Development (PD) programme in Greece, and examined teachers' views and profiles when designing and reflecting on CPW. Participants were 28 in-service preschool teachers who were assigned to design, implement and reflect on CPW. Qualitative content analysis of their discussions, questionnaires, and

reflections revealed that teachers came up with fewer difficulties in play, but with no prior experience in using play-based methods in science. Teachers provided positive reflections on CPW as well as on collaborating with researchers. Furthermore, six teacher profiles derived from the analysis of their design sessions and reflections, namely, focus on science, scientific methods, pedagogy, play, engineering and collaboration. Implications inform teacher education designers for implementing personalised support in play-based PD programmes.

Stand-Alone Paper

Teacher & Environmental Educator Perspectives: Environmentally-themed Elementary School Partnership programs

Rachel Stronach*, University of Massachusetts Dartmouth, USA

Hamza Malik, Lloyd Center for the Environment, USA

Stephen Witzig, University of Massachusetts Dartmouth, USA

ABSTRACT

This qualitative case study illuminates how key stakeholders (six elementary teachers and the Education Director at an environmental center) describe the goals of a long-standing environmentally-themed formal/informal elementary science education partnership with a suburban school district. Stakeholders described the goals of the partnership programs as addressing state standards/standardized testing, attending to science literacy, and creating excitement and joy around science. What we uncovered in this study is that stakeholders identify environmental issues or human impacts on the environment as tangential goals, and occasionally even problematic. However, the participants all stated the long-term benefits of both the partnership programs and exposure to environmental issues at the elementary grade-level. This study raises a crucial issue around how we engage in environmental issues within the context of partnership programs in formal public schools. As a global community, if we are going to tackle critical environmental issues, such as climate change, then there needs to be a focus on science education that extends beyond the confines of the formal context and connects the community to their local environment (people and organizations) in a meaningful way. Additionally, we need to find ways to openly discuss environmental issues in all educational settings.

Stand-Alone Paper

STEM and Successful Play-based Programs

Michael Kamen*, Southwestern University, USA

Sydney Jackson*, Southwestern University, USA

ABSTRACT

This paper analyzes successful play-based educational programs where STEM is supported through play. Programs range from fully implemented systemic play-based curricula where students control their education (self-directed learning) to traditional schools with play built into the weekly schedule. The purpose is to understand a variety of models that result in sustained and successful play-based programs as defined by the school staff and

administrators. The researchers are not assessing the effectiveness of the programs from the outside but rather reporting on emergent themes reflecting support of ongoing implementation. The data were collected through in-depth interviews. Interviewees all reported on the relevance of STEM in playful learning and teaching. These “Playing with STEM” themes that emerged:

- * Authenticity: Students are often fully engaged in STEM activities with ownership and a purpose, and have powerful learning experiences.

- * STEM has a structure that is easily applied to a “playful” approach to teaching.

- * A playful mindset is vital and natural in STEM.

- * It takes energy to maintain a playful learning environment. Cultural and political realities push educational entities to align with a more typical and traditional pedagogy. It takes diligence, commitment, and a shared vision to maintain the innovation of a playful mindset.

Stand-Alone Paper

Teacher Professional Learning for Productive Interdisciplinary Engagement in Nature-based Learning

Kay Ramey*, University of Iowa, USA

Bianca Schamberger, University of Iowa, USA

ABSTRACT

Opportunities for science learning can be enhanced when we take K-12 students outside. The interdisciplinary opportunities afforded by less formal, nature-based learning (NBL) allow young people to investigate the ‘what?’ and ‘how?’ of natural phenomena while also inquiring into the ‘so what?’ of human-nature interactions that are relevant to their own lives and local/global sustainability efforts. This ‘so what?’ links interdisciplinary inquiries to social studies through questions about how we want to live together with each other and our more-than-human environment. In a larger study, we accompanied traditional classroom teachers and county naturalists in their first iteration of facilitating a week-long nature-based learning program with 4th-6th-graders. Here, we analyze how one science-focused educator and one of the authors with a social studies background created opportunities for productive interdisciplinary engagement (PIE) in a water testing activity. We illustrate this case as instructive example for additional teachers’ professional learning to facilitate PIE in outdoor learning environments.

Equity Inclusion and Critical Perspectives in STEM Education

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

21-Apr-26, 14:30-16:00

Location: Willow B (L2)

Stand-Alone Paper

Bridging High School and College with STEM Experiences and Community: A Longitudinal Mixed Methods Study

Dustin Van Orman*, Western Washington University, USA

Domenico Galati*, Western Washington University, USA

Kadalyna Franck-Tolentino, Western Washington University, USA

ABSTRACT

It is well known that first generation college students face significant challenges navigating higher education and they persist in Science, Technology, Engineering, and Mathematics (STEM) programs at lower rates than their continuing generation peers. Yet, there is limited research describing the high school to college transition for these students or the factors that contribute to whether students ultimately pursue college and STEM. This paper describes the processes and outcomes of a longitudinal college bridge program for high school students whose parents did not complete a four-year degree. We investigate how, from 10th grade to post-high school graduation, high school contributes to students' science identity, motivation, and belonging over time, how students conceptualize and prepare for college, the barriers to pursuing a four-year degree, and the impacts of the bridge program on students' experiences in and decision to continue studying STEM. We find mixed effects of students' high school experiences on science identity, motivation, and belonging, and identify salient factors that support (e.g., engaging in scientific research) and inhibit (e.g., cost of attendance, self-doubt) students' decision to pursue STEM in college. We describe important considerations for preparing students to pursue STEM degrees and careers.

Stand-Alone Paper

Academic capitalism meets feminist socialism: The gender of science teaching in the neoliberal university

Katherine Doerr*, Malmö University, Sweden

ABSTRACT

This study contributes to explanations of why men are overrepresented in science academia worldwide, as well as why the culture of science remains tenaciously masculine. The research approach was comparative ethnography of faculty in two science departments - at a university in the United States and a university in Sweden. Using theories of gender as a social system, data in the form of field observations and thematic interviews was collected over two years. The main finding was that in both contexts, women faculty experienced marginalization due to the perceived competition and intensity of research science. But they were impacted differently. In the United States, faculty cited lack of institutional policies to

support families as contributing to women opting out of the competitive culture, while men could stay in it. In Sweden, faculty praised their government's extensive social support for working families. Instead, they explained women's underrepresentation in STEM as due to a deficit of brilliance or competitive instinct relative to men. The comparative methodology produces a deeper understanding how teaching in science produces gender inequality. When science identity remains gendered, even the most feminist institutional interventions such as the Swedish social welfare model remain insufficient to counteract masculine hegemony in science.

Stand-Alone Paper

Undergraduate Learning Assistants' Conceptions of Racial Equity: Reproducing and Resisting Color-Evasiveness in Postsecondary STEM Classrooms

Regan Levy*, Michigan State University, USA

Shahnaz Masani, Michigan State University, USA

ABSTRACT

This study examines how undergraduate Learning Assistants (LAs) conceptualize race and equity in STEM classrooms. We conducted 27 interviews with LAs at a predominantly white institution, drawing on Bonilla-Silva's (2021) color-evasive framework to explore how they make meaning of race in their roles as educators. All participants drew on the four color-evasive frames—naturalization, minimization, abstract liberalism, and cultural racism—relying on discourses of meritocracy and cultural neutrality to sidestep discussions of race. When structural racism was acknowledged, LAs often employed disconnected power analysis, using systemic language while distancing themselves from responsibility. These findings challenge the assumption that LAs inherently advance equity and highlight the need for sustained, justice-focused training that empowers LAs to enact just STEM learning environments.

Stand-Alone Paper

Adaptive Equity-Oriented Pedagogy Predicts STEM Student Achievement in Higher Education: Evidence from a Multi-Site Study

Andrew Phuong, UC San Diego, USA

Fan Huang, UC San Diego, USA

Judy Nguyen, UC San Diego, USA

Carolyn Hofstetter, UC San Diego, USA

Fabrizio Mejia, UC Berkeley, USA

Stanley Lo*, UC San Diego, USA

ABSTRACT

This study investigates whether instructors' equity-oriented teaching competencies predict student success. In a pedagogy course, graduate and undergraduate-students instructors (hereafter "instructors" for simplicity) completed the Adaptive Equity-Oriented Pedagogy (AEP) Competency assessment after teaching lessons. This portfolio-based assessment asks

instructors to document AEP competencies, and evaluates how instructors plan, teach, reflect, and adapt teaching to address students' equity barriers to learning. At two R1 institutions, multilevel regression modeling suggests that higher AEP competency scores significantly predicted greater student achievement in 14+ STEM and Social Science courses, controlling for instructors' course, class size, teaching experience, race, and gender. The AEP competency assessment supported instructional effectiveness, with many instructors attributing student achievement gains to the use of AEP practices. The previously validated AEP competency assessment has demonstrated strong reliability, exhibits no statistical evidence of gender or racial bias, and correlates with researchers' independent review of instructors' teaching methods and materials. Furthermore, addressing the pernicious belief that equity undermines rigor in curriculum, this study provides evidence that centering equity through AEP can positively impact instructor and student success. This larger-scale study extends prior research from a single site, which found that AEP increased average student achievement by over a letter grade for all students.

Educator Identity, Development & Community

Strand 6: Science Learning in Informal Contexts

21-Apr-26, 14:30-16:00

Location: Seneca (L4)

Stand-Alone Paper

Science Museum Educators' Sense of Community, Self-Worth, and Organizational Commitment

Megan Ennes*, University of Florida, USA

Elizabeth Riotto, University of Florida, USA

ABSTRACT

Museum educators play a vital role in learning in museums for visitors of all backgrounds. However, museum educators tend to be overworked and underpaid leading to high levels of turnover in the field. There are many factors that influence whether educators choose to remain in the field. Grounded in Self-Determination Theory, this study set out to assess the relationship between science museum educators' Sense of Community and Self-Worth and their Organizational Commitment. A survey was created from existing tools and sent out through professional museum listservs. Of the participants, 197 identified as working in science museums. Each construct was composed of multiple subconstructs. A mean sum score was calculated for each subconstruct and a Pearson's correlation coefficient was calculated to assess the relationships between the constructs. The highest correlation was between Sense of Community in the museum education field with Sense of Community in the museum field broadly suggesting participants did not differentiate between the two. High levels of correlation were found between Sense of Community and Affective Commitment- suggesting educators who felt part of the museum community were more

likely to want to stay at their organization. This suggests that building a Sense of Community may support educator retention.

Stand-Alone Paper

Facilitating for Ownership: Supporting Out-of-School Time Educators in Cultivating Youth-Directed STEM Learning

Heidi Cian*, Maine Mathematics and Science Alliance, USA

ABSTRACT

Out-of-school time (OST) programs are increasingly recognized as critical spaces for youth to engage in STEM in ways that foster agency, identity, and ownership over learning. Yet OST educators may feel constrained by scripted curricula or accountability pressures, limiting opportunities for youth to shape their learning experiences. This case study examines how participation in a professional learning module supported OST educators in identifying and enacting facilitation strategies that foster youth mattering in STEM contexts. Using video recordings of three virtual cohort sessions, educator-filmed practice videos, program artifacts, and delayed-time follow-up interviews, we analyzed how four OST educators' discourse and reflections evolved during the program. Findings highlight three key shifts: (1) recognizing latent opportunities for youth voice and choice even in highly structured programs, (2) using facilitator curiosity to elicit and act upon youth reasoning, and (3) extending youth contributions beyond the program to community audiences. Theoretical framing through mattering (Prilleltensky, 2020) underscores the importance of both acknowledging and acting on youth contributions. Findings point to the value of structured peer feedback on authentic practice artifacts and the potential of longitudinal research to connect educator facilitation shifts to youth outcomes.

Stand-Alone Paper

From Classroom to Content Creator: Leadership Practices and Identities of Female Science Teachers on TikTok

Rachel Benzoni*, University of Nebraska-Lincoln, USA

ABSTRACT

This qualitative multiple case study investigates how four secondary science teachers use TikTok to advocate for science education and how content creation shapes their professional identities as leaders. Using interviews and video content with a framework integrating constructivist leadership, Leader Identity Construction Theory (LICT), and the Social Change Model (SCM), findings show participants enacted leadership outside formal roles through distributed and relational practices leveraging social media's affordances. Five themes emerged from the analysis: (1) Reconceptualizing Teacher Leadership on Social Media, (2) Leadership Through Equity-Driven Practice, (3) Constructing and Leading in Online Professional Learning Communities, (4) Forming and Negotiating Identities in New Contexts, and (5) Navigating Perceptions of Expertise and Legitimacy in Science Discourse. Participants used TikTok to reflect on practice, connect with peers, assert professional

authority, and promote inclusive science teaching. This study contributes to research on informal teacher leadership by illustrating how educators use social media to influence science discourse, build community, and advance equity, with implications for teacher preparation, teacher leadership development, and science education policy.

Stand-Alone Paper

Creating a Sense of Belonging: Exploring Informal Science Educator Pedagogies, Storied Identities, & Critical Positional Praxis

Shaghig Chaparian*, NYU, USA

Olivia Ortiz, NYU, USA

Wendy Barrales, John Jay College - City University of New York (CUNY), USA

Luz Velasco Vela, Fordham University, USA

Jasmine Ma, NYU, USA

Latasha Wright, BioBus, USA

ABSTRACT

This study examines how the lived experiences of informal science educators, shaped by experiences related to factors such as race, gender, class, family background, and immigration status, inform the development of their activist identities and justice-oriented teaching practices. Drawing on the frameworks of critical positional praxis (Rodriguez, Mirra, & McNeill, 2023) and storied identities (Avraamidou, 2016; Ibourk, 2022), the research analyzes how the personal and political histories of educators influence their views on science, knowledge, and teaching. Using semi-structured interviews and ethnographic fieldwork at a nonprofit science education organization, this study presents case narratives of four educators showcasing how identity formation, dissent, and relational care emerge through science teaching practices that challenge exclusionary norms and promote community accountability while emphasizing how educators resist depoliticization and reclaim science as a collective endeavor. The findings highlight that emotionally, culturally, and politically grounded experiences, rather than mere mastery of scientific content, serve as the foundation for transformative science education. This research contributes to scholarship on informal STEM education by revealing how informal science educators can navigate power structures, reimagine access and belonging, and teach science as a political, relational, and justice-driven practice.

Cultivating Preservice Teachers Through Authentic Experience and Mentorship

Strand 7: Pre-service Science Teacher Education

21-Apr-26, 14:30-16:00

Location: Boren (L4)

Stand-Alone Paper

Structured Project-Based Learning to Build Science Teaching Expertise in a Didactics Module

Angela Stott*, University of the Free State, South Africa

ABSTRACT

An actionable model to effectively promote the conversion of pedagogic theory to enacted pedagogical content knowledge (ePCK) could guide preservice teacher didactics module design. To this end, this pragmatic, mixed-methods instrumental case study investigates a project-based learning (PjBL) model for developing ePCK. Fifteen fourth-year South African Bachelor of Education students, preparing to teach middle school natural sciences, engaged in a structured PjBL module that scaffolded their three culminating microlessons. This scaffolding involved flipped-classroom content delivery, exemplar video analysis, and iterative lesson planning using Content Representation templates. This study assesses and suggests improvements to this model. Data sources included questionnaires, interviews and videoed microlessons. Data were analysed thematically or with descriptive statistics. Findings indicate that the students perceived the module components to be effective and displayed considerable uptake for most theoretically targeted teaching behaviours. This lends support to the PjBL approach, although this needs adjustment, particularly regarding workload reduction, ongoing opportunities for teaching enactment and more context-appropriate exemplars. The study suggests the potential of structured PjBL to support ePCK development and begins the process of proposing a model to achieve theory-to-practice conversion.

Stand-Alone Paper

Impact of Preservice Science Teachers' Authentic Science Experiences on Agency and Future Classroom Practices

Kim McComas*, University of Arkansas, USA

William McComas*, University of Arkansas, USA

Stephen Burgin*, University of Arkansas, USA

ABSTRACT

This study follows 13 science teachers participating in a five-year fellowship who, as preservice teachers, mentored students in extracurricular clubs in the authentic practice of creating and implementing investigations for a regional science fair. In the subsequent four years of in-service teaching, teachers were tasked with leading a STEM-related student club to continue a focus on authentic practices. A major focus of the fellowship was on the development of teacher and student agency as students engage in authentic science practices. Teachers reported a deepened relationship with science that motivated their

desire to teach science. They described that their students exhibited agency in selection of topics and methodology for investigations, making relevant decisions, seeking answers to questions, knowing when to shift strategies, and resilience and perseverance when faced with setbacks. Another focus of the study included teachers' perceptions of how their involvement in the science fair clubs as preservice teachers later influenced their classroom practices as inservice teachers. Allowing more student autonomy, interest-based assignments, and tweaking assignments to increase authenticity were common responses. Results suggest that embedding authentic science experiences in teacher preparation by involvement in science fairs has benefits for teachers and their students as they immerse themselves in science.

Stand-Alone Paper

From Curiosity to Investigation: How the H4SI Toolkit Improves Preservice Elementary Teachers' Scientific Question Formulation

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

Formulating high-quality scientific investigative questions remains a persistent challenge for preservice elementary teachers (PSTs), who often struggle to create questions that are testable, scientifically accurate, and developmentally appropriate. This comparative study examined whether the Hopscotch 4 Scientific Investigations (H4SI) web-based toolkit improves PSTs' capacity to develop investigative questions aligned with NGSS three-dimensional learning principles. Thirty-two PSTs enrolled in integrated science courses at a public university in Georgia used the H4SI toolkit's nine-step structured scaffold to plan phenomenon-based investigations. Their investigative questions were evaluated using a validated framework assessing testability (0-2 points), scientific accuracy (0-1), alignment to objectives (0-1), and K-5 appropriateness (0-2). Results were compared with previously published data from non-H4SI cohorts using identical coding criteria. The H4SI cohort demonstrated dramatic improvements across all categories, with testability showing the most striking gains (93.8% highest scores versus 40% non-H4SI groups). Overall quality scores of 6 points exceeded 60% for H4SI users compared to 22.7-28.0% for non-H4SI cohorts. While 15.6% of questions remained overly complex for elementary learners, the toolkit effectively transformed PSTs' vague observational prompts into measurable, scientifically grounded investigations. These findings offer teacher educators a practical, evidence-based framework for developing PSTs' inquiry skills essential for facilitating authentic elementary science learning.

Stand-Alone Paper

Developing Elementary Pre-Service Teachers' Science Teaching Self-Efficacy Through A Near-Peer Mentorship Program

Taiwo Ogundapo*, Indiana University Bloomington, USA

Meredith Park Rogers, Indiana University, USA

ABSTRACT

This research examines how a near-peer mentorship program influence the self-efficacy of elementary pre-service teachers, using a single case study approach. Six pre-service teachers took part in a structured mentorship initiative that paired them with mentors who were only slightly more experienced and had recently undergone similar teacher training. Data was gathered through semi-structured interviews and was analyzed thematically with the aid of NVivo software. The findings reveal that near-peer mentorship significantly enhanced the teaching self-efficacy of the participants through three interconnected processes: (a) learning from relatable role models, (b) receiving constructive feedback and emotional support in a supportive environment with minimal power distance, and (c) engaging in guided practice and reflective activities. The participants reported increased confidence in areas such as lesson planning, classroom management, and adapting instruction to meet student needs, as well as a stronger sense of belonging within the teaching profession. These results highlight the effectiveness of near-peer mentorship as a cost-efficient and contextually relevant approach to improving self-efficacy in teacher preparation programs, especially in situations where access to experienced mentors is scarce. The study discusses implications for program design, teacher education curricula, and future research focused on peer-based professional development.

Reimagining Curriculum-focused Professional Learning: Building Teachers' Practical Ideologies for Curricular Sensemaking, Adaptation and Enactment

Strand 8: In-service Science Teacher Education

21-Apr-26, 14:30-16:00

Location: Greenwood (L3)

Related Paper Set

What About Student Resources?: A Teacher's Pedagogical Design Capacity for Planning and Enacting Equitable Discussions

Kevin Hall*, Stanford University, USA

Nicholas Leonardi, University of Illinois Urbana-Champaign, USA

Christina Krist, Stanford University, USA

Barbara Hug, University of Illinois Urbana-Champaign, USA

ABSTRACT

Reform efforts in science education advocate for approaches that support students' sensemaking (NRC, 2012). Sensemaking can be made more equitable by leveraging "students' ideas, experiences, and cultural resources while disrupting power structures" (Haverly et al., 2020, p. 63). This requires teachers to develop pedagogical design capacity (PDC), or a teacher's ability to leverage various teacher and curricular resources to make productive instructional changes (Brown, 2002; Davis et al., 2011). Our project aimed to support teachers' PDC for supporting students' equitable sensemaking using scientist circles. We sought to understand: How does a teacher's PDC develop through the planning and enactment of scientist circle discussions across a school year? To answer this, we investigated a case study of one teacher, Fiona, across four scientist circle enactments in a school year. We document how she leveraged student resources alongside teacher and curricular resources. Our analysis shows that Fiona's hypervigilance to student risk-taking created a feedback loop shaping her beliefs, pedagogical content knowledge, and subsequent instructional choices. We argue that incorporating student resources into the PDC framework broadens our understanding of how teachers develop capacity for equitable discussions and adapt curriculum materials to support students' equitable sensemaking.

Related Paper Set

Building reciprocal classroom-community partnerships as a catalyst for supporting students' critical science agency

Julia Poel*, Stanford University, USA

Christina Krist*, Stanford University, USA

Liz Harris*, Stanford University, USA

Kevin Hall, Stanford University, USA

Michelle Zhang, Stanford University, USA

ABSTRACT

Reform efforts call to position students as epistemic agents in the "figuring out" out of science phenomena (Reiser et al., 2021; Windschitl & Stroupe, 2017). One way to build on these reform efforts is to support students' critical science agency (CSA). Students demonstrate CSA when they work to figure out a relevant science phenomenon and connect transdisciplinary knowledge to address a justice issue (Schenkel & Calabrese Barton, 2020). Partnerships with community organizations can help provide these opportunities for students. However, developing partnerships is challenging, and teachers are not often equipped with time, skills, or resources to navigate meaningful partnership development. We explore how a professional learning workshop with a focus on developing reciprocal partnerships begins to shape teachers' plans for supporting students' CSA. Our findings suggest that reciprocal classroom-community partnerships may serve as a catalyst for students' CSA, helping teachers position students as leaders of their science learning (Reiser et al., 2021; Windschitl & Stroupe, 2017). However, how teachers continue to shape their plans for community partnerships and students' CSA is yet to be seen. As the project continues, we plan to lean into the different pathways teachers are taking to support students' CSA through their community partnership development.

Related Paper Set

From Practical Ideology to Implementation: How Curriculum Shape Teacher Change

Nga Hoang, University of Colorado Boulder, USA

Mon-Lin Monica Ko, University of Colorado Boulder, USA

ABSTRACT

This paper reports results from a year-long professional learning series designed to center students' epistemic agency as a lens for deepening teachers' pedagogical design capacity in the use of curriculum materials. Five science teachers articulated an epistemic-agency framing, planned adaptations in the Summer, then implementation and reflection through Fall and Spring meet-ups. Using field notes and video transcripts, we conducted within-case coding to build each teacher's trajectory across summer, fall, and spring, then compared cases. We report two contrasting cases. Cagney, whose practical ideology aligned with curricular features, could offload task design to the curriculum and focus on enacting, reflecting on, and refining an existing instructional routine. By contrast, Childer's curriculum lacked routines aligned with her practical ideology, faced a redesign burden that stalled implementation. Across cases, we find that while professional learning can foster productive epistemic-agency orientations, teachers' ability to adapt and enact curriculum in alignment with these ideologies is shaped by the curriculum materials they are building from.

Related Paper Set

Recognizing Community Cultural Wealth: Challenges to and Opportunities For Building Classroom-Community Partnerships

Mon-Lin Monica Ko*, University of Colorado Boulder, USA

Melissa Campanella, University of Colorado Boulder, USA

ABSTRACT

This study examines a professional learning (PL) approach designed to help science teachers adapt curriculum materials to center community cultural wealth (Yosso, 2005) and local expertise. While NGSS-aligned, open-source curricula offer transformative potential, they often overlook students' community contexts. In a linguistically and culturally diverse Midwestern high school, five science teachers participated in a three-day workshop to explore how reciprocal partnerships with community-based organizations could shape instruction in Chemistry, Biology, and Earth Science. Activities included reflecting on prior partnerships, analyzing equity-oriented teaching cases, engaging in social annotation of scholarship on school-community collaboration, and developing plans for justice-oriented curricular adaptations. Analysis of annotations, discussions, and teacher journals revealed both opportunities and challenges in integrating community knowledge. Teachers envisioned leveraging local expertise—such as family members' professional skills—as scientific resources, while also grappling with how to represent the complexity of highly diverse communities within limited instructional time. The workshop surfaced tensions

between honoring diversity and designing feasible classroom enactments, while fostering concrete ideas for partnerships and curricular changes. Findings highlight how PL can position teachers to see community cultural wealth as integral to science learning, setting the stage for future research on how such partnerships influence curriculum design and student engagement.

What's in a Frame?: Challenges and Opportunities in Learning to Teach for Equity

Strand 8: In-service Science Teacher Education

21-Apr-26, 14:30-16:00

Location: Issaquah AB (L3)

Related Paper Set

A Teacher's Use of Equity Frames in Their Noticing and Decision-Making

Linsey Brennan*, Michigan State University, USA

ABSTRACT

The mental frames teachers use guide their noticing and decision-making, positioning equity frames as particularly critical for professional learning facilitators to attend to as they support efforts to teach for equity. This paper examines how a teacher uses different equity frames to make sense of classroom video and decide on an instructional response. I use noticing for equity to analyze the teacher's discourse during video analysis sessions as they reflect on videos of their teaching and plan equity-oriented action-steps. Through reflexive thematic analysis and critical discourse analysis, I illustrate how different ecological scales (e.g., institutional policies, lack of seniority among colleagues) can constrain teachers' perceived agency, and as a result may prompt shifts in their equity frames towards ones they see themselves having the greatest control over. This paper suggests different ecological scales may provide professional learning challenges and opportunities by influencing the variety of equity frames teachers use as they make sense of their classroom and decide what it means to teach for equity.

Related Paper Set

"Seeing Where We Stand": Building Ideological Attunement Through Pedagogical Judgement

Matt Stewart*, University of Washington, USA

ABSTRACT

What teachers do during PLCs and what issues they attend to are central questions that researchers need to understand in order to better support and theorize in-service teachers' professional learning. This paper examines teachers' pedagogical judgment in the context of PLCs, focusing on how teachers reify or resist dominant ideologies and rearticulate

ideologies toward ambitious and equity goals. I use the concept of ideology-in-pieces to explore the process of teachers' conceptualization and transformation of equity and their teaching practice, as they grapple with taking asset-based views of students' abilities, the role of dominant language in classrooms, and how science is framed alongside equity. I use an analytical framework of pedagogical judgement to explore four middle school teachers' PLC discussions in which they describe their pedagogical actions, reasoning, and responsibilities in episodes of student work analysis. I will present findings that show how teachers' pedagogical judgement is taken up by others, how these ideas relate to interactions, elaborations, and shared understandings, and their classroom practices, and I will explore the processes of teachers' ideological sense-making and shifts to take up more well-elaborated and nuanced ideological conceptual resources.

Related Paper Set

Ethical Decision-Making in Action: Teachers' Learning Opportunities Through Case-Based Discussions in Professional Learning

Nicholas Leonardi*, University of Illinois Urbana-Champaign, USA

ABSTRACT

Teachers can customize curriculum materials to make instruction more equitable by enhancing relevance (McNeill et al., 2024). However, customizing for relevance raises a variety of ethical dilemmas that teachers must grapple with. For example, teachers might need to make decisions about whose cultural experiences to make space for or center and when (Miller et al., 2018). One strategy to support teachers' ethical decision-making is through the use of normative case studies (NCS). NCS are texts that include a series of events, raise questions about whether and how something should be done, and are complex and based on reality (Taylor, 2024). This study explores the learning opportunities for a team of professional learning (PL) participants engaged in a NCS discussion focused on the ethical dilemma of whether to incorporate and discuss a societal issue. The findings of this study suggest that NCS provide a useful structure to engage teachers in ethical decision-making around their customization choices in PL. These findings have implications for the design of PL experiences focused on radically re-imagining curriculum materials and instructional practices to be more equitable, and address the needs identified in the 2024 NASEM Equity Report to examine PL experiences and teachers' decision-making around equity.

Related Paper Set

Staying, Moving, or Leaving?: The Career Trajectories of Early Career Science Teachers in High-Needs Schools

Adepeju Prince*, Kent State University, USA

ABSTRACT

Early career teacher attrition remains a pressing challenge in education, with science teachers in high-needs schools particularly vulnerable due to specialized content demands, inadequate resources, and inconsistent support. High turnover may hinder the National

Academies of Science, Engineering, and Medicine (NASEM) 2024 equity vision of engaging and valuing the diverse identities and experiences of historically marginalized science, technology, engineering, and mathematics (STEM) students. Guided by Bronfenbrenner's Ecological Systems Model (ESM), this qualitative multiple case study examined the career migration decisions of six early career science teachers (ECSTs) in high-needs schools; two stayers, two movers, and two leavers over three years. Data sources included pre- and end-of-year interviews, a teacher commitment scale, and exit interviews. Cross-case analysis revealed that the retention microsystem supports sustained retention. Movers relocated to regain ecological alignment, while leavers experienced progressive erosion of support, compounded by increased workload and reduced resources. Macrosystem alignment between school culture and teacher identity bolstered commitment, whereas cultural mismatch often triggered migration. Findings highlight the importance of sustaining ecological fit through intentional placement, science-specific resources, and long-term mentoring. Addressing these multi-layered influences can improve retention of ECSTs in high-needs contexts, ensuring stability and quality in science education for underserved students.

Culturally Sustaining Approaches to Classroom Assessment in Science and Engineering: Findings, Tensions, and Open Questions

Strand 10: Curriculum and Assessment

21-Apr-26, 14:30-16:00

Location: Capitol Hill (L3)

Symposium

Culturally Sustaining Approaches to Classroom Assessment in Science and Engineering: Findings, Tensions, and Open Questions

Erin Furtak*, University of Colorado Boulder, USA

Hosun Kang*, University of California Irvine, USA

Christopher Wright*, Drexel University, USA

Clarissa Deverel-Rico*, BSCS Science Learning, USA

Shakhnoza Kayumova*, University of Massachusetts Dartmouth, USA

Veronica McGowan*, University of Washington Bothell, USA

Lauren Stoll, WestEd, USA

Nelly Tsai, Northwood High School, USA

Django Paris, University of Washington Seattle, USA

Dionne Champion, University of Florida, USA

ABSTRACT

How can we transform science and engineering classroom assessment so that it better attends to learners' repertoires of practice, embracing what they know and can do and who they are, builds on community knowledge and epistemologies, and engages all the intellectual and linguistic resources they bring to learning environments? This symposium

brings together five teams of scholars and practitioners conducting research in the emerging area of culturally sustaining approaches to science and engineering classroom assessment across various contexts (e.g., classrooms, teacher learning, informal spaces). The purpose is to: a) promote discussion across different ways of conceptualizing and conducting work in this area, b) highlight recent empirical findings, and c) articulate tensions and newly emerging questions to inform future work. This session directly addresses this year's theme, "Joyful Transgressions and Radical Imagination in Science Education" by theoretically and practically exploring new possibilities of science and engineering classroom assessments toward a more equitable and just future.

Operationalizing culturally responsive, relevant, and sustaining pedagogies

Strand 11: Cultural, Social, and Gender Issues

21-Apr-26, 14:30-16:00

Location: Ballard (L3)

Stand-Alone Paper

Finding Moments of Joy: Reimagining Relationships with Science through Culturally Responsive Science Teaching

Jamie Wallace*, American Museum of Natural History, USA

Elaine Howes, American Museum of Natural History, USA

Melanie Hopkins, American Museum of Natural History, USA

Aline Gjelog, American Museum of Natural History, USA

Steven Riccio, American Museum of Natural History, USA

ABSTRACT

Culturally responsive teaching (CRE) is an equity pedagogy that supports effective science teaching. This case study explores CRE as one science teacher implements it, utilizing a framework describing teaching that holds high expectations for learning, values and uses students' assets, draws upon students' cultures, and supports students in developing a critical stance. Deeliah supports students in accessing science through their lived experiences, interests, and cultures via enacting CRE, providing multiple access points for students to connect with science. Several themes surfaced illustrating how Deeliah creates multiple access points for students: 1) opportunities for students to see themselves in science, 2) incorporating student choice, 3) using creativity as an entryway to support CRE, and 4) finding moments for joy and fun.

Stand-Alone Paper

Re-imagining pre-service science teacher preparation: A microethnographic exploration on equity-minded pedagogy development through Foucauldian perspectives

Gina Zaccagnini*, Purdue University, USA

ABSTRACT

As K-12 schools in the U.S. continue to diversify, education organizations have initiated efforts to integrate multicultural education across disciplines, including science. This shift then began a crucial discussion on effectively meeting the needs of diverse cultures in the classroom. From the perspective of equitable teaching, the framework of equity-mindedness was developed to address structural inequities in education. However, limited research exists on pre-service teachers' (PST) perspectives on integrating equity-minded practices into their science instruction. It is essential for PST programs to intentionally make learning equitable for all students. Therefore, early exposure to equity-mindedness ensures PSTs enter the profession with a solid understanding of inclusive practices, fostering a lifelong commitment to educational equity and impactful teaching careers. This study explores PSTs' development of equity-minded pedagogy using a microethnographic approach, as well as Foucault's theory of power/knowledge to understand any conflict the PSTs might have with this new pedagogy within science. Three PSTs participated in a semester-long learning community focused on equity-minded practices and discourse. Findings show a clear connection between participants' experiences and Foucault's theories on the historicity of science and normalization, and the interplay between power dynamics and knowledge production within science education.

Stand-Alone Paper

Humanizing Science Instruction through Culturally and Historically Responsive Teaching and Learning

Vanessa Louis*, University of Michigan, USA

ABSTRACT

This presentation examines the limitations of current K-12 science education reforms in effectively addressing racial inequities and directly confronting issues of race and racism. Although the Framework for K-12 Science Education aspires to "Science and Engineering for All," it often fails to recognize race and racism as fundamental factors in educational disparities, thereby implicitly shifting responsibility for achievement gaps onto Black students rather than the educational system itself. To address this shortcoming, the presentation proposes the adoption of Ghoddy Muhammad's Culturally and Historically Responsive Teaching and Learning (CHRTL) and HILL framework in science instruction. Drawing on case studies and lesson examples from two early-career science teachers implementing the HILL approach, this presentation demonstrates how centering identity and criticality within pedagogy can foster deeper human connections and enhance science learning outcomes.

Stand-Alone Paper

Affirming Undergraduates' Science Identity through Community-Based and Culturally Relevant Science Teaching

Perla Ramos Carranza*, Cal Poly, San Luis Obispo, USA

Jasmine Nation, Cal Poly, San Luis Obispo, USA

Alejandra Yep, Cal Poly, San Luis Obispo, USA

Xavier Aguilar, Cal Poly, San Luis Obispo, USA

Thais Malfavon, Cal Poly, San Luis Obispo, USA

Jessica Garcia-Tapia, Cal Poly, San Luis Obispo, USA

Isaiah Rivera, Cal Poly, San Luis Obispo, USA

ABSTRACT

To support the retention and persistence of underrepresented minoritized (URM) students in science, it is valuable to consider the implementation in higher education of pedagogical approaches that counter traditional views of science, such as service-learning and culturally relevant pedagogy. This paper centers the experience of undergraduates who participated in a service-learning course where they taught microbiology lessons in Spanish to bilingual elementary students and examines how their participation shaped their science identity. Focus group interviews were conducted with 32 undergraduates (78% female; 75% Latinx/Chicanx) who enrolled in the service-learning course for at least one quarter between 2021-2024. A thematic analysis that included multiple iterative rounds of inductive and deductive coding and group discussions to refine the observed patterns was completed. We found three themes that exemplify how participation in the service-learning course shaped undergraduates' views of their past, present, and future selves in relation to science: connecting to childhood selves, transforming perceptions of science, and envisioning new possibilities for the future. This paper has important practical implications for science faculty and departments in higher education that seek to transform their science learning spaces to promote the identity and belonging of URM students.

Stand-Alone Paper

What Do You Mean Community? Contextualizing Community Through STEM

D'Angelo Peters*, Purdue University, USA

Lynn Bryan, Purdue University, USA

Elizabeth Thiel, Purdue University, USA

ABSTRACT

A push for science and STEM education to consider student and their communities within the science classroom has risen across America. To make science a space where students' communities are valued, we have designed two STEM units that focus on student agency regarding their geographical and sociocultural communities. We utilized culturally sustaining pedagogy (CSP) as the theoretical backbone for developing these two units.

Affirmative Transgressions: Exploring the Relationship Between Black STEM Students and Place Identity

Strand 11: Cultural, Social, and Gender Issues

21-Apr-26, 14:30-16:00

Location: Cedar AB (L2)

Symposium

Affirmative Transgressions: Exploring the Relationship Between Black STEM Students and Place Identity

Shari Watkins*, American University, USA

Terrell Morton*, University of Illinois Chicago, USA

Jenn Adams*, University of Calgary, Canada

Tia Madkins*, University of Texas Austin, USA

Ashley Woodson*, Wayne State University, USA

Nickolaus Ortiz, Georgia State University, USA

Joanna Ali, North Carolina A&T State University, USA

Paula Groves Price, North Carolina A&T State University, USA

Yasmiyn Irizarry, University of Texas Austin, USA

Brian McGowan, American University, USA

Andrea Tyler, Tennessee State University, USA

ABSTRACT

This symposium constitutes a collection of ideas that examine the real and imagined homelands, migrations, and markers of history and belonging for Black people. Black geographies identify socio-spatial events, or significant cultural moments that help us understand how Black people “are shaped by, and are shaping, the imaginative, three-dimensional, social, and political contours of human geographies” (McKittrick & Woods, 2007, p. 5). The four presentations in this symposium build theory that connects the historical experience of dispossession to undergraduate students’ identity formation. Race and place work together to produce personal and collective identities. We posit this knowledge can be used to empower yet another source of intrinsic motivation for Black undergraduate STEM majors.

Expansive Science Learning for Heterogeneity, Justice, and Towards More Sustainable Futures.

Strand 11: Cultural, Social, and Gender Issues

21-Apr-26, 14:30-16:00

Location: Ravenna AB (L3)

Symposium

Expansive Science Learning for Heterogeneity, Justice, and Towards More Sustainable Futures.

Veronica Cassone McGowan*, University of Washington Bothell, USA

Carrie Tzou*, Northwestern, USA

Symone Gyles*, University of California Irvine, USA

Elizabeth Starks*, University of Washington, USA

Bryan White, University of Washington Bothell, USA

Megan Bang, Northwestern University, USA

ABSTRACT

This session explores the ways that one multi-layered design-based research project supports the learning of preservice and practicing teachers, and university faculty, at the edges of contemporary scientific disciplines. In this session, we will share design work and findings from an NSF-funded project to design two “science for elementary teachers” courses and a professional development series that integrate NGSS-aligned science and engineering concepts, equity and power, and contemporary scientific tools and practices in the context of examining the history of racist research practices within science itself. In this session, we ask: how can undergraduate science courses and science teacher professional learning integrate issues of racial justice to support more just and equitable teaching of science across K-16 contexts?

Navigating the Transformative Potential of AI in Science Education: Adaptive Learning Architectures and Ethical Considerations

Strand 12: Technology for Teaching, Learning, and Research

21-Apr-26, 14:30-16:00

Location: Jefferson B (L4)

Stand-Alone Paper

Navigating the Transformative Potential of AI in Science Education: Adaptive Learning Architectures and Ethical Considerations

Marcus Kubsch*, Freie Universität Berlin, Germany

Knut Neumann, IPN – Leibniz Institute for Science and Mathematics Education, Germany

Paul Martin, JLU Gießen, Germany

Brandon Yik, University of Georgia, USA

Benjamin Burlingham, Indiana University, USA

Nicole Graulich, JLU Gießen, Germany

Peter Wulff, PH Ludwigsburg, Germany

Paul Wulff, TU Berlin, Germany

ABSTRACT

This symposium examines the transformative potential and inherent challenges of AI integration in science education through four complementary presentations addressing adaptive learning architectures and ethical considerations. It opens with theoretical

contextualization of adaptive learning frameworks, followed by empirical investigations of both student-facing and teacher-facing pathways in AI-enhanced instruction.

The first presentation explores AI-supported individualized science teaching through learning progression analytics, demonstrating how automated assessment of student artifacts can inform pedagogical decision-making in physics education. The second presentation investigates undergraduate chemistry students' learning trajectories in AI-based adaptive systems through the lens of educational debt, revealing how current implementations may perpetuate rather than mitigate educational inequities across demographic groups.

The third contribution examines generative AI's capabilities for automated assessment and complex data processing in science education research, highlighting both the potential for sophisticated pattern recognition and the limitations of inductive learning approaches. The concluding presentation provides critical analysis of AI's ethical dimensions, challenging automation-centric narratives while proposing an equity-centered framework emphasizing transparency, contextual sensitivity, and accountability.

Through integrative synthesis and open discussion, this symposium offers essential discourse on navigating AI's educational potential while systematically addressing neo-colonial dynamics, algorithmic bias, and the imperative to prioritize equity over technological optimization in science education transformation.

Learning about Viral Epidemics through Engagement with Different Types of Models

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

21-Apr-26, 14:30-16:00

Location: Virginia (L4)

Related Paper Set

Students' Epistemic Considerations of Modeling in the Context of COVID-19

Shumin Zhao, University of Nevada, Reno, USA

Li Ke*, University of Washington, USA

Laura Zangori, University of Missouri, USA

Troy Sadler, University of North Carolina at Chapel Hill, USA

ABSTRACT

This study explored middle school students' epistemic considerations of modeling in the context of COVID-19. A qualitative case study design was used, involving nineteen students who participated in a researcher-led summer camp focused on viral transmission. Students were asked to create two types of models to explain virus transmission and illustrate the societal impacts of the pandemic. Semi-structured interviews were conducted at the end of

the camp to capture students' perspectives on both types of models. A five-dimensions framework for students' epistemic considerations of modeling was used to analyze the data. Findings indicate that 1) students were able to identify key components and use evidence in their modeling; 2) students found it challenging to articulate limitations of their models; 3) students considered their audience during the modeling process.

Related Paper Set

Socio-scientific Issue Based Learning with Multiple Models

Troy Sadler*, University of North Carolina at Chapel Hill, USA

Laura Zangori, University of Missouri, USA

Eric Kirk, Utah State University, USA

ABSTRACT

Today's science classrooms should be spaces in which learners explore complex Socioscientific Issues (SSI). Recent research on teaching and learning with SSI has revealed that

scientific modeling can help students learn important science associated with SSI as well as serve as epistemic tools to support decision-making and responsible action. This paper presents an investigation of the design and implementation of multiple modeling activities related to viral pandemics. It explores how students make sense of viral pandemics through engagement in modeling practices across different types of models and how should opportunities to engage in modeling practices across different types of models be scaffolded and sequenced. Insights from this work include student development of conceptual understanding through engagement with multiple models, student enthusiasm for modeling opportunities, and student tendencies to focus on details of a context at the expense of conceptual generalizations.

Related Paper Set

"What Works for MLLs Works for Everyone": Unpacking Science Teachers'

Understanding of Language in Modeling

Ayça Fackler*, The University of Missouri, USA

Madeline Good, Truman State University, USA

Laura Zangori, The University of Missouri, USA

ABSTRACT

Modeling, a core science practice in the Next Generation Science Standards, holds particular promise for multilingual learners (MLLs) due to its multimodal and iterative nature. However, in many classrooms, modeling is framed as a product-oriented task focused on technical vocabulary, limiting its potential for integrated language and idea development. This exploratory single case study examines how three middle school science teachers in linguistically diverse contexts understood language use in modeling during a professional learning (PL) program centered on socioscientific issues, specifically viral epidemics.

Grounded in a raciolinguistic perspective and the concept of language architecture, we analyzed interviews, PL recordings, surveys, artifacts, and memos using thematic analysis. Three themes emerged: (1) delaying model labels vs. sensemaking, (2) humanizing modeling practices amid structural barriers, and (3) modeling as an invitation to language. Teachers varied in whether they positioned language as a resource for sensemaking or a prerequisite for participation, revealing both deficit-oriented assumptions and expansive framings. Findings highlight how PL can surface, challenge, and extend teacher thinking about language use in modeling, affirming that approaches supporting MLLs—positioning language as a gateway rather than a gatekeeping practice—enhance access, agency, and disciplinary engagement for all learners.

Related Paper Set

Design Reasoning During SSI Solution-finding

Jamie Steiner*, University of North Carolina at Chapel Hill, USA

Troy Sadler, University of North Carolina at Chapel Hill, USA

ABSTRACT

National science standards include “designing solutions” as an important practice all students should learn during their K-12 education. Students often have limited opportunities to engage in solution-finding for real-world societal problems such as climate change, viral pandemics, food shortages, or genetic engineering. In addition, educators report uncertainty with knowing how to incorporate solution-based activities in their classrooms. We develop an approach to guide students through phases of solution-finding which includes investigating the problem using models, brainstorming solutions, and assessing solutions based on pre-determined criteria. In this paper, we analyze how students reason about the solutions they design such as dimensions of the issue they prioritize and the kinds of evidence they use to justify their claims. Our goal is to support learners in developing comprehensive solutions which are based on scientific principles but also attend to morals and ethics involved in the problem.

Climate Change and Global Competence: Youth Voices and Transformative Experiences

Strand 14: Environmental Education and Sustainability

21-Apr-26, 14:30-16:00

Location: Jefferson A (L4)

Stand-Alone Paper

Empowering urban high school students in geoscience through an environmental geochemistry intervention

Lisa Marco-Bujosa*, Villanova University, USA

Hannah Feldman, Villanova University, USA

Steven Goldsmith, Villanova University, USA
Kabindra Shakya, Villanova University, USA
Vanessa Boschi, Villanova University, USA
Evelyn Sperry, Villanova University, USA
Jacob Turko, School District of Philadelphia, USA
Najwa Smith, School District of Philadelphia, USA

ABSTRACT

Underrepresented racially and ethnically minoritized residents in urban communities are disproportionately impacted by environmental contamination. This underrepresentation can, in part, be attributed to decreased access to geoscience coursework and exposure at a high school level that causes a disproportionately low bachelor's degree attainment by minoritized youth (<20%). In response, we designed a geoscience curriculum enhancement and summer pathway program consisting of hands-on, place-based, and justice-centered exploration of geoscience concepts related to issues of urban environmental contamination. The findings report on two years of activities. The curriculum enhancement was administered in partnership with a high school environmental horticulture teacher, while the summer pathway program was carried out in the environmental science department of a university. Data sources included pre/post surveys, focus groups, student artifacts, and field observations. Findings showed increased student interest in the geosciences and the role of geoscientists in communities, increased critical science agency, and successful acquisition and application of geoscience knowledge. Overall, the study results suggest that a high school learning experience centered on urban environmental contamination, presented through a justice focused lens, could broaden student engagement with the geosciences.

Stand-Alone Paper

Undergraduate Attitudes and Beliefs About Climate Change Following a Study-Abroad Experience in Fiji

Krista Lucas*, Pepperdine University, USA
Abigail Baker*, Pepperdine University, USA
Catherine Nguyen*, Pepperdine University, USA
Elizabeth Stansberry*, Pepperdine University, USA
Timothy Lucas, Pepperdine University, USA
Donna Nofziger, Pepperdine University, USA

ABSTRACT

As climate change becomes an increasingly pressing global issue, education and experiences surrounding the environment—particularly for younger generations—are a more relevant field of study than ever. This project explores the impact of a study abroad experience on undergraduate students' perspectives on climate change. We used both qualitative and quantitative methods to assess the nature and extent of changes in participants' views. Preliminary findings, consisting of survey results from Likert-style questions alongside open-ended responses, indicate that this experience catalyzed increases in students' awareness of the impacts of climate change and their sense of the urgency concerning this issue. Students

also reflected on environmental injustice and human contributions to climate change. The results represent strong support for place-based learning, where geographical and cultural grounding enhances informal education, even in a program which has a primarily clinical, rather than environmental, focus. Importantly, the changes were not limited to theory; after the study abroad experience, we found significant changes in students' willingness to take pro-environmental action. Given the global reach and extensive impacts of climate change, experiential learning that drives measurable change is crucial, especially for future community leaders and decision makers.

Stand-Alone Paper

Student-Centered STEM Education: Highlighting Youth Voices Through Policymaking

Hamza Malik, Lloyd Center for the Environment, USA

Muhammad Usman Ijaz*, UMassD, USA

Syed Nauman Wazir*, UMassD, USA

Rachel Stronach, UMassD, USA

Chad McGuire, UMassD, USA

Stephen Witzig, UMassD, USA

ABSTRACT

Youth engagement in policymaking is a powerful means for amplifying their voices and instilling a sense of civic responsibility. This research study explores and provides evidence about how a coastal ecology program empowered youth voices by integrating the 4L approach: 1) Listen to your students, 2) Learn about their context, 3) Let students be the leaders, and 4) Leverage out-of-classroom experiences. We share detailed examples from our program about the impact of student-centered instruction on fostering critical thinking and decision-making skills. By getting to know students' unique interests and backgrounds, educators can tailor instruction to meet their needs. Focusing on local environmental issues can help connect classroom discussions to real-world issues. Inviting students to lead policy-making tasks and decision-making processes promotes a sense of ownership and empowers them to propose practical solutions. Findings suggest that positioning students as active contributors rather than passive learners increases their sense of agency and investment in environmental solutions and, most importantly, enhances ways to increase youth voices in STEM learning spaces. Our approach offers a replicable model for fostering youth leadership in addressing pressing environmental and societal issues in various educational contexts.

Stand-Alone Paper

Nurturing Global Competence in Science Classrooms through a Unit on Climate Change

Arya Karumanthra*, Indiana University, USA

Gayle Buck, Indiana University, USA

ABSTRACT

This study contributes to the growing field of science education that seeks to reimagine the curriculum around global challenges. Using a participatory approach between researchers and teachers, the study explores how global competence, specifically the capacities to investigate the world, appreciate diverse perspectives, and take informed action, can be realized in middle school science classrooms while teaching a unit on climate change. A purposeful comparison pedagogy, one of the signature pedagogies of global competence, was employed, where students engaged in cross-national comparisons of energy mix and place-based resource allocation across three countries. Data were collected from 29 seventh-grade students and the participating team through classroom observations, focus group interviews, student artifacts, pre- and post-questionnaires, teacher journals, and teacher interviews. The data analysis guided by Carspecken's critical qualitative analysis suggests that after going through the key learning experiences of purposeful comparison pedagogy, students demonstrated the core capacities and an orientation towards 'taking action.' The study also identifies instructional strategies that supported these outcomes and documents teachers' professional growth. This offers hopeful evidence that global competence can be meaningfully developed in science classrooms without compromising disciplinary rigor.

Bridging Cultures and Knowledge: Fostering Cross-Cultural Connections in Indigenized STEM Education and Research

21-Apr-26, 14:30-16:00

Location: Willow A (L2)

Administrative Session

Organizers

Julie Robinson, University of North Dakota, Grand Forks, ND, USA

Contributors

Julie Robinson, University of North Dakota, Grand Forks, ND, USA

Joshua Hunter, University of North Dakota, Grand Forks, ND, USA

Ari Krakowski, University of California-Berkeley, USA

Peresang Sukinarhimi, National Sun Yat-sen University, Taiwan

Pauline Chinn, University of Hawai'i at Mānoa, Honolulu, Hawai'i, USA

Stacy Potes, University of Hawai'i at Mānoa, Honolulu, Hawai'i, USA

Jhu Chun Yang, National Cheng Kung University, Taiwan

Paichi Pat Shein, National Sun Yat-sen University, Taiwan

Stephanie Erickson, University of Minnesota, USA

Bhaskar Upadhyay, University of Minnesota, USA

Abstract

Research indicates that place-based, interdisciplinary, and culturally-situated connections within STEM are supportive of Indigenous Science and that fostering such educational experiences requires intentional cross-cultural dialogue, sharing, and engagement among educators, researchers, and community partners and stakeholders. How individuals from diverse cultures develop relationships with and through a place, its ecology, and community has implications for how these cross-cultural connections impact STEM education and research, with potential for meaningful sharing of values, place relationships, and collaborative learning to influence how STEM ideas can be explored both locally and expanded globally. This administrative session will highlight the work of educators and researchers who are engaging in cross-cultural approaches in which the sharing of multicultural strengths and perspectives within different shared places is enhancing STEM learning. This session will allow for discussion on best practices for fostering such intercultural co-learning opportunities that eliminate hierarchy among knowledge systems and expand our understanding of what science education and research can be. By providing opportunities for open dialogue, we are decolonizing the space in which this work is shared, inviting the opportunity for discourse and shared understanding, with the aim of providing greater relevance for more diverse students. Presenters in this Administrative Session from diverse cultures, regions of the world, and science education and research contexts. Developing community partnerships, effectively integrating Indigenous Science Knowledge with conventional science, exploring place relationships and attachment from multicultural perspectives, and including local cultural and linguistic connections into science curricula are topics for exploration and discussion among participants in the session.

Planning Together the NARST Centennial Celebration and 2027 Conference

21-Apr-26, 14:30-16:00

Location: Grand Ballroom (L2)

Administrative Session

Organizers

Maria Varelas, University of Illinois Chicago, USA

Abstract

In this session, attendees will design, discuss, and share possibilities for our association's centennial celebration. This milestone year will commence after the 2026 conference and continue throughout 2027, with several events taking place at the 2027 annual conference in Boston. During this working session, facilitated by the organizer, attendees will generate and sketch out in small groups ideas for events and activities that could be further developed via virtual collaborations after the 2026 conference, engaging additional members. The goal of this session is to create spaces and places for NARST members to collaboratively design parts

of the 2027 conference to reflect on the past, ponder the present, and imagine the future of science education scholarship as NARST celebrates its 100 first years.

Fostering Creativity and Critical Thinking in Science

Strand 1: Science Learning: Development of student understanding

21-Apr-26, 16:15-17:45

Location: Ravenna C (L3)

Stand-Alone Paper

A Meta-Analysis on Scientific Creativity Development through Problem-Solving and STEM Contexts

Fredyrose Ivan Pinar*, De La Salle University, Philippines

Albert Andry Panergayo, Laguna State Polytechnic University, Philippines

Lydia Roleda, De La Salle University, Philippines

Maricar Prudente, De La Salle University, Philippines

Dharel Acut, Cebu Technological University, Philippines

Richard Sagcal, De La Salle University, Philippines

ABSTRACT

Scientific creativity is an essential 21st-century skill, enabling learners to generate innovative solutions to complex, real-world problems. Despite its importance, the unique contributions of scientific problem-solving approaches to fostering creativity remain underexplored. This meta-analysis synthesizes evidence from 19 experimental and quasi-experimental studies (21 effect sizes; $N = 1,756$) conducted between 2000 and 2023, evaluating the effects of Inquiry-Based Learning (IBL), Problem-Based Learning (PBL), Project-Based Learning (PjBL), and STEM/STEAM contexts on students' scientific creativity. Using PRISMA guidelines, findings reveal a large overall effect ($g = 1.33$), with PjBL ($g = 2.10$) and PBL ($g = 1.49$) producing the strongest impacts, followed by STEM/STEAM ($g = 1.21$) and IBL ($g = 0.43$). Moderator analysis highlights the influence of educational level, intervention duration, and learning format, with college-level, short-term, and collaborative settings yielding greater gains. Results align with the Scientific Structure Creativity Model and the stages of the scientific method, emphasizing authentic, interdisciplinary, and collaborative learning. However, the small sample of studies and possible publication bias limit generalizability. Expanding research across varied educational settings is recommended. This offers evidence-based guidance for integrating creativity-focused pedagogies in science education and contributes to the NARST mission by advancing research-based instructional practices that foster innovation.

Stand-Alone Paper

A Systematic Literature Review of Data Literacy in K-12 Science Education

Hui Jin*, Georgia Southern University, USA

Bailey Nafziger, Georgia Southern University, USA

ABSTRACT

Data-intensive science has emerged as a new research paradigm, leading to discoveries across science disciplines. It requires cross-domain reasoning that bridges the natural, mathematical, and scientific domains through three cognitive processes: Extraction, Identification, and Conceptualization. Using cross-domain reasoning as the guiding framework, this literature review analyzes and synthesizes 54 articles on data literacy in K-12 science education, published or made available between January 2011 and December 2024. It identified three themes. First, challenges in Extraction hinder performance in Identification and Conceptualization. Second, three major factors shape the difficulty of Identification and Conceptualization are the complexity of mathematical relationships presented in graphs, the sophistication of scientific ideas and practices needed to make sense of them, and the specific type of multivariate reasoning involved. Finally, effective pedagogical and technological approaches fall into three groups, including supporting reasoning forward from Extraction, to Identification, and to Conceptualization; providing opportunities to reason backward; and enhancing self-to-data relationships. This review also identifies critical research gaps in existing literature and offers recommendations.

Stand-Alone Paper

Fostering Criticality and Agency in AI-Mediated Science Learning: Extending the CT-S Framework

Eric Greenwald*, University of California Berkeley, Lawrence Hall of Science, USA

Timothy Hurt, University of California Berkeley, Lawrence Hall of Science, USA

Ari Krakowski, University of California Berkeley, Lawrence Hall of Science, USA

Vanessa Lujan, University of California Berkeley, Lawrence Hall of Science, USA

ABSTRACT

The Computational Thinking for Science (CT-S) framework conceptualizes how computational tools mediate learning at the intersection of science and computational thinking, drawing a critical distinction between rote and reflective use of computational tools. We extend this framework to address the growing role of artificial intelligence (AI) in education by proposing an additional category: invisible use. That is, engagement with AI systems without awareness of their presence or functioning, a mode increasingly normalized by seamless commercial AI interfaces. This invisibility limits opportunities for sociotechnical understanding, criticality, and learner agency in engagement with AI. Building on The CT-S

framework's attention to tool-mediated cognition, we argue for designing AI-mediated learning experiences that make the role of AI visible and discussable, fostering deeper disciplinary engagement and critical awareness. We illustrate invisible AI use in schools (e.g., LMS analytics, grading, learning copilots) and propose ways to adapt instructional design to shift from invisible or rote use to reflective use through structured engagement with a "4-D" heuristic for interrogating AI systems: Determination, Data, Design, and Deployment. This extension offers a conceptual and practical blueprint for researchers, educators, and designers seeking to align AI integration in education with authentic disciplinary practice and equitable learning outcomes.

Supporting Teachers: Professional Growth, Knowledge, and Retention

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

21-Apr-26, 16:15-17:45

Location: Cedar AB (L2)

Stand-Alone Paper

Characterizing Course-based Research Experiences in Secondary Schools: A Systematic Review

Daniel Shay*, Washington State University, USA

Andy Cavagnetto, Washington State University, USA

ABSTRACT

Course-Based Research Experiences (CREs) are a popular model in undergraduate education, but many have noted their absence in secondary science education. This systematic review seeks to determine the extent that CREs have been implemented at the secondary level by searching databases for strategies with a similar definition: Project Based Learning, Citizen Science, and Student-Teacher-Scientist Partnerships. This systematic review examines 21 studies describing in-school, class-wide research projects involving novel discovery with broad relevance. Using a rubric developed to characterize the level of Discovery, Relevance, Science Practices, Collaboration and Iteration, we analyzed how these elements are represented in secondary settings. While many studies emphasized relevance and scientific practices, iteration and collaboration were often under-described. Results suggest that CRE-like experiences do exist in secondary education, though often under different labels such as project-based or citizen science. This work contributes a framework for identifying and refining CREs in secondary classrooms and highlights opportunities to better support authenticity, ownership, and student agency in science education

Stand-Alone Paper

Should I Stay or Should I Go: Results From a Survey on Science Teacher Retention

Lauren Harper*, Horizon Research, Inc., USA

Patrick Smith*, Horizon Research, Inc., USA

Jamie Wallace*, American Museum of Natural History, USA

ABSTRACT

Science teacher retention remains a critical issue, with nearly half leaving the profession within five years, especially in high-need schools. This study, originating from a secondary science teacher residency program, investigates factors that encourage science teachers to remain in the classroom. Guided by Expectancy-Value Theory, researchers developed and field-tested a national survey with over 1,000 current middle and high school science teachers. The survey identified 11 key factors—six related to influence and five to encouragement. Findings reveal that being treated respectfully and experiencing personal fulfillment are the strongest motivators for retention. Notably, experienced teachers rated mentoring and benefits more highly than novices. Open-ended responses emphasized the importance of factors as teachers shared stories about the impact making a difference in students' lives and the role of school leadership has on their motivation. These insights offer actionable strategies for teacher preparation programs and school leaders to improve retention, particularly in high-need contexts. The study also refines the application of Expectancy-Value Theory to teacher motivation, providing a dual lens of self-efficacy and perceived value. Results have implications beyond science education, contributing to broader efforts to address teacher shortages nationwide.

Stand-Alone Paper

Sustaining Science Teacher Leadership: Applying the Community of Practice Model Across Urban and Rural Contexts

Natasha Johnson*, University of Toledo, USA

ABSTRACT

Persistent teacher shortages, especially in STEM, disproportionately impact high-need urban and rural schools. While recruitment is important, retaining highly qualified teachers is critical for improving outcomes and reducing the costs of turnover. This qualitative study examined secondary science teacher leadership identity development using the Community of Practice Teacher Leader Identity Model (CoPTLM). Participants, identified as science teacher leaders in grades 6–12, were recruited from urban and rural districts in the Midwestern United States. Data were gathered through semi-structured interviews with teachers, principals, and colleagues, and analyzed using grounded theory coding methods.

Findings reveal shared competencies across contexts, including deep pedagogical knowledge, collaborative facilitation, data-informed decision making, and a commitment to

equity. However, contextual factors shape how these elements are enacted. Urban teacher leaders often navigate complex systems, engage culturally and linguistically diverse communities, and advocate for systemic equity. Rural teacher leaders rely on deep community integration, adaptability in multi-role positions, and resourcefulness in sustaining programs aligned with local values. This research offers insight into cultivating science teacher leaders who mentor peers, influence instructional practice, and strengthen science teaching and learning, providing guidance for policies and professional development that increase retention and impact in high-need schools.

Stand-Alone Paper

Teachers' Conceptual Knowledge of Wildfire and Human Interaction

Debika Jana*, University of Nevada Las Vegas, USA

Merryn Cole*, University of Nevada Las Vegas, USA

ABSTRACT

This study aimed to identify the teachers' understanding about wildfire and its relationship with humans. Researchers used an anonymous survey method. Data was collected from K-12 educators who are currently working in a classroom as a full-time licensed teacher, a long-term substitute teacher or a practicum/student teacher. Findings indicated that most of the participants (69%) did not conceptualize wildfire as uncontrolled fire and 12% of respondents mentioned wildfires were always unintentional. About the cause of wildfire, only 18% mentioned human impacts on climate change or how it affects wildfires and 43% only mentioned accidental causes. Additionally, most of the participants (75%) did not have enough knowledge about the positive effects of wildfires or didn't think to share them. Some of them (25%) knew that wildfires have a positive effect but were not very clear about how wildfires can benefit humans. Future researchers should explore the origin of misconceptions about wildfire and how teacher misconceptions about wildfire and human interaction influence student learning and engagement. Furthermore, this study suggested exploring the effectiveness of professional development interventions that target both content knowledge and pedagogical strategies for complex socio-scientific topics.

Stand-Alone Paper

Teaching Science Using Knowledge-in-Pieces during Nature-Based Learning

Phillip Dixon, University of Iowa, USA

Matthew Lira, University of Iowa, USA

Kay Ramey, University of Iowa, USA

ABSTRACT

The purpose of science education is to understand how the natural world works. One goal of science education is to develop a scientifically literate society where all learners can apply scientific concepts to make sense of phenomena, solve problems, and think innovatively. The purpose of teaching science in middle school is to meet this goal. To help more students learn science successfully, new methods and models must be employed. This qualitative case

study of one sixth-grade student with a learning difference takes place outdoors in a Nature-Based Learning (NBL) setting. We analyzed video and field notes of the student's learning interactions during an inquiry-based teaching setting using Knowledge Analysis (KA) and Interaction Analysis (IA) to determine how she learned about a prairie ecosystem. The findings suggest she constructed her knowledge through structured learning and exploration. Drawing on the Knowledge-in-Pieces (KiP) framework, the analysis shows how knowledge activation was demonstrated and how it was or was not supported interactionally. These findings imply that NBL can support scientific thinking and learning for students with learning differences, particularly when space is created for interactionally engaging in active knowledge construction. The findings show the potential of Knowledge-in-Pieces as a framework for classroom teaching.

Roundtables Session 2

21-Apr-26, 16:15-17:45

Location: Grand Ballroom (L2)

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

Roundtable

"Be Better Than You Need to Be": A-Level Physics Students' Peer Pedagogy on TikTok

Wonyong Park*, University of Southampton, United Kingdom

ABSTRACT

Amid the rapid growth of social media, students increasingly turn to short-form platforms for study support and advice. This study examines how A-level Physics (school leaving qualifications and examinations in England taken at 16-18) is portrayed by student creators on TikTok, a popular platform amongst students for peer-to-peer educational guidance and information sharing. Using reflexive thematic analysis of 57 TikTok videos via #alevelphysics, we explore how A-level Physics is characterized and what pathways to success are constructed within these informal discourses. The findings show that the subject is depicted as both intellectually demanding and emotionally taxing, with the examination system perceived as a flawed gatekeeper. Creators narrate their experiences through a blend of hyperboles, frustration, and resilience, offering sophisticated peer-generated pedagogies alongside cautionary tales. Recommendations emphasise strategic resource curation, sustained practice, systematic memorization, and a mindset of deliberate over-preparation. These portrayals of subject demands and agentic responses resonate with prior research on the cultural construction of physics as hard and exclusionary, while also illustrating how affinity spaces on social media enable students to reframe difficulty through shared feelings and tactics. We discuss the value of student-led online discourses about high-stakes examinations for educators in supporting prospective and current physics students.

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

WIP Roundtable

Undergraduates' Perceptions and Beliefs of Generative AI in Introductory Physics Learning

Carina Rebello*, Purdue University, USA

Qurat-ul-Ann Mirza, Purdue University, USA

Mina Megally, Toronto Metropolitan University, Canada

N. Sanjay Rebello, Purdue University, USA

ABSTRACT

Generative artificial intelligence (AI) tools have gained significant attention within the context of science teaching and learning, including in physics. Numerous studies have explored their educational potential, highlighting their ability to personalize learning, foster critical thinking, provide immediate feedback, and scaffold complex concepts. Additionally, numerous studies have shown how generative AI tools can be integrated into physics instruction. This study addresses limited research on students' perceptions and beliefs of generative AI in physics instruction and course work at diverse institutions. Findings in this study reveal that nearly all participants reported using generative AI tools—most commonly ChatGPT—and valued them for their accessibility, convenience, and low-pressure learning environment. Participants appear to value AI as a supportive tool rather than a substitute for active learning and recognize the importance of maintaining a balance to preserve their conceptual understanding and academic independence. These findings point to a clear need for instructional guidance on how to use generative AI both effectively and ethically in physics problem-solving contexts.

Strand 7: Pre-service Science Teacher Education

Roundtable

How and why young people position science teaching as a back-up career

Emily MacLeod*, McGill University, Canada

ABSTRACT

Science teacher shortages are severe and persistent. These science teacher shortages have negative consequences for young people, current educators, and the future STEM workforce. At this roundtable I will present data from a longitudinal study of science students in England driven by the research question: Why do science students drop their teaching aspirations? Using data from 58 interviews I will present the science teaching aspirations of five participants over 11 years. These participants all expressed an interest in becoming a science teacher at least once between age 10/11 and 20/21. By age 22 three of the five participants had applied to Initial Teacher Education (ITE) to become science teachers, but none were pursuing science teaching. One contributing reason why none of the five were pursuing teaching—despite their earlier aspirations, and the need for more science teachers—was that they positioned teaching as a back-up career aspiration. This finding is framed through the concept of 'insurance' against the risks associated with non-teaching

science careers (Harrison, 2019). I will facilitate a roundtable discussion about the implications of this finding, driven by the question: What can we do to encourage more science specialists to consider teaching as a first-choice career?

Strand 7: Pre-service Science Teacher Education

Roundtable

Using Q-Methodology to Understand Shifts in Orientation towards Equitable Teaching among Pre-service Elementary Science Teachers

Lynne Zummo*, University of Utah, USA

Tracy Dobie, University of Utah, USA

Lauren Barth-Cohen, University of Utah, USA

Connor Warner, University of Utah, USA

ABSTRACT

A major challenge in elementary science teacher preparation involves advancing pre-service teachers' (PSTs) learning of teaching practices that mitigate deepening inequities. Many studies of equity-oriented interventions rely upon intensive qualitative methods, such as observation, to assess shifts in teachers' beliefs and practices. While this provides rich qualitative data, documenting changes among large groups of PSTs remains challenging. In light of this challenge, this study aims to test, refine, and iterate upon a tool that leverages Q-methodology to understand changes in PSTs' orientations towards equitable science teaching. As part of a larger research project studying the learning of equitable teaching practices among PSTs, we developed and implemented a Q-sort task with PSTs in Elementary Science and Mathematics Teaching Methods courses to understand shifts over time in their orientation to equitable teaching. Results show some evidence for change along certain dimensions. Additionally, we identify several affordances of using the Q-sort and many challenges. With the proposed roundtable session, we will engage participants in a model Q-sort activity and prompt discussion around how to refine the tool towards more widespread usability, as well as how others might use this tool and adapt it to their own context.

Strand 7: Pre-service Science Teacher Education

Roundtable

Preservice Elementary Teachers' Views on Scripted Science Curriculum in Linguistically and Culturally Diverse Classrooms

Sissy Wong*, University of Houston, USA

Samuel Katende, University of Houston, USA

Hien Tran, University of Houston, USA

Jie Zhang, University of Houston, USA

Raju Ahmmed, University of Houston, USA

Maria Walsh, University of Houston, USA

ABSTRACT

Historically, scripted curricula were only used in language arts, but recently, accountability measures have driven it to expand into other content areas, like science. Some argue that scripted curricula have perceived benefits, including standardizing the instruction that occurs in classrooms, but it can negatively impact teacher professional development. This study examined three preservice elementary teachers' views on scripted curricula which was mandated in the school district in which they completed student teaching. Results show the teachers viewed the shift to scripted curricula as a detriment to their own professional learning, especially as they prepared to teach Emergent Bilingual students that need differentiated support to facilitate learning of content and language simultaneously.

Strand 7: Pre-service Science Teacher Education WIP Roundtable

Bridging Local Knowledge and Global Citizenship through Place-Based Exchange Program between Taiwan and Hawaii

Yu-Chieh Wu*, University of Hawaii, USA

Jhu Chun Yang*, Sun Yat Sen University, Taiwan

Pauline Chinn*, University of Hawaii, USA

ABSTRACT

This study explores how place-based education (PBE) fosters Global Citizenship Education (GCE) through a cross-cultural sustainability exchange program linking universities in southern Taiwan and Hawai'i. Grounded in the OECD Global Competence Framework, the program engaged students in field-based learning, addressing issues such as marine microplastic pollution, actions to be a responsible global citizen, and indigenous traditional knowledge. Using a qualitative case study design, data were collected from students' concept maps before and after the program. The concept map is analyzed thematically across three dimensions: knowledge, skills, and attitudes. Findings reveal a shift from broad, fact-based understandings of marine microplastics toward cause-oriented perspectives connecting human and ecological health. Students moved beyond isolated individual actions to open-minded, culturally informed approaches emphasizing awareness and intergenerational responsibility. Attitudinally, participants deepened their recognition of Indigenous traditional knowledge as both scientific and humanistic, reframing it as vital to sustainability and intercultural understanding. These outcomes suggest that immersive PBE not only strengthens students' sense of place but also cultivates GCE. The study highlights the transformative potential of linking local knowledge with global responsibility in higher education.

Strand 8: In-service Science Teacher Education

Roundtable

Coaching Coaches: An Autoethnographic Reflection

Melissa Mendenhall*, Utah Valley University, USA

ABSTRACT

This autoethnographic reflective essay highlights the challenges and successes of coaching science coaches in understanding the value of disciplinary literacy. It is the lived, personal experience of a professional development provider, not typically told in research articles. The intent is to help others learn from this experience.

Strand 8: In-service Science Teacher Education

WIP Roundtable

Reimagining a practitioner-researcher collaboration model. Leveraging trust; Nurturing relationships; Responding to science classroom needs.

Tej Dalvi*, University of Massachusetts, USA

Pat Paugh, University of Massachusetts, USA

Jihan Mehideen, Boston Public Schools, USA

ABSTRACT

This submission presents a redefined vision for responsive and individualized practitioner-researchers collaboration model that attends to teachers' classroom needs around teaching and learning of science. Rather than implementing and revising a pre-designed professional development, we partner with elementary teachers to create ways to support their individual professional trajectories. Our model calls for repositioning teachers as researchers who act on identified problems, and university researchers as responsive scaffolders who help teachers navigate their trajectories. The model's operation is based on mitigating challenges to students' learning of science, identified by the teachers. And our goal is to find ways, through action research to create paths to respond to those challenges in ways that support students scientific sense-making. We propose this submission as a work in progress roundtable, to share our vision, and a pilot based on it. We bring data from one years' work on the pilot with three teachers action research studies. Our goal is to share preliminary results, outcomes and discuss to seek inputs on value and structure of our model, and its role in finding sustainable ways to create trust amongst all elementary educators to ensure that science and scientific literacy remain an integral part of students' school experiences.

**Strand 8: In-service Science Teacher Education
Roundtable**

"I should have ensured its accessibility" – Science Teachers' Epistemic Empathy for Blind and Low-Vision Students

Mutiara Syifa*, Illinois State University, USA

Natalie Shaheen, Illinois State University, USA

ABSTRACT

In 2024, the National Academies of Sciences, Engineering, and Medicine (NASEM) released a report on disrupting ableism and advancing the success of disabled people in STEM. While efforts to make STEM more equitable for marginalized groups has been discussed for decades, support for disabled learners remains limited in both K-12 and higher education. An upcoming April 2026 Americans with Disabilities Act (ADA) Title II compliance deadline, requiring accessible web and mobile technologies, adds urgency to preparing teachers for this responsibility. Challenging systemic injustices such as ableism demand radical imagination, enabling teachers to adopt pedagogies that allow disabled students to fully engage in classrooms. Cultivating teachers' epistemic empathy (Jaber et al., 2021) may help dismantle the barriers disabled students face in science education. This study examines how teachers express epistemic empathy in professional development about born-accessible science learning for Blind and Low-Vision students. We argue that interdisciplinary collaboration between science education and blind and low vision education is urgently needed to disrupt ableism. We call on science teacher educators and researchers to raise accessibility awareness in science education by embedding epistemic empathy into teacher preparation and professional learning.

**Strand 8: In-service Science Teacher Education
Roundtable**

Developing and Implementing an Integrated STEM Curriculum Grounded in an Up-to-Date, Authentic University-Based Research

Maram Alaqra, Sharjah Education Academy, UAE

Bugrahan Yalvac*, Texas A&M university, USA

ABSTRACT

Located in a city in the Southwest US, Latinx students often face limited access to quality learning opportunities that prepare them for careers in scientific disciplines. Decontextualized learning activities fail to capture their interest. To promote social justice and educational equity, it is essential to engage Latinx students in contextualized, experiential STEM experiences.

Funded by two major US agencies, a team of university faculty and researchers developed a contextualized STEM instruction-based project. The project includes multiple components in which selected teachers and students from two schools in a US border community participate in training and outreach activities.

This proposal focuses on one component that engaged teachers of underrepresented minority (URM) students in an authentic STEM research experience. Using a qualitative approach, we explored and documented the teachers' experiences and examined how these shaped their identities, teaching approaches, and views on scientific research. Findings suggest that authentic research experiences can shift teachers' stereotypical views of science and scientists, provide eye-opening exposure to real scientific practices, and foster a community of practice. These outcomes highlight the potential of such experiences to transform STEM teaching and inspire more equitable, relevant science education for Latinx and other URM students.

Strand 8: In-service Science Teacher Education Roundtable

Affirming Learning Walks: providing promise for teachers' self-efficacy, emotions, and retention.

Donna Ross*, San Diego State University, USA

Matt Graham*, University of Oregon, USA

Bryan Rebar*, University of Oregon, USA

Jenefer Husman, University of Oregon, USA

ABSTRACT

Our study included 40 teachers and 6 administrators from high need, urban schools. We used mixed methods to explore the influence of a professional development project that included 4 days of Affirming Learning Walks with associated debriefs and meetings. Quantitative results showed increased self-efficacy and decreased anxiety. Qualitative results showed a greater feeling of connection with fellow teachers and a greater sense of being acknowledged for their work by fellow teachers and administrators. We suggest implications including that elementary teachers might particularly benefit from the increase in self-efficacy when teaching science and the secondary teachers might particularly benefit from the greater sense of being recognized. This could yield more science teaching by the elementary teachers and high retention levels among secondary science teachers. We look forward to considering the synergy of this approach with other practices to increase retention.

Strand 10: Curriculum and Assessment Roundtable

Three Teachers Experience Implementing a Paleontology and Computer Vision Curriculum: Barriers and Opportunities

Christine Wusylko*, Kennesaw State University, USA

Gabriella Haire, University of Florida, USA

Breuna Wilson, University of Florida, USA

Pasha Antonenko*, University of Florida, USA

Jeremy Waisome, University of Florida, USA

Brian Abramowitz, Northern Essex Community College, USA

Victor Perez, St. Mary's College of Maryland, USA

Stephanie Killingsworth, University of Florida, USA

ABSTRACT

In this cross-case analysis, we explore the challenges and opportunities of three middle school teachers who taught a paleontology and computer vision curriculum designed to teach science with AI. We analyzed these teacher's experiences within and across their contexts utilizing the frameworks UTAUT and first and second-order barriers to technology integration. We found all the teachers had strong value beliefs in teaching AI, but had varying experiences with barriers to technology integration which affected their implementation. We also found teachers struggled with utilizing a computer vision software developed outside of the project. By shedding light on these teachers' experiences, we hope to inform others who design or implement AI curricula in formal spaces.

Strand 10: Curriculum and Assessment

Roundtable

From Structure to Fairness: Validating the Interdisciplinary Science Assessment of Carbon Cycling II

Hyesun You*, University of Iowa, USA

Sunyoung Park, California Lutheran University, USA

ABSTRACT

Addressing complex global issues requires interdisciplinary (ID) approaches that integrate knowledge across scientific disciplines. However, most science education remains discipline-specific, limiting students' ability to make cross-disciplinary connections. To address this gap, we developed and validated the Interdisciplinary Science Assessment of Carbon Cycling II (ISACC II), designed to measure both disciplinary and ID understanding of carbon cycling. ISACC II consists of 24 items (14 multiple-choice, 10 constructed-response) and was administered to 556 college students from two public research universities. Using confirmatory factor analysis (CFA), we found that a two-factor path model—disciplinary understanding predicting ID understanding—fit the data well (RMSEA = 0.030, CFI = 0.983, TLI = 0.982). Reliability was strong ($\alpha = 0.87$, $\omega = 0.88$). Measurement invariance testing supported comparability across gender and race groups with partial adjustments. Structural equation modeling showed that the number of science courses taken positively predicted disciplinary understanding, which in turn enhanced ID understanding. Gender differences favored females in ID understanding, while racial differences operated indirectly through science course exposure. The findings support the validity, reliability, and fairness of the ISACC II, providing educators with a robust tool to assess and promote students' ability to integrate disciplinary knowledge into coherent ID scientific reasoning.

Strand 10: Curriculum and Assessment

WIP Roundtable

Culturally Relevant or More of The Same? Unpacking Standards-Aligned Elementary Science Curriculum Materials

TERRANCE Burgess*, Michigan State University, USA

ABSTRACT

The Next Generation Science Standards were developed as a tool to engage all students in equitable science learning. Specifically, the standards arguably incorporate equitable instructional practices through its promotion of three-dimensional instruction, where teachers are expected to enact science instruction that engages disciplinary core ideas through scientific and engineering practices and crosscutting concepts. Additionally, we know elementary students in the United States have very limited opportunities to engage in science learning. Thus, it is crucial to understand how this instruction is taken up within schools vis-à-vis the curriculum. Given the fact that students of Color have been marginalized within science disciplines, these standards offer promise to begin disrupting this narrative. Functioning as an intersection of sorts, this study enacts content analysis to understand exactly how these equity-oriented standards are incorporated within the science curriculum as well as how it attends to the multiple identities of elementary students of Color. Using one fifth grade reform-based instructional unit designed to engage students in the practices of developing a particle model of matter, findings indicate that the teacher-enacted lesson design and instructional practices perpetuate a one-dimensional fact-based science learning while ignoring the diverse lived experiences and identities of students of Color.

Strand 10: Curriculum and Assessment

Roundtable

Developing Secondary Interdisciplinary STEM Curricula in Two Countries: Design Approaches and Challenges

Erin Furtak*, University of Colorado Boulder, USA

Lukáš Rokos, University of South Bohemia, Czech Republic

Lien Amin*, University of Colorado Boulder, USA

ABSTRACT

International science education reforms in the past 15 years have prioritized engagement in science practices as a key outcome of learning, as well as placing students' opportunities to learn in context. This has included new efforts towards curriculum resources that, in order to address real-world problems and phenomena, necessitate learning across different science disciplines. In essence, this means that to truly engage students in learning across science, technology, engineering, and mathematics (STEM), curricula need to be developed that are not only multidisciplinary (alternating between, but not integrating STEM disciplines), but interdisciplinary (combining STEM disciplines) or transdisciplinary (integrating and going beyond STEM disciplines). This paper presents a comparative case study of the design of two secondary school curricula developed in two different national contexts and analyzes the

degree to which each exemplifies different kinds of approaches to STEM education. We analyzed documents from the two curriculum development projects and present results according to the standards addressed, design approaches, and assessments for the purpose of better understanding how each project embodied trans- and interdisciplinary STEM goals and challenges faced. Findings point to the potential of these kinds of curricula to radically re-imagine science and STEM learning environments.

Strand 10: Curriculum and Assessment

Stand-Alone Paper

Bridging Disciplinary Boundaries: Development and Validation of the Interdisciplinary Science Assessment of Carbon Cycling II

Hyesun You*, University of Iowa, USA

Minju Hong, Chung-Ang University, Korea, Republic of

Won-Chan Lee, University of Iowa, USA

ABSTRACT

Interdisciplinary (ID) understanding is critical for reasoning about complex socio-environmental issues, yet few validated tools exist to measure it. This study reports the development and validation of the Interdisciplinary Science Assessment of Carbon Cycling II, designed to assess college students' integration of concepts from biology, chemistry, Earth science, and related domains. Using a construct-modeling framework, we created a developmental construct map, aligned items to core ideas (e.g., photosynthesis, carbon fluxes, feedback loops), and developed analytic rubrics for constructed responses (CR). The 24-item instrument (14 MC, 10 CR) was administered to 556 students at two U.S. public research universities (2021–2023). Psychometric analyses using confirmatory factor analysis and multidimensional item response theory supported a two-factor model (disciplinary vs. interdisciplinary understanding; RMSEA $\approx .02$, CFI $\approx .99$). MC items used the 2-parameter logistic model; CR items used the generalized partial credit model. Internal consistency was strong (full test $\alpha = .86$; $\omega = .89$; ID subscale $\alpha = .79$; $\omega = .84$). Inter-rater reliability for CR items was high (overall ICC[2,k] = .93). No significant differential item functioning by gender or race was found. ISACC II offers a reliable, valid, and equitable measure for advancing interdisciplinary science learning tied to sustainability challenges.

Strand 11: Cultural, Social, and Gender Issues

Roundtable

“Silent Suffering” and “Crippling Fear”: Understanding how science learners describe impostor experiences using conceptual metaphors

Devasmita Chakraverty*, Indian Institute of Management Ahmedabad, India

ABSTRACT

Impostor phenomenon occurs when successful people disbelieve in their success, attributing it to luck or other external factors unrelated to their ability or competence. It is prevalent in science, technology, engineering, and mathematics (STEM) fields. Using conceptual

metaphor theory, this US-based study conducted a secondary analysis of archived data from a prior study (2018). The research question analyzed was: What is the most widely used metaphor family describing impostor phenomenon among PhD students in STEM and how is it used? Sixty-five semi-structured interviews with participants experiencing impostor phenomenon (~30-45 minutes each) were analyzed. Qualitative text of ~360,000 words/700 pages coded inductively and deductively (hybrid coding). Health metaphors were most widely used (e.g., crippling, suffering, crutch, dumb, lame, handicap, paralysis, condition, cure, heal, plague, symptom), categorized as disability and disease metaphors. This cross-sectional study showed how STEM persons use language to frame impostor experiences when not prompted a priori (through scale items). Metaphors of impostor phenomenon are unexplored but useful in designing future interventions to help people manage it better through conscious language framing; and to develop new, more contextually relevant measurement scales.

Strand 11: Cultural, Social, and Gender Issues
Roundtable

Reflections on Positioning of a Summer Science Teaching Intern: Mai's Story

Maria Rivera Maulucci*, Barnard College, Columbia University, USA

ABSTRACT

The summer teaching experience program was developed to address recruitment and retention challenges, particularly for high-need schools. This mixed-method case study draws on efficacy scales, teaching portfolios, teaching observation rubrics and reports, debriefing notes, post-lesson reflections, and semi-structured interviews to explore the self-efficacy and positioning of a case study intern. The intern's case record shows their positioning by others, and/or their engagement in self-positioning as teachers during their lesson planning, coteaching, debriefing sessions, and lesson reflections. The analysis reveals three key findings: 1) the role of lesson plans as a form of pre-positioning for novice teachers that provides valuable insights into their understanding of a teacher's roles and concomitant student duties; 2) Mai's storyline of becoming a teacher as she reflexively positions herself in the classroom as a caring, engaged teacher, thereby challenging her initial lower self-efficacy assessments; and 3) Mai's storyline of interactive positioning from co-teachers, her instructor, and her mentor teachers and the impact on Mai's sense of individual and team efficacy. This study reveals a need for teacher educators to consider the impacts of self- and interactive pre-positioning, positioning, and post-positioning of teacher candidates, especially for candidates who initially present with lower self-efficacy.

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

Play, Power, and Pedagogy: Reimagining Science Education in Times of Rising Authoritarianism

Erica Carlson-Moudry*, University of Nebraska at Omaha, USA

K. Mendoza*, University of Nebraska at Omaha, USA

ABSTRACT

This theoretical paper examines the intersections of playful, inquiry-based science education and anti-fascist pedagogy in contexts of rising authoritarianism. Drawing on historical and contemporary literature, it traces the politicized genealogies of progressive education, from Montessori, Dewey, and Vygotsky to anarchist, decolonial, and abolitionist frameworks, showing how such pedagogies have operated as both tools of resistance and instruments of authoritarian co-option. We argue that play and inquiry hold significant potential for advancing anti-authoritarian aims when consciously mobilized toward justice-oriented educational practice. Situating science education within broader socio-political struggles, the paper explores three interconnected areas: (1) historical roots of progressive pedagogies in moments of political upheaval, (2) the ways play and inquiry have been harnessed for social and political purposes, and (3) the role of science education in leveraging play and inquiry to advance equity, critical consciousness, and collective action for justice. We position science classrooms as contested spaces where epistemic authority, civic formation, and social justice converge, urging educators to embed anti-fascist principles into curricula and teacher education. This work-in-progress roundtable invites critical feedback and generative discussion to refine our theoretical positioning, expand connections to historical and contemporary contexts, and co-develop ideas for enacting playful, justice-centered science education in practice.

Strand 11: Cultural, Social, and Gender Issues

WIP Roundtable

(Re)Defining Scientific Wealth: Exploring Economic and Sociocultural Currencies Within STEM Education

Ava Breitbeck*, Syracuse University, USA

ABSTRACT

Learners engage in the continual exchange of knowledge and meaning within formal and informal learning spaces. In STEM classrooms, learners participate in the exchange of currencies that include language, skills, identity, and culture. These currencies work to fulfill the goals of a community – whether it be to promote science learning or advance competitive STEM industries or cultivate a scientifically literate citizenry. In this review, I ask, how can sociocultural perspectives inform our understanding of wealth and value in science, technology, engineering, and mathematics (STEM) learning? The purpose of this review is to explore various forms of currency under exchange within STEM education contexts in order to shed light on this question. I find that sociocultural theories facilitate broader understandings of these currencies – specifically by transcending traditional notions of currency as a monetary phenomenon to currency as language, skills, identity, and beyond. Through this extended metaphor, we gain a more comprehensive understanding of the wide range of impacts that high quality STEM education can have on students' scientific wealth.

Strand 11: Cultural, Social, and Gender Issues

WIP Roundtable

Advancing Theory with Doctoral Students at an International Ph.D. Summer School

Kevin Nguyen*, Sonoma State University, USA

Bjørn Johannsen, University College Copenhagen, Denmark

Katherine Doerr, Malmö University, Sweden

Katerina Günter, Umeå University, Sweden

Tatiane Russo-Tait, University of Georgia, USA

ABSTRACT

In this work-in-progress roundtable session, we will facilitate a discussion centered on preliminary results from a theory-focused STEM Education Ph.D. summer school. As we see it, many newcomers to discipline-based education research sometimes struggle when applying theory to their empirical work. Another issue is that beginners may also apply frameworks that do not capture the richness of their data, especially qualitative data. Sometimes important lenses such as gender, coloniality, justice, and joy are missing or purposely left out of research education programs. The goal of the Ph.D. summer school was to discuss how to apply and identify theory in STEM education research and explore lenses that transgress multiple boundaries. Our main research questions were: How do doctoral students value, contribute, and apply theory in science education research? We gathered 30 international doctoral students to participate in the three-day intensive summer school. We designed theory-focused workshops to help students make their own contributions to theory. We collected qualitative data from students; this included their capstone project conference notes, personal research items, artifacts from creative activities, and reflections. Preliminary data suggests a broad range of engagement in theory, with many students eager to engage in critical theory.

Strand 11: Cultural, Social, and Gender Issues

WIP Roundtable

Goals and impacts of West African women academics engaging in academic communication on social media.

Shallom Lumor*, Technion Israel Institute of Technology, Israel

Tzipora Rakedzon, Technion, Israel Institute of Technology, Israel

ABSTRACT

Social media has become a vital tool for academic communication, expanding researchers' reach and impact. Previous studies have highlighted how such platforms enable academics to share research and expand their networks, with evidence suggesting that social media can broaden dissemination and even support lecturers' academic productivity. Despite these advances, our understanding of how gender and cultural contexts influence academics' goals and outcomes in social media engagement remains limited, particularly within STEM fields. This case study, therefore, examined the goals and impacts of social media use among West African women academics in STEM fields. It investigated how socio-cultural norms and

platform-specific affordances of visibility shaped academic communication, influencing the ways these women communicated and engaged professionally on LinkedIn, X, and ResearchGate. Semi-structured interviews were conducted with 15 women academics from West African countries. Findings revealed that participants primarily used social media to enhance personal and institutional visibility through professional digital presence, access professional networks, and disseminate their research to non-scientific audiences. This study contributes to the scholarship on gender and academic communication by demonstrating how social media serves as both a tool of empowerment and a means of facilitating the broader dissemination of research results.

Strand 11: Cultural, Social, and Gender Issues Roundtable

Issues of Equity and Engineering: How Professionals Conceptualize Equity as Integral to Good Engineering Practice

Joy Anogwih, University of Alabama, USA

Shannon Davidson*, University of Alabama, USA

Abiodun Babalola, University of Alabama, USA

ABSTRACT

Despite STEM fields being integral to the development of possible solutions to global challenges, engineering has historically struggled with diversity and equity issues. While research related to engineering and issues of equity often focuses on student outcomes, little is known about how individual engineers conceptualize issues of equity in professional practice. Through semi-structured interviews, we explore how five engineer mentors in a Research Experience for Teachers program describe issues of equity as relating to their fields of engineering. Engineers in this study described the interlinking of equity and engineering across six themes that demonstrated recognition of systemic and structural inequity, the importance of values and ethics, and practical considerations for equity when engaging in engineering research and design process. Participants noted the importance of recognizing and navigating institutional constraints when grappling with issues of equity. Participants described contending with issues of equity as integral to good engineering practice. As such, this work adds to the literature highlighting engineers' understandings of the connections between professional practice and issues of equity. Additionally, this work may have important implications for how RET mentors may communicate connections between issues of equity and engineering practice to K-12 educators in professional learning programs such as RET.

Strand II: Cultural, Social, and Gender Issues

Roundtable

Science Teachers for Social Justice: Creating a transformative community of practice

Katherine Wade-Jaimes*, University of Nevada, USA

ABSTRACT

Many science teachers, and educational researchers, have explored the ways in which teaching science can be used as a tool for social justice, a goal that has become increasingly important in these volatile political times. Unfortunately, teachers who wish to engage in social justice oriented science teaching often face limited resources and support for this type of work. This study explores a transformative community of practice, Science Teachers for Social Justice, that was designed to provide the resources and support social justice oriented science teachers need. Using an ethnographic approach, based primarily on participant observation of monthly meetings of the group, data was analyzed to reveal how the group aligns with, and pushes the boundaries of, a community of practice framework. The findings demonstrate that while this group functioned as a community of practice by legitimizing teachers' work, offering multiple ways to engage in social justice oriented science teaching, and decentering a traditional pedagogical format, it also worked to transform the community of science education by introducing new goals and envisioning new forms of productive activity, aligned with social justice science teaching.

Strand II: Cultural, Social, and Gender Issues

WIP Roundtable

"They are scientists, not women scientists": A Qualitative Case Study of Female Scientists on Xiaohongshu

Shumin Zhao*, University of Nevada, Reno, USA

ABSTRACT

Gender stereotypes remain barriers to women's participation in STEM, yet social media platforms offer new opportunities to challenge these biases. This qualitative case study examines how female scientists are portrayed in role-playing videos on Xiaohongshu, a Chinese social media platform.

Five videos featuring historical and contemporary female scientists were analyzed through qualitative content analysis, grounded in Gender Equity in STEM Education, Role Model Theory, and Social Representation Theory. Three key themes emerged: (1) Barriers on the Path to Scientific Pursuit; (2) Identity Construction of Female Scientists; and (3) The Dramatized Depiction of the Scientific Process.

The findings position Xiaohongshu as an informal learning environment where gendered perceptions are negotiated. These videos function as digital role models that may inspire young women in STEM while serving as effective science communication tools for more equitable representations.

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

The impact of Augmented Reality to enhance students' cognitive outcomes : a systematic review

Erick Soan*, University of Florida, USA

ABSTRACT

This study conducts a systematic review to analyse how Augmented Reality affects the cognitive outcomes of high school students learning chemistry. Using AR technology in learning chemistry will help students gain a higher understanding while experiencing the technology, so as an abstract lesson, students will find it easy. This research was approached by a systematic review published between 2017 and 2023, which analyzed the impact of AR on raising students' cognitive outcomes in the learning chemistry process. This article is based on the sources of the Academic Premier and Education and is analyzed using narrative system methods. The first findings show that AR can enhance students' cognitive outcomes when learning chemistry. The result of this study is to provide empirical evidence of the effectiveness of using AR in learning chemistry, and for future recommendations that this study can be developed further to improve the chemistry learning system in Senior High School.

Strand 12: Technology for Teaching, Learning, and Research WIP Roundtable

Climate Change x Geoinformatics - a Combination to Overcome Educational Segregation?

MARIE JOHANNA UNIVER*, University of Tartu, Estonia

Birgit Viru, University of Tartu, Estonia

Regina Soobard, University of Tartu, Estonia

ABSTRACT

Educators are on the frontline of climate education. In Country, there is a noticeable conflict between the written curriculum and actual classroom practice. Teachers are crucial agents whose varying approaches could in turn either deepen or bridge the gap between schools. Therefore, it is time to implement an online climate course, which prepares students for high school Geography while fostering collaboration and self-directed learning. The course will be publicly accessible which could reduce current (geo)educational segregation. By interviewing experienced Geography teachers, authors asked how climate change is taught and if geographic information systems are present. Previous studies share differing views on whether to teach 'the' technology or 'with' technology. Interviews help define if GIS is used in

isolation or is there room to delve deeper. The results offer insight into the expectations of high school teachers of the 10th graders enrolling in their Geography course. As the authors are developing an online climate and GIS course, they asked for notes for improvement. Interventional methods bringing climate education into (Geography) lessons have been proven as successful, hence teachers were asked to reflect on the necessity of a curricular intervention in Country's middle school Geography syllabus using the online in-development course.

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

What Happens When AI Enters the Science Classroom? Lessons from Korea and the U.S.

Benjamin Oh*, Lynbrook high school, USA

Jonghyun Park, Daejeon Science high school for the gifted, Korea, Republic of

Cheol-Hong Jeon, Korea National University of Education, Korea, Republic of

Suna Ryu*, Korea National University of Education, Korea, Republic of

ABSTRACT

This study examined teacher and student engagement during AI-integrated science instruction in South Korea and the United States. Using text mining techniques, we investigated the cognitive and emotional experiences in science classrooms in both countries. While students were optimistic about AI, they also reported challenges related to unfamiliarity and skill demands. Korean students focused on learning concepts related to their tasks. They exhibited more anxiety when facing difficulties. In contrast, American students expressed enjoyment and sought peer support throughout the process. However, they cared less about learning. These findings underscore the necessity of providing tailored support and emotionally responsive AI-based science instruction to address cross-cultural differences in learning styles

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

Preservice Teachers' Evaluation Process and Criteria for AI Suggestions in Science Lesson Planning

Soo Won Shim*, Illinois State University, USA

ABSTRACT

This mixed-methods study explored how elementary preservice teachers (PSTs) evaluate and integrate AI suggestions during science lesson planning and how an AI module influences their AI self-efficacy. Thirty-eight PSTs completed a two-session module that introduced AI concepts, prompt engineering, and ethical considerations. A paired t-test showed a significant increase in PSTs' self-efficacy ($p = .004$, $d = 0.56$). Thematic analysis, guided by Intelligent-TPACK (Celik, 2023), revealed a five-step, iterative process of AI-informed science

lesson planning: drafting a non-AI lesson, identifying improvement areas, crafting prompts, evaluating AI suggestions, and integrating, modifying, or rejecting suggestions. Evaluation criteria included student needs, standards alignment, feasibility, lesson coherence, and ethics. While confidence increased, PSTs reported challenges in writing precise prompts and expressed concerns about bias, privacy, and misuse. Findings offer insights into designing AI modules that foster critical evaluation, ethical reasoning, and effective AI use in science lesson planning.

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

Considering the Future of Nature of Science in Science Instruction: What's Next?

William McComas*, University of Arkansas, USA

Douglas Allchin*, University of Minnesota, USA

Christine McDonald, Griffith University, Australia

Kostas Kampourakis*, University of Geneva, Switzerland

Erin Peters-Burton*, George Mason University, USA

ABSTRACT

This round-table will focus on current questions and future directions regarding the Nature of Science (NOS) in science teaching. Even though NOS has long been seen as a vital element of science instruction, the field seems to have stalled recently both from philosophical and research perspectives. Therefore, we will collectively address the question of what's next? The diverse team of six panelists will bring their long experience in NOS scholarship to review current concerns and offer commentary on future directions of NOS in science education. We begin with some of the more obvious challenges with the integration of NOS into the science curriculum, move to a discussion of why a holistic vision of NOS may be advantageous, consider an expanded view of science based on its instrumental success, examine potential avenues to counter distrust in science and conclude with considerations of why epistemic network analysis might be a fruitful way to assess individuals' conceptions of science. These individual presentations will be followed by a potentially rich conversation between audience members and presenters about the ideas presented and perhaps offer some concluding thoughts about what's next in NOS scholarship and classroom impact.

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

Artificial Intelligence and the Nature of Science: Rethinking School Science for a New Era

Zoubeida Dagher*, University of Delaware, USA

Sibel Erduran, University of Oxford, United Kingdom

ABSTRACT

Artificial intelligence (AI) is rapidly transforming the ways scientific knowledge is produced, validated, and communicated. While science education research has increasingly explored AI

as a teaching and learning tool, less attention has been paid to how AI-driven changes in scientific practice can inform the teaching of the nature of science (NOS). This theoretical paper examines how advances in AI—such as large-scale data analysis, automated modeling, and hypothesis generation—are reshaping scientific inquiry, and how these shifts might be meaningfully incorporated into school science. Drawing on recent developments in AI applications in chemistry and other disciplines, we highlight opportunities and caveats for aligning classroom practices with contemporary scientific methods while preserving students' epistemic agency. We present a framework linking AI's roles in science and engineering to NOS learning goals, illustrating how AI can both enrich and potentially undermine key aspects of science education. We conclude with recommendations for reorienting curriculum and pedagogy to reflect the realities of 21st-century scientific practice without sacrificing the development of core disciplinary skills and critical thinking.

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

Why Does Dealing with Data Really Matter? Benefits and the Conditions That Support Them

Gregor Benz, Technical University of Munich, Germany

Joshua Rosenberg*, University of Tennessee, Knoxville, USA

Victor Lee, Stanford University, USA

ABSTRACT

Dealing with data is essential for informed citizenship and contemporary science learning. Yet justifications for data work are often normative and dispersed across standards; teachers lack coherent guidance about what students should actually do with data. This proposal addresses that gap by (a) clarifying what counts as data in science—as external, structured records and boundary objects that enable comparison and coordination—and (b) articulating why dealing with data matters. We synthesize five ends for data work—cultivating curiosity and ownership; developing data skepticism and metacognition; strengthening communication, collaboration, and argumentation; advancing quantitative and computational thinking; and supporting ethical reasoning and responsible scientific practice—and specify instructional aims and conditions for each. We show how these ends cut across different areas of scholarship related to students' work with data, and where descriptions are inconsistent. By the conference, we will refine the framework and offer classroom vignettes and design principles that make these benefits actionable for curriculum, teaching, and research.

Strand 14: Environmental Education and Sustainability

Roundtable

Building Resilient and Inclusive Education Systems: Insights from International Literature

Narendra Deshmukh*, Ret. from Homi Bhabha Centre for Science Education, TIFR, India

ABSTRACT

Education systems worldwide are undergoing significant transformation to align with the demands of the 21st century, emphasizing skills such as critical thinking, creativity, collaboration, and digital literacy. Global literature highlights the importance of inclusive, equitable, and student-centered pedagogies that prepare learners for rapidly evolving economic, social, and technological contexts. Research underscores that effective education reform requires a balance between foundational knowledge and future-oriented competencies, supported by robust teacher training, curriculum innovation, and assessment reform. International experiences reveal that integrating interdisciplinary learning, fostering lifelong learning mindsets, and leveraging technology for personalized education are central to improving learning outcomes. Comparative studies demonstrate that high-performing systems often combine strong public investment in education with policies that address equity and access. Moreover, global evidence emphasizes the role of culturally responsive teaching in engaging diverse learners and reducing achievement gaps. As education continues to evolve, cross-national collaboration and exchange of best practices are essential for addressing shared challenges such as learning loss, technological disruptions, and climate-related crises. By synthesizing insights from diverse contexts, this paper seeks to contribute to a deeper understanding of effective strategies for building resilient, adaptable, and inclusive education systems worldwide.

Strand 14: Environmental Education and Sustainability

Roundtable

Examining Adult Climate Change Educator Identity and Agency Shifts Across Professional Contexts

Emma Schectman*, UC Davis, USA

ABSTRACT

This research aims to gain understanding about how environmental educator identities shift as they adopt climate change education curriculum for adult audiences by observing and interviewing participants in a climate change education instructor training program. Teaching about climate change in a way that fully addresses the root causes and works towards effective adaptation and mitigation strategies can put educators at odds with their identities because of the potential to cause anxiety for their students. Professional identities (the way in which one sees themselves fitting in their professional context) are challenging to form which makes teacher training programs particularly

important. Educators who do not have strong professional identities tend to avoid teaching about controversial topics and climate change education is considered controversial due to its politicized nature. As climate change increasingly affects all populations around the world, climate change education amongst adults is necessary as they have power to act and engage with climate change adaptation and mitigation efforts and their views affect the attitudes of youth.

Strand 14: Environmental Education and Sustainability

WIP Roundtable

Context as Curriculum: Learning from the Land on which We are Settlers

Angela D'Souza*, University of Massachusetts, USA

Jeanne Brunner, University of Massachusetts, USA

ABSTRACT

U.S. education systems have rallied around three purposes: (1) democratic participation, (2) socially engineered contributions; and (3) socio-economic mobility predicated on the myths of American exceptionalism and meritocracy. One result of policy towards praxis is that the nation-state is naturalized as a unit of sovereignty, subsuming into the federal and state governments' purview, scales of economy and academic industry. Consequently, science education in school settings is predicated on universalizing scientific truths, rather than place-based ecologies that position humans as a part of and in relation to the more-than-human world, as Indigenous ways of knowing do.

In an after-school gardening and ecology program, middle schoolers residing in the North East are asked to participate in a Photo Elicitation study, where their beliefs and behaviors are revealed through dialogue, following structured introductions to Indigenous knowledges. Middle school participants take photographs to respond to prompts about how they relate to communities, including the more-than-human world. Engaging in interviews that includes authored images, our analysis of student sense-making yields examples for adopting pedagogies that include cultural knowledges and value relational dynamics over assessment. By employing an Indigenous pedagogies, particularly land education, science educators may contend with implicit biases of epistemological bases for K-12 curriculum.

Strand 14: Environmental Education and Sustainability

Roundtable

We Are Scientists: Science Identity, Language, and Cultural Relevance in Environmental Education

Becca VanArnam*, University of California Davis, USA

Peggy Harte, UC Davis Center for Community and Citizen Science, USA

Heidi Ballard, University of California Davis, USA

ABSTRACT

This study examines how participation in an anonymous Community and Citizen Science (CCS) program shapes high school students' science identity, with attention to language and cultural diversity. The program engages students from continuation and traditional high schools, juvenile detention facilities, a deaf and hard-of-hearing program, and college opportunity programs in monitoring salmon affected by vitamin B1 deficiency. Students collect and submit behavioral data, interact with researchers, and contribute to ongoing salmon conservation research. We conducted semi-structured interviews and paired pre/post surveys with 94 students (22 interviewed) and 11 teachers (11 interviewed). Quantitative analysis assessed changes in science identity, and language and cultural relevance, while qualitative thematic analysis explored recognition patterns. Findings show that students developed a stronger collective science identity ("we are scientists") rather than individual self-identification as scientists. Recognition was more prevalent in school settings than at home, particularly for students from immigrant families. Language and cultural relevance were inconsistently integrated, limiting opportunities to bridge recognition across contexts. These results extend science identity literature highlighting the role of collective recognition in environmental education and suggest that integrating students' linguistic and cultural resources may strengthen both individual and collective identities, fostering deeper connections between school-based science and home communities.

Strand 14: Environmental Education and Sustainability Roundtable

Science learning at sea: STEMSEAS as a model of experiential and transformative science learning

Shondricka Burrell PhD*, Morgan State University, USA

Keshiyena Pieters*, Morgan State University, USA

ABSTRACT

Over the past decade, there has been an average decrease in undergraduate geoscience course enrollment and degrees awarded in the United States (AGI, 2025). Simultaneously there are pressing local and global concerns including but not limited to climate change, extreme weather events, and persistent patterns of disproportionate environmental exposures. STEMSEAS (STEM Student Experiences Aboard Ships), is a model of experiential Earth and marine science learning and mentored research activities at sea purposefully designed to address the current science learning opportunity gap in the geosciences. The goal of this research is to determine if students who complete 5-10day sea going expeditions experience transformative learning—operationalized as student perception of science as applicable, relevant, and valuable (Pugh, 2002, 2020). Data analysis included iterative qualitative content coding of student written reflections from three expeditions. Preliminary findings indicate evidence of transformative learning for student participants in STEMSEAS expeditions.

**Strand 14: Environmental Education and Sustainability
Roundtable**

Climate change curriculum as a communication tool for supporting teachers' epistemic practices

Shweta Lahiri*, University of Georgia, USA

Emily Adah Miller, University of Georgia, USA

Hong Tran, Purdue University, USA

Yuxi Huans, University of California, Irvine, California, USA

Joe DeLuca, University of Georgia, USA

ABSTRACT

Climate change is an important socioscientific challenge with significant implications for children's futures. This case study examines how a climate change curriculum influenced the perspectives of an upper-elementary science teacher in an area that is affected by climate impacts. The teacher emphasized building content knowledge, and there was a shift in his perspective about the causes of climate change where he considered the role of human activities. The findings highlight the need for equitable teacher involvement in curriculum design to enhance agency and effectiveness in climate change education.

**Strand 14: Environmental Education and Sustainability
Roundtable**

Teachers' Approaches to Instructional Design for Environmental Science Agency

Won Jung Kim*, Santa Clara University, USA

ABSTRACT

Environmental Science Agency(ESA), as a form of critical agency, extends beyond being literate in environmental knowledge and inquiry toward using that literacy to address critical local-to-global environmental issues, taking actions for individual and systemic change. This study documents teachers' ESA-integrated instructional design. Employing a mixed methods approach to analyze teachers' lesson plans(LPs) supplemented by course discussions and instructor field note, three key findings emerged: (1) teachers identified and utilized a wide range of environmental phenomena and issues applicable to standards-informed school science contexts. (2) LPs that explicitly addressed ESA in learning goals were more likely to align ESA with assessment and activities coherently. ESA integration into instructional activities was associated with the timing of the activities first introduced in the lesson sequence. (3) Teacher descriptions of ESA-integrated activities widely varied, but with a salient focus on knowledge over other ESA aspects such as inquiry, positioning students as experts, or attention to civic and systemic changes. These findings highlight both the positive potential for teacher agentic design for ESA as well as the areas where further support for teacher learning and instruction is needed. Discussions address the implications for teacher education research and practices for fostering environmentally consequential science learning.

Strand 15: Policy, Reform, and Program Evaluation

Roundtable

Expanding Climate Education Using a Networked Improvement Community: A Case Study

Eric Nolan*, California State University, East Bay, USA

Michele Korb, California State University, East Bay, USA

Itzel Parada, California State University, East Bay, USA

Kathryn Hayes, California State University, East Bay, USA

Emily Harris, BSCS, USA

Karina Garbesi, California State University, East Bay, USA

ABSTRACT

Scaling climate education beyond individual classrooms necessitates balancing the efficacy of standardized models with the relevance of locally adapted approaches. Our roundtable discussion will share findings from a case study of the “Climate Solutionaries Community Project” (CSC, pseudonym), which started as a professional development opportunity for secondary teachers to integrate climate education into their classrooms. Over time, the structure and function of CSC as a Networked Improvement Community (NIC) facilitated resources for members to expand their efforts into a district-supported, multi-school initiative. Using meeting records, interviews, and project artifacts, we explore how NIC features transformed climate education from classroom practices led by individual teachers into a broader district effort. Findings from our research highlight strategies we found meaningful for maintaining participation throughout the network, aligning classroom practices with organizational and community goals, and integrating climate literacy into school and community events. The discussion we propose will focus on key design principles for forming coalitions that prioritize equity, encourage community involvement, and remain adaptable when scaling climate education reform. NARST participants will have an opportunity to consider how NIC structures help expand climate education across different contexts, making climate change an essential, interdisciplinary topic in secondary education.

Pathways to Persistence: Belonging, Motivation, and Engagement

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

21-Apr-26, 16:15-17:45

Location: Willow B (L2)

Stand-Alone Paper

Strengthening STEM Pathways Through Cohort-Based Learning and Career Engagement in Community College

Ti'Era Worsley*, Northern Virginia Community College, USA

Justin Owen, Northern Virginia Community College, USA

Jack Bidlack, Northern Virginia Community College, USA

Christopher Russell, Northern Virginia Community College, USA

Joshua Labrie, Northern Virginia Community College, USA

ABSTRACT

The semiconductor manufacturing and data center industries offer high-growth, well-compensated STEM career opportunities, yet many community college students remain unaware of these pathways or lack targeted preparation. The Technician Pathway Program (TPP) was developed to address this gap through a one-year, cohort-based model leading to a certificate in engineering technology. Grounded in Social Cognitive Career Theory (SCCT), TPP integrates structured peer networks, contextualized industry experiences, and targeted academic/professional support to enhance students' self-efficacy, outcome expectations, and career identity. Using a Design-Based Research approach, this study examined the experiences of 19 TPP participants through surveys, feedback, and observational data collected over one academic year. Thematic analysis revealed three key mechanisms supporting persistence and workforce readiness: 1) community engagement via block time, providing opportunity building relationships and mutual accountability; 2) wraparound support beyond coursework, addressing academic, administrative, and professional skill development; and 3) industry engagement with career awareness, providing authentic exposure to STEM-based workplace norms and networking opportunities. Findings highlight the potential of intentional cohort structures to strengthen STEM persistence in community colleges, particularly when coupled with industry partnerships. TPP illustrates how integrated academic, social, and industry-aligned supports can bridge the gap between technical education and high-demand workforce needs.

Stand-Alone Paper

Science Identity and College Transitions at an HBCU

Elizabeth Deimeke*, Clark Atlanta University, USA

Reneé Schwartz, Georgia State University, USA

ABSTRACT

Increasing the quantity and diversity of STEM professionals requires enhancing the number of students who graduate with baccalaureate degrees in STEM fields. Historically Black colleges and universities (HBCUs) produce a disproportionate number of Black STEM graduates. In this qualitative study, we explore how Black, female undergraduates at an HBCU use community cultural wealth (CCW) to build communities and cultivate counterspaces that promote science identity and self-efficacy. Analysis revealed individuals and events at the HBCU reflected shared CCW, which encouraged community building and sense of belonging. Peer study groups, family, and faculty relationships functioned as counterspaces when threatened by challenges in science. The collective use of CCW within these counterspaces protected science self-efficacy and enabled critical navigation of what it means to be successful in science. This study will help HBCUs improve the experiences and persistence of first-year STEM students by reinforcing collective CCW and supporting the counterspaces students rely on for support.

Stand-Alone Paper

Belonging in Biology Education: Intersectional Experiences and Recommendations from Undergraduate Muslim Students in the US

Rahmi Aini*, Middle Tennessee State University, USA

M. Elizabeth Barnes, Middle Tennessee State University, USA

ABSTRACT

This study investigates how undergraduate American Muslim women experience belonging in biology courses through the lens of intersectionality. While prior research has highlighted challenges faced by students from marginalized racial and gender groups, religious identity remains underexplored in science education. Using qualitative interviews with 12 self-identified Muslim women in biology programs, we examined how their visible and invisible identities, such as wearing a hijab, shape classroom experiences, identity management, and perceptions of inclusion. Additionally, some biology content, such as embryology, anatomy, physiology, and genetics, can support spiritual reflection; other topics, like evolution and genetic modification, pose conflicts with religious beliefs. Students also recommended culturally competent teaching practices, including acknowledging religious diversity, offering discussion, and accommodating religious observances during the month of Ramadan. These findings reveal how intersecting religious, racial, and gender identities influence Muslim students' participation and belonging in biology education. The study offers practical implications for creating more inclusive learning environments that support the success and well-being of religiously marginalized students in science in general.

Cultivating Teacher Identity and Agency in Preservice Education

Strand 7: Pre-service Science Teacher Education

21-Apr-26, 16:15-17:45

Location: Boren (L4)

Stand-Alone Paper

"I feel like you're trying to science teacher me": Challenging epistemic hierarchies in teacher education

Elizabeth Harris*, Stanford University, USA

ABSTRACT

This study examines how pre-service secondary science teachers position themselves and others in relation to epistemic authority, agency, and affect during an inquiry-based teaching methods course. Using a microethnographic approach and video data, the research captures fine-grained classroom interactions to explore how one student, Ed, repeatedly asserted epistemic authority through scientific language, control of materials, and "teacher-like" questioning. Two key episodes reveal how Ed's bids for authority influenced the participation and emotional engagement of his peers. In one instance, a peer directly challenges Ed's

positioning, while in another, shared laughter disrupts the epistemic hierarchy, allowing for more equitable collaboration. These findings highlight the socioemotional dimensions of epistemological shifts in teacher education and the ways in which power dynamics shape opportunities for students to experience agency and affect in science learning. The study suggests that teacher educators must actively surface and challenge epistemic hierarchies to foster equitable classroom environments and prepare future teachers to support all students as capable knowledge-builders. Emphasizing everyday language and relational learning over formal science talk may help redistribute authority, reduce emotional labor, and invite more diverse learners into authentic scientific inquiry.

Stand-Alone Paper

Why Stay? Exploring Preservice Elementary Teachers' Intent to Remain in the Profession

Jeanna Wieselmann*, Southern Methodist University, USA

Grace Morison, Southern Methodist University, USA

Deepika Menon, University of Nebraska - Lincoln, USA

Sarah Haines, Towson University, USA

Sumreen Asim, Indiana University Southeast, USA

ABSTRACT

Teacher attrition remains a global concern, particularly among early-career educators and within high-need educational contexts. This mixed-methods study examined the factors that influence preservice elementary teachers' (PSTs') intent to remain in the teaching profession. Grounded in Social Cognitive Career Theory, we analyzed qualitative and quantitative data from 683 PSTs enrolled in science methods courses in 15 U.S. institutions. Open-ended survey responses were thematically coded and quantitized to identify common factors shaping intent, while Likert and ordinal scale items provided quantitative insights into perceived alignment with the teaching profession. Results indicate that salary, administrative support, family responsibilities, personal wellbeing, and passion for teaching were the most frequently cited influences. Few participants referenced broader systemic issues, indicating a primary focus on personal and school-based conditions. While most participants expressed intentions to remain in teaching long term, concerns about burnout and financial insecurity may shift these trajectories. This study contributes to a deeper understanding of how early-career teachers evaluate their future in the profession and offers implications for improving teacher preparation, supporting career resilience, and addressing early attrition, particularly in elementary science education contexts.

The impact of professional learning and research-practice partnerships

Strand 8: In-service Science Teacher Education

21-Apr-26, 16:15-17:45

Location: Greenwood (L3)

Stand-Alone Paper

Changes in Fifth-Grade Teachers Socioscientific Issues Instruction: Assessing the impact of professional development

Jerrid Kruse*, Drake University, USA

Sarah Borzo*, Drake University, USA

Ava Dembowski, Drake University, USA

Macy Gardner, Drake University, USA

Lucas Menke, Drake University, USA

Isaiah Kent-Schneider, Purdue, USA

Maddie Kampf, Drake University, USA

ABSTRACT

Socioscientific issue (SSI) instruction is a powerful way to help students deeply learn science content while exploring interactions with society and potential ways to help create social change. Effective science and socioscientific issues instruction both require deep levels of understanding and confidence but are often not emphasized in elementary schools. Therefore, we created a year-long professional development program designed to help fifth-grade teachers build their understanding and implementation of effective socioscientific issues instructions. This study investigates the impact of the professional development on the enactment of fifth-grade teachers' socioscientific issues instruction. From videos of classroom instruction and using the socioscientific issues observation protocol (SSI-OP) and an inductive qualitative analysis, we will report on changes in participants' SSI instruction from pre to post professional development. Findings include that participants improved their framing of SSIs as local ethical problems, but continued to struggle to include robust science content learning. Implications and next steps will be discussed.

Stand-Alone Paper

Fifth-grade Teachers' Critical Science Literacy: Investigating the impact of professional development

Lucas Menke*, Drake University, USA

Jerrid Kruse*, Drake University, USA

Sarah Hunt, Drake University, USA

Sarah Borzo, Drake University, USA

Mitch Klocke, Drake University, USA

Ava Dembowski, Drake University, USA

Megan Huberty, Drake University, USA

Grace Hegard, Drake University, USA

ABSTRACT

Decision-making about issues related to science— often known as socioscientific issues (SSI)— is often challenging due to the complexity of such issues and the many perspectives that hold stake in them. Because of the prevalence of such issues in modern society, many researchers and science educators note the importance of including instruction surrounding SSI in K-12 schooling (Ke et al., 2021; Owens et al., 2021; Zeidler & Sadler, 2011). However, SSI instruction is rare in elementary schools (Blank, 2013; Plumley, 2019). If elementary teachers are to start introducing their students to SSI, then they themselves need to be socioscientifically literate. In this project and study, the authors sought to help elementary teachers develop their literacy regarding SSI through the critical science literacy framework (Author et al., 2025). Specifically, 5th grade teachers were taken through think aloud protocols (Van Someren et al., 1994) before and after engaging in a SSI-based professional development program. Findings highlight the ways in which participants' thinking changed and grew, as well as the areas in which teachers struggled despite the program. Such findings may help viewers better support elementary teachers in implementing SSI instruction.

Stand-Alone Paper

Why Well-Designed Professional Learning Programs Can Fail: Evidence from a PL Program on Scientific Reasoning

Richard Sannert*, IPN - Leibniz Institute for Science and Mathematics Education, Germany

Verena Petermann, Justus Liebig University Giessen, Germany

Janet Carlson, Stanford University, USA

Jan van Driel, University of Melbourne, Australia

Moritz Krell, IPN - Leibniz Institute for Science and Mathematics Education, Germany

ABSTRACT

Professional Learning (PL) programs are an essential means for supporting science teachers in their teaching and, ultimately, enabling students to acquire 21st century skills, such as scientific reasoning (SR). Yet, even well-designed PL programs do not always show positive effects on all teachers, classroom practice and students. For this reason, it is argued that individual barriers can hinder progression: (1) acceptance barriers—factors limiting teachers' uptake of PL content; (2) implementation barriers—factors hindering the application of PL content in classrooms; and (3) student impact barriers—factors constraining the development of students' SR competencies. This qualitative case study investigates three contrasting cases of science teachers who participated in the same PL program on SR but showed different trajectories during and after the program, particularly in their classroom practice to promote SR. Interviews revealed both general barriers and specific barriers to promoting SR, such as difficulties in assessing SR competencies or lack of time to adapt inquiry lessons. The barriers each teacher reported varied considerably, suggesting that individualized support may be more effective than a "one-size-fits-all" approach in PL programs. Our findings can inform PL facilitators in helping teachers identify their individual barriers and develop tailored strategies to overcome them.

Stand-Alone Paper

Building and Sustaining Research-Practice Partnerships in Geospatial Education: Lessons from a Four-Year Collaboration

Danielle Malone*, Purdue University, USA

Kate Popejoy*, Popejoy STEM LLC, USA

Judith Morrison, Washington State University, USA

Jonah Firestone, Washington State University, USA

Thomas Hammond, Lehigh University, USA

Molly Weinburgh, Texas Christian University, USA

Kristen Brown, Texas Christian University, USA

Lindsay Lightner, Washington State University, USA

Alec Bodzin, Lehigh University, USA

ABSTRACT

This research examines the sustainability of a four-year research–practice partnership (RPP) between researchers and teachers. This project focused on integrating Geographic Information Systems (GIS) into inquiry-based, socio-environmental curricula. This partnership aimed to develop teachers' geospatial technological pedagogical content knowledge (GS-TPACK), enhance students' engagement with socio-environmental investigations, and foster collaborative relationships between researchers and practitioners. The research team and external evaluators administered annual GS-TPACK and Wilder Collaboration Factors Inventory surveys and interviewed all RPP members. PD focused on improving technical knowledge and pedagogical approaches for integrating these tools into curricula. The findings show significant teacher growth in their GS-TPACK, with substantial gains in applying GIS to authentic investigations, designing student-centered lessons, and integrating spatial reasoning into existing curricula. The RPP consistently demonstrated strength in relational trust, having a shared purpose, and respecting the collective expertise of the group. There were lower ratings for workload pacing, coordination capacity, and resource availability. Qualitative results indicated that when activities aligned with curricular and student needs, teachers expressed stronger intentions to continue GIS use. This research uses measurable indicators of teacher knowledge gains together with RPP health metrics to demonstrate how instructional work and relational work intertwine in the maintenance of educational partnerships.

Science teachers' epistemic beliefs and modeling practices

Strand 8: In-service Science Teacher Education

21-Apr-26, 16:15-17:45

Location: Issaquah AB (L3)

Stand-Alone Paper

Making Sense with Models: Modeling as a Gateway to the NGSS Science and Engineering Practices

Katherine Glover*, North Carolina State University, USA

Laura Chalfant, North Carolina State University, USA

Grace Carroll, North Carolina State University, USA

Khalid Alharbi, North Carolina State University, USA

Lynn Huff, North Carolina State University, USA

Soonhye Park, North Carolina State University, USA

Matt Reynolds, North Carolina State University, USA

ABSTRACT

This quantitative study empirically tested the theoretical assertion that the scientific and engineering practice (SEP) of Developing and Using Models can serve as an anchor for integration of other SEPs into instruction. Seventy-two videos of 21 high school science teachers' lessons were analyzed to (1) determine the SEPs teachers incorporated throughout the modeling cycle and (2) understand the relationship between teachers' implementation of a model-based teaching approach and their integration of SEPs. Findings revealed teachers incorporated SEPs into all phases of knowledge construction (Investigating, Sensemaking, and Evaluating and Communicating) as they engaged in the modeling cycle. SEPs in the Sensemaking phase (Analyzing and Interpreting Data, Developing and Using Models, and Constructing Explanations) were incorporated more frequently than SEPs in the Investigating and Evaluating and Communicating phases. Additionally, as teachers implemented model-based teaching, they more frequently enacted indicators of SEPs that are classified as having high cognitive involvement from students rather than low cognitive involvement with the exception of the indicators in Planning and Carrying out Investigations. Targeted professional development to strengthen enactment of SEPs that were less commonly incorporated into instruction or were used with low cognitive involvement tasks could support teachers in more effectively integrating SEPs into instruction.

Stand-Alone Paper

Investigating the Interplay of Teachers' PCK, Epistemic Beliefs, and Their Implementation of Modeling Instruction

Laura Chalfant*, North Carolina State University, USA

Grace Carroll, North Carolina State University, USA

Matt Reynolds, North Carolina State University, USA

Soonhye Park, North Carolina State University, USA

Katherine Glover, North Carolina State University, USA

Khalid Alharbi, North Carolina State University, USA

Lynn Huff, North Carolina State University, USA

Scott Ragan, North Carolina State University, USA

Jason Painter, North Carolina State University, USA

ABSTRACT

This study highlights two teachers from a cohort of high school science teachers who participated in a professional development program to teach them the principles of MI and how to implement this type of learning in their classrooms. Using the Epistemic Orientations to Teaching Science for Knowledge Generation survey, lesson plans, content representations, semi-structured interviews, classroom videos, and the Model-Based Teaching Observation Protocol (MBTOP), we sought to discover how teachers with similar PCK and epistemic beliefs might implement MI differently, given that research has shown that PCK and EBs are important in teachers' use of teaching practices like MI. Findings indicate that while both teachers demonstrated similar PCK profiles and EBs aligned with knowledge-generative teaching, their MI implementation differed markedly. The higher-scoring teacher engaged students in the full modeling cycle, including evaluation and revision, whereas the other emphasized teacher-led construction with limited student reflection or prediction. These results suggest that while PD can strengthen PCK and align EBs with reform-oriented instruction, contextual factors such as school environment may significantly influence enactment. Implications highlight the need for PD to address not only teacher knowledge and beliefs but also strategies for navigating local teaching contexts.

Stand-Alone Paper

Exploring Patterns of Assessment Literacy in Model-Based Science Instruction

Alexis Gonzalez-Donoso*, The University of British Columbia, Canada

Samia Khan, University of British Columbia, Canada

ABSTRACT

Model-based teaching (MBT) emphasizes students' active construction, evaluation, and refinement of scientific models. However, in-service science teachers (ISTs) often face challenges in assessing these practices in the science classroom. This study investigates ISTs' self-reported assessment practices in MBT and identifies patterns in these practices using the QALMBT-Modeling questionnaire. A total of 386 middle and secondary science teachers from diverse schools in Chile completed the instrument, which measured the frequency of 35 assessment practices on a 5-point Likert scale. Principal Component Analysis (PCA) and k-means clustering were applied to teachers' experience, weekly workload, and the number of science education topics studied at any time in their preparation. Results revealed three distinct profiles: highly experienced teachers with broad training, low-experience teachers with limited training, and low-experience teachers with moderate training. Teachers' experience and exposure to science education topics were strongly associated with higher assessment literacy, whereas weekly workload had a minor impact. These findings highlight the importance of both teaching experience and professional learning in developing assessment literacy in MBT. Implications for teacher education include prioritizing targeted

professional development that supports assessment of model construction, revision, and evidence-based reasoning to foster student learning in science.

Curriculum Co-Design and Customization: Understanding Teacher Choices and Challenges

Strand 10: Curriculum and Assessment

21-Apr-26, 16:15-17:45

Location: Capitol Hill (L3)

Stand-Alone Paper

Supporting Teacher Customization for Equitable Discussion through Cycles of Enactment and Reflection

Brianna Balke*, Boston College, USA

Maria Moreno Vera, Boston College, USA

Austin Moore, Boston College, USA

Katherine McNeill, Boston College, USA

ABSTRACT

Promoting equitable learning environments necessitates teacher customization of curriculum in response to student needs. Intentionally designed professional learning can encourage teacher customizations that center equity. In this study, we examine how a customization process grounded in an equity goal can support equitable classroom instruction by exploring one teacher's customizations and reflections over the course of a year-long professional learning experience. Specifically, we look at how one teacher's goal of elevating students' voice and perspectives evolved over time, the strategies she used to address that goal, and the factors that influenced her customization of instruction for equity. To explore these questions, we analyzed post-lesson reflection conversations and an interview with the teacher, and consulted secondary data sources like lesson recordings and artifacts. The teacher deepened her thinking around what it means to support equity in discussions as her equity goal evolved. She also developed a greater repertoire of strategies to support equitable discussions. This evolution was supported by the establishment of dedicated space and time for reflection grounded in close observation of students and their work, as well as a sustained focus on an equity goal within that reflection space.

Stand-Alone Paper

Design Dilemmas as Productive Spaces for Teacher Learning: Insights from a Curriculum Co-Design Case Study

Katarzyna Pomian Bogdanov*, Florida State University, USA

ABSTRACT

This proposal examines how design dilemmas – episodes of productive uncertainty in collaborative curriculum design – can serve as generative contexts for teacher learning (Author, 2025). Drawing on 34 hours of OpenSciEd co-design meetings, I analyze the frequency, duration, initiation patterns, and content of 65 design dilemmas. I show that dilemmas were sustained, value-rich, and dialogic, enabling teachers to articulate and negotiate pedagogical commitments. I highlight the case of Kristen, a high school science teacher whose reflective participation bridged student-centered and teacher-centered concerns. The analysis suggests that productively supporting or intentionally fostering design dilemmas can enhance teacher learning and agency in collaborative design settings.

Stand-Alone Paper

Co-designing a CS Infused Gardening Curriculum with Community Partners in a Rural Research Practice Partnership

Quentin Biddy*, University of Colorado, USA

Jennifer Jacobs, University of Colorado, USA

Srinjita Bhaduri, University of Colorado, USA

Lalita Suwattee, University of Colorado, USA

ABSTRACT

This paper describes the collaborative design process of a place-based, phenomenon-driven computer science (CS) infused curriculum designed around the context of community gardening and aligned to the Next Generation Science Standards (NGSS) and Computer Science Teacher Association (CSTA) Standards. Importantly the co-design process included not only teachers from the partner school district but members of multiple community partner organizations, all of whom played a critical role in designing core components of the curriculum. We address the question: How can teachers and community partners be leveraged to support curriculum development through a rural research practice partnership (RPP)? Whereas traditional co-design efforts highlight development, implementation, and iteration, we discuss the importance of attending to pre-development using a process adapted from Noam & Tillinger's (2004) framework for partnership development. We articulate the processes by which the RPP engaged in pre-development and development phases of curricular co-design, and the steps taken to ensure that the curriculum mapped to

shared goals and interests. We posit that intentional pre-development partnership work provided a strong foundation for the upcoming co-design workshop, helped align goals of all stakeholders, and accelerated movement towards an increasingly collaborative and deliberative enterprise.

Stand-Alone Paper

Navigating through Pedagogical Dilemmas in Curriculum Customization for Equity

Yang Zhang*, Northwestern University, USA

Jason Buell, Northwestern University, USA

Etta Pope, Northwestern University, USA

Brian Reiser, Northwestern University, USA

ABSTRACT

Curriculum customization for equitable instruction requires teachers to navigate multiple goals that can support or contradict each other. Trying to achieve those goals at the same time can lead to teachers navigating through pedagogical dilemmas with no obviously “right” solution. In this paper, we present an illustrative case study to demonstrate the complex decision-making process a group of three middle school science teachers went through in the context of a professional learning community (PLC). Drawing upon the construct of pedagogical dilemma, we used thematic coding to identify and construct the participants’ pedagogical reasoning, which consisted of what dilemmas they experienced and why, and how they responded to those dilemmas. The findings show that instead of a decision made out of one incident or to achieve a single goal, the teachers orchestrated their goals and other resources and constraints to make sometimes, compromised decisions. With an analysis of data collected from the curriculum writer, the findings also illustrate how teachers’ pedagogical reasoning was shaped by a series of decisions at other levels of the system, from establishing the performance expectation to what to include and not include in the curriculum.

Envisioning Equitable Futures Through Science Education: Challenging Dominant Norms and Centering Marginalized Voices

Strand 11: Cultural, Social, and Gender Issues

21-Apr-26, 16:15-17:45

Location: Ballard (L3)

Related Paper Set

Preservice Elementary Teachers’ Work to Expand What Counts as Science

Jessica Bautista*, University of Michigan, USA

Elizabeth Davis, University of Michigan, USA

ABSTRACT

An essential component of science teacher education is supporting preservice teachers to understand the importance of and be able to draw on the strengths and experiences of the children in their classrooms. One approach to this is positioning children, families, and communities as experts with valuable knowledge to share. This qualitative case study explores 16 preservice elementary teachers' conceptions of and instructional practices related to expanding what counts as science to extend beyond the classroom. We aim to illustrate what may be possible for early career elementary teachers as they work toward justice-centered science education that can support all children to see themselves as knowers and doers of science. We discuss implications for science education research and elementary teacher education.

Related Paper Set

Building Queer Belonging in STEM Education Curriculum

Kyle Nolting*, University of Denver, USA

ABSTRACT

The disciplines of STEM education have historically marginalized queer identities and perspectives, shaping inaccurate curricula and inequitably influencing expertise in the fields of STEM. To address this, my research uses design-based research to investigate the design of queer-inclusive STEM curricular resources. I partnered with in-service secondary STEM teachers amidst a professional development course to co-create curricular resources. My research is grounded in queer theory, using a queer literacy framework to collaboratively develop inclusive design principles. My findings revealed a strong desire by teacher participants for more authentic and fluid representations of gender and sexuality in STEM curricula, particularly beyond the biological science discipline. My study emphasizes the importance of fostering belonging for LGBTQIA+ students in STEM classrooms.

Related Paper Set

Middle School Students' Sensemaking as Experts on Their Community in a Justice-Oriented Wildfire Science Unit

Spencer Eusden*, University of Nevada, Reno, USA

Li Ke, University of Washington, USA

ABSTRACT

A growing consideration for equity in K-12 education is the role that impacts from climate change-driven disasters and environmental issues are having on communities and students. In the space of phenomena-based and storyline approaches to science curricula, these climate issues are compelling anchoring phenomena for both science learning and disaster resilience. However, how disasters and environmental issues are used as phenomena and whose knowledge of these issues is valued shapes whether such curricula support justice or more deeply entrench issues of equity in student learning and disaster resilience. This paper shares the results from a co-produced middle school wildfire science unit that foregrounds

students' expertise of their community concerning wildfire. This community is at high risk of fire and has recently experienced a wildfire in a neighboring town, resulting in multiple homes lost. Results include 1) How students situate themselves in data sets about their town and the impact of this on student learning, and 2) How students draw on knowledge of their community to make sense of wildfire issues. Student sensemaking was in part shaped by the neighborhood where they live, identity, and lived experiences with family members who are more sensitive to impacts from wildfire

Community, Transparency, and Tinkering for Just Futures: Lessons Learned from the Critical AI Literacy Institute

Strand 12: Technology for Teaching, Learning, and Research

21-Apr-26, 16:15-17:45

Location: Jefferson B (L4)

Related Paper Set

Tinkering as Critical AI Literacy: Teaching Infrastructure through Breakdown & (Re)Configuration

Zachary Muhlbauer*, CUNY Graduate Center, USA

ABSTRACT

In my workshop for CUNY faculty at the Critical AI Literacy Institute, I proposed tinkering as a critical practice that reveals a productive pedagogical tension: the more we expose large language models' instability and configurability, the more we recenter discovery and reassert agency in educational spaces. When I demonstrated temperature manipulation, participants examined how parameter adjustments shift outputs from deterministic similarity to creative disorder, illustrating that AI responses are approximations by configurable systems rather than authoritative answers. My Historical OCR prototype exemplified this situated tinkering: I built a tool using Mistral's vision-language model for archival transcription to demonstrate how we can integrate AI components selectively within academic workflows without replacing interpretive labor. When participants asked "Where would this break? Which documents couldn't it handle?"—their inquiries reframed breakdown as a site for collective sense-making, and infrastructure as malleable rather than fixed. This led me to develop the ChatUI Helper, which enables educators to customize chatbots with transparent parameters while exposing students to the configuration files that commercial platforms conceal. Following Susan Leigh Star's insight that infrastructure becomes visible upon breakdown, I treat model customization and instability as pedagogical resources, demonstrating that no system is inevitable and no technological future predetermined.

Related Paper Set

The Critical AI Literacy Institute: Asserting and Preserving Scholarly Agency in the Age of AI

Luke Waltzer*, CUNY Graduate Center, USA

ABSTRACT

As generative AI reshapes higher education, universities face critical decisions about adoption, pedagogy, and institutional values. This paper presents research from the Critical Artificial Intelligence Literacy Institute (CALI), a three-year project at the City University of New York that explores how universities can develop comprehensive and just responses to generative AI which center faculty, student, and staff agency.

CALI's objective is to foster critical literacies by examining genAI's disciplinary and epistemological impacts on knowledge creation. The Institute employs an interdisciplinary, iterative, research-driven methodology grounded in critical AI studies, critical university studies, the digital humanities, and the scholarship of teaching and learning to engage faculty fellows in collaborative examination of AI's effects across academic fields. Preliminary data from the Institute confirms significant disciplinary tensions regarding generative AI adoption, revealing that while the technology shows promise in some areas, it creates epistemological and ethical challenges in others. The project's research confirms that effective institutional responses must accommodate strategic refusal, thoughtful adoption, and wise investment rather than blanket implementation.

This work contributes to conversations about university governance and curriculum by promoting literacy frameworks that center student and faculty agency while demonstrating the need for policies that address AI's various impacts on higher education.

Related Paper Set

Fostering Critical AI Literacy as Collective World-Building: Curricular Models for Teaching With/About Generative AI

Laurie Hurson*, The CUNY Graduate Center, The City University of New York, USA

ABSTRACT

Definitions of "AI literacy" often present few opportunities for refusal or critique of GenAI tools or the systems from which they emerge, demonstrating a need for critical inquiry within current AI literacy frameworks. The Critical AI Literacy Institute provided faculty with an opportunity to consider the implications of GenAI tools on teaching and learning and engage in reflective inquiry in order to develop curricular interventions for fostering students' AI literacy. This paper will explore three interventions produced at the institute: a module exploring GenAI functionality and material consequences, an activity examining GenAI outputs, and writing activities that recenter embodied experiences in the learning process. Bringing together pedagogical approaches that foreground community and collaboration

with methods of critical inquiry, the interventions examine technological systems across scale, support diverse ways of knowing, and connect knowledge production to lived experiences of learners and communities. The interventions demonstrate how critical AI literacy can refuse or embrace GenAI tools while centering social, environmental, and epistemological justice issues. Drawing on these models, educators can approach teaching critical AI literacy as part of a larger project of world-building—one that resists inevitability narratives, centers relationships, and envisions education as a collective endeavor to create more just futures.

Related Paper Set

Beyond the Black Box: Resisting AI Inevitability Rhetoric and Implications for Science Education

Sule Aksoy*, SUNY Brockport, USA

ABSTRACT

Given that many studies in science education lack criticality and fall short of addressing sociopolitical structures shaping genAI, there is a significant need to explore how faculty reflect on the inevitability of AI discourse within interdisciplinary communities of practice. This study examines how faculty in the CALI project resist AI inevitability rhetoric and apply critical scientific thinking to technology adoption decisions. I analyze faculty reflections from online group discussions focused on disciplinary knowledge production, agency, and pedagogy regarding genAI. Findings reveal that faculty resistance to AI demonstrates application of critical inquiry practices such as questioning claims, examining evidence, considering social implications, and recognizing human agency in shaping technological futures. Faculty articulated tensions between maintaining critical pedagogical approaches and institutional pressures for AI adoption, while connecting AI development to broader issues of environmental and social justice. Rather than viewing resistance as an obstacle, I argue that faculty responses model the critical scientific literacy that science education aims to develop. This study contributes to understanding how interdisciplinary science education can lead to critical approaches to emerging technologies.

Nature of science in disciplinary contexts

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

21-Apr-26, 16:15-17:45

Location: Virginia (L4)

Stand-Alone Paper

The Structure of Biological Explanation: Extending the Nature of Scientific Explanation Framework Beyond Physical Sciences

Sahar Alameh*, University of Kentucky, USA

Fouad Abd-El-Khalick, University of Massachusetts Amherst, USA

ABSTRACT

This conceptual framework extends the Nature of Scientific Explanation (NOSE) framework, originally developed to examine and assess explanations in the physical sciences (NOSE-P), to the examination and analysis of explanations in the biological sciences. Drawing on philosophical models of scientific explanation, we adapt and expand the framework to create the NOSE-B framework. Our NOSE-B framework examines how biological explanations differ structurally and epistemically from those in the physical sciences, highlighting the central roles of descriptive and functional observations, causal processes, generalizations, and teleological reasoning - that are unique to biological phenomena. We present how the NOSE-B framework provides a systematic method for distinguishing between biological explanations and other scientific constructs, identifying structural elements within biological explanations, and examining their adequacy based on accuracy, relevance, and completeness. In our development of the framework, we took into account the contingent, historically shaped, and multi-level nature of biological phenomena, where universal laws are often absent or play a different role compared to the physical sciences. By offering a structured method for analyzing and constructing scientific explanations specific to biology, NOSE-B provides conceptual and practical tools for clarifying scientific explanations in research, instruction, and assessment.

Stand-Alone Paper

Promoting Undergraduate Non-Science Majors' Evolution Learning Perspectives through NOS, Mis/disinformation, and Bias Regulation Teaching

Benjamin Herman*, Texas A&M University, USA

Tamara Powers, Texas A&M University, USA

Magda Villwock, Texas A&M University, USA

Daniel De Jesús, Texas A&M University, USA

Michael Clough, Texas A&M University, USA

Ben Janney, Utah Tech University, USA

Aaron Kidd, University of Science and Arts of Oklahoma, USA

ABSTRACT

Students often struggle to accept evolution for a bevy of reasons to include incorrect science related views and ideologically grounded perspectives such as those associated with religious and political orientations. Despite knowing possible impediments to students' accepting and understanding evolution, post-secondary biology coursework is typically unresponsive to those factors and instead focuses only on the transmission of science content. This mixed-methods investigation determined how an undergraduate contemporary science issues course for non-science majors focused on evolution that integrates instruction on motivated reasoning, self-bias regulation, NOS, and mis/disinformation impacts students' (N =87) perspectives of those topics. From before to after their course experiences, the students' evolution acceptance, and NOS and mis/disinformation perspectives significantly improved. Furthermore, after completing the course the students felt more positive about learning about evolution and explicitly

expressed appreciation for the course instructors' pedagogical approach to teaching that topic. This session will present details regarding the undergraduate contemporary science issues course for non-science majors, and how that course promoted students' evolution acceptance, receptivity toward learning evolution, and views about NOS and mis/disinformation.

Stand-Alone Paper

The influence of NOS understandings on the science identities of two undergraduate science majors

Robert Bennett*, Georgia State University, USA

Renee Schwartz, Georgia State University, USA

ABSTRACT

Scientific Literacy (SL) is an important goal of science education reform. Nature of science (NOS) researchers have worked for decades to increase SL through NOS instruction. Science identity researchers have worked to increase SL and diversity in science fields by helping students to see themselves as science people. This research study used qualitative methods to explore the connections between NOS understandings and science identities in two African American women studying in science fields at universities in the southeastern US. Using NOS questionnaires and three rounds of semi-structured interviews, connections were shown to exist between science identity development and several aspects of NOS in the consensus view (Lederman et al., 2002). Subjective NOS, tentative NOS, creative NOS, and sociocultural NOS all impacted the ability of the women in this study to recognize themselves as scientists. Implications for the teaching of science and teacher preparation in science fields will be discussed.

Stand-Alone Paper

Systematic review on critics about Galton's eugenics

Natália Carvalho*, Programa de Pós-Graduação Interunidades em Ensino de Ciências da USP, Brazil

Rena Orofino*, School of Education, University of São Paulo, Brazil

Kátia Ribeiro, Federal Institute of Maranhão (IFMA), Brazil

ABSTRACT

This systematic review aimed at understanding the sources and contents of criticism of Galtonian Eugenics to establish a dialogue with educational research. Eugenics was proposed as a scientific solution in England during the industrial revolution and the contradictions it brought to English society. We conducted a search on the Web of Science for Eugen* and Galton* in titles, abstracts, and keywords. Five full-texts were selected with criticisms from fields such as History of Science, Criminology, Data Science, Media Studies, and Psychology. The criticisms address aspects related to the social consequences of Galton's propositions; the theoretical, methodological, and argumentative weaknesses of his propositions; the class and racial biases that influenced his investigative processes; and the

positivist conception of science and quantitativist ontology underlying his ideas. There is a gap in the field of science education research regarding studies on Eugenics, which constitutes a shortcoming, since important aspects of the Nature of Science could be addressed through this historical case to promote a more critical science education, committed to social justice and social transformation, by problematizing the interfaces between eugenic propositions and science, as well as the appropriation of biological concepts and theories to sustain eugenic reasoning.

Indigenous STEM Knowledge and Storytelling: Using Stories to Develop STEM Understandings for All Students

Strand 14: Environmental Education and Sustainability

21-Apr-26, 16:15-17:45

Location: Willow A (L2)

Symposium

Indigenous STEM Knowledge and Storytelling: Using Stories to Develop STEM Understandings for All Students

Stacy Potes*, University of Hawaii at Manoa, USA

Piata Allen*, University of Auckland, New Zealand

Nicole Chlebek*, Florida International University, USA

Kat Gardner-Vandy*, Oklahoma State University, USA

Lenora Crabtree*, University of North Carolina at Charlotte, USA

Rebekah Hammack*, Purdue University, USA

Kristal Turner, University of Calgary, Canada

David Owens*, University of Montana Missoula, USA

ABSTRACT

Scientific knowledge is embedded within epistemological orientations and biocultural contexts, and opportunities to braid knowledge systems within education can empower all learners, particularly those who are historically disenfranchised by a solely Western approach to science. Accessing scientific concepts through storytelling is the oldest of technologies in which humans have engaged in scientific sense-making and can offer students a meaningful lens with which to connect to science knowledge. Use of story as both content and as a pedagogical tool can support the weaving of multiple ways of knowing, connect students more authentically to their cultural and place-based identities, and contribute to the decolonization of more mainstream approaches to science education. Stories passed down from Indigenous cultures around the world highlight scientific knowledge and processes, showcasing the connection between nonhuman kin and human survival. They demonstrate diverse uses of structure, values, and resources, revealing rich scientific and technological insights and their role in centering Indigenous identity in STEM. The purpose of this proposed symposium is to share the many ways that researchers, educators, and community members

are collaborating to elevate Indigenous stories to share scientific knowledge, with the goal of expanding our collective understanding of best practices and approaches to doing so.

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

21-Apr-26, 16:15-17:45

Location: Redwood AB (L2)

Administrative Session

Organizers

Kent Crippen, University of Florida, FL, USA

Xiaoming Zhai, University of Georgia, Athens, GA, USA

Contributors

André Meyer, Leibniz Universität Hannover, Germany

Arne Bewersdorff, Technical University of Munich, Germany

Noel Kuriakos, University of Maryland, USA

Manav Sharma, University of Miami, USA.

Shreyashi Halder, ETS, USA

Fatma CANER, Özyeğin Üniversitesi, Turkey

Elad Yacobson, Technion – Israel Institute of Technology, Israel

Gyeonggeon Lee, Nanyang Technological University, Singapore

Hasan Deniz, University of Nevada Las Vegas, USA

Xin Xia, University of Georgia, USA

Abstract

Artificial intelligence (AI) is rapidly reshaping science education, offering both exciting opportunities and critical challenges. From transforming how students engage in inquiry and problem solving to redefining teacher development and communication, AI now influences classrooms, curricula, and research. This year's RAISE-sponsored poster session highlights innovative approaches scholars are taking to explore AI's role in science teaching and learning. The featured studies span a wide range of inquiry. Presentations include the design of AI-integrated curricula for multilingual learners using robotics, frameworks leveraging large language models to scaffold dialogic science communication, and case studies on how AI alters students' problem-solving practices. Other works demonstrate generative AI in molecular design, propose frameworks for redesigning science and engineering activities in AI-rich contexts, and explore GenAI-powered teaching simulations for teacher learning. Additional contributions examine students' emerging "AI interest" as a construct, assess open-source AI for feedback on science tasks, and offer design principles enabling teachers to build custom simulations with advanced GenAI tools. Studies also highlight how AI-driven agents scaffold middle school investigations, how AI can enhance teacher professional

development through discourse analysis, and how embodied AI literacy can be fostered in informal STEM settings. Together, these posters provide a timely, multidimensional look at responsible AI integration in science education. By convening diverse perspectives, the session aims to spark dialogue among researchers, educators, and policymakers. The goal is to deepen understanding of AI's possibilities and pitfalls, illuminate effective design principles, and chart pathways toward equitable, innovative, and future-ready science learning.

Research Social Hour -- Join NARST Colleagues for Cookies and Collaboration!

21-Apr-26, 18:00-19:00

Location: Willow A (L2)

Administrative Session

Organizers

Melissa Mendenhall, Utah Valley University, Orem, Utah, USA

Karen Woodruff, Kean University, Union, NJ, USA

Kelli Paul, Indiana University, IN, USA

Contributors

Grace Tukurah, Michigan State University, USA

Carla Zembal-Saul, Penn State, USA

Lilian Rudge Bentley, Georgia State University, USA

Alexander Bohn, Northern Virginia Community College, USA

Yurdagül Boğar, Hakkari University, Turkey

Abstract

Members of the Research and Practice Impacts Subcommittee and Program Committee invite the NARST community to come together for cross-strand conversations in a joyful, welcoming space. We'll gather to explore how we think about the impacts of our research, within and across science teaching and learning contexts, and to learn from one another as we do.

As NARST moves towards our centennial, we are rethinking how we describe, honour and value diverse research activities. This session will be the opportunity to reflect openly and gather ideas about what it means to engage in science education research, how our work informs practice, and the ways it touches diverse communities of learners and educators. By building trust and nurturing authentic relationships, we can embrace joyful transgressions and begin imagining bold, liberatory possibilities for science education.

Using the 2026 proposals, the organizers identified 10 cross-cutting themes. In this interactive, come-as-you-are session, you will grab a snack and wander among themed tables highlighting key areas of interest in our field. Move freely, share your ideas, listen generously, and make meaningful connections along the way.

Themes include:

Disciplinary literacy

AI in Research

AI in Teaching

Navigating political climates

Integrated STEAM

Bilingual/Multilingual science education

Informal Science Education

Joyful science teaching

Climate Education and Sustainability

Agency, Affect, Motivation and Identity

This is an open, informal space where curiosity leads the conversation. Together, we will imagine and co-create new ways to generate impactful research and practice through dialogue, creativity, and joy. Join us!

Equity and Ethics Dinner

21-Apr-26, 18:00-21:00

Location: Offsite

Social Event

Conference Day 4 22 April 2026

NARST Fellows Breakfast and Meeting

22-Apr-26, 7:00-8:00

Location: Willow A (L2)

Social Event

Meet the NARST Board of Directors - Breakfast

22-Apr-26, 7:00-8:00

Location: Grand Ballroom Foyer (L2)

Social Event

Membership and Business Meeting

22-Apr-26, 8:00-8:45

Location: Grand Ballroom (L2)

Strengthening Crosscutting Concepts and Knowledge-in-Use

Strand 1: Science Learning: Development of student understanding

22-Apr-26, 9:00-10:30

Location: Ravenna C (L3)

Stand-Alone Paper

Using Explicit Scaffolding Strategies to Foster Knowledge-in-use of Crosscutting Concepts

Qian Wu*, East China Normal University, China

Joseph Krajcik, Michigan State University, USA

Xinning Pei, East China Normal University, China

ABSTRACT

Knowledge-in-use, the ability to integrate disciplinary core ideas, practices, and crosscutting concepts (CCCs) to make sense of phenomena and solve problems in novel situations, is a key scientific competency emphasized in K-12 education. This study uses Systems and System Models (SSM2) as a focal example to examine how explicit and reflective CCC instruction can foster students' knowledge-in-use within project-based learning (PBL) environments. This quasi-experimental study investigated sixth-grade

students' conceptual understanding and application of CCCs during a five-week unit, The Cold Cup Challenge, implemented at a public elementary school in central China. A total of 104 students from two intact classes participated: one received explicit scaffolded CCC instruction through mini-lessons, teacher-guided questioning, reference cards, and reflection prompts, while the other engaged in identical PBL tasks without such scaffolding. Data were collected from students' final annotated system models, pre- and posttests, and focal students' presentations and interviews. Quantitative analyses revealed that the explicit group significantly outperformed the implicit group across four SSM2 dimensions (all $p < .01$), with large effects in energy and matter flow representation (Hedges' $g = 1.37$) and system boundary identification (Hedges' $g = 1.25$), underscoring the importance of explicit CCC scaffolding in helping students construct knowledge-in-use.

Stand-Alone Paper

Support in Developing Decision-Making Skills - Results from an Intervention Study in Chemistry Education

Jana-Sabrin Blome-Rohrbach*, TU Dortmund University, Germany

Insa Melle, TU Dortmund University, Germany

ABSTRACT

In light of societal challenges and increasing misinformation, fostering evidence-based decision-making is a key goal of science education.

This study explores the impact of a digital scaffolding tool on secondary school students' decision-making skills and their content knowledge. In a quasi-experimental design, two groups engaged with a digital learning environment. In a subsequent phase, students were asked to write an evaluation of the sustainability of hydrogen vehicles. One group was given a scaffolding tool to guide their argumentation (ST group), while the other group proceeded with their own approach (OA group).

The study assesses content knowledge (pre, mid, post) and decision-making skills (pre, post) as well as learning products (between mid and post). The results show a significant gain in content knowledge in both groups ($p = <.001$, $\eta^2 = .248$) and in decision-making skills ($p = <.001$, $\eta^2 = .288$) with a large effect size, with no significant group differences. However, a quartile-based analysis revealed that students with lower prior decision-making skills showed markedly higher learning gains than those with higher prior skills. Moreover, students who used the scaffolding tool demonstrated more coherent and value-based reasoning. These findings suggest that scaffolding can effectively enhance decision-making in chemistry education.

Stand-Alone Paper

Investigating Science and Technology Competition Experience's Impact on Crosscutting Concepts Proficiency Level

YUJING GUO*, capital normal university, China
YUPENG WANG, capital normal university, China
KUANG HE, People's Education Press, China
XIN BAI, capital normal university, China

ABSTRACT

This study employs a mixed-methods research approach to systematically investigate the impact mechanism of science and technology competitions on crosscutting concepts mastery among middle school students. Quantitative analysis reveals that students in the science and technology competition group significantly outperformed students in the regular group in the total score and sub-dimensions of the crosscutting concepts test. Qualitative interviews further reveal four core influence mechanisms. The study indicates that science and technology competitions effectively promote the internalization of crosscutting concepts through practical activities, providing empirical evidence for science education reform under the China new curriculum standards, and suggests translating the competition logic into regular teaching through methods such as 'micro-iterative tasks'.

Stand-Alone Paper

Reasoning About Life Cycles Across Elementary Grade Levels

Christelle Fayad*, Texas Christian University, USA
Hayat Hokayem*, Texas Christian University, USA

ABSTRACT

Life cycles are considered a foundational concept in science, yet little research has examined how students reason about the life cycles of different organisms. This study investigates the reasoning levels of elementary students regarding life cycles. We conducted interviews with students in grades K–5 at an elementary school in Lebanon, probing their general ideas about life cycles as well as their ability to compare the life cycles of different organisms. Analysis of the interviews revealed themes in students' reasoning, including their definitions of life cycles, understandings of death and continuity of life, and structure–function reasoning. We found that younger students' ideas were largely informal, while those in grades 4 and 5 demonstrated more sophisticated thinking. Nevertheless, even upper elementary students often struggled to reach the highest reasoning levels, particularly in comparing life cycles and understanding metamorphosis. Based on these findings, we offer recommendations for curriculum development and instructional practice.

Engineering Design and Co-Design to Transform STEM Classrooms

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

22-Apr-26, 9:00-10:30

Location: Ballard (L3)

Stand-Alone Paper

Engineering Education in Middle School STEM towards a Rightful Presence for Minoritized Students

Virginia Swindell*, University of North Carolina at Greensboro, USA

Edna Tan, University of North Carolina at Greensboro, USA

ABSTRACT

There are many challenges with integrating engineering education within K-12 STEM that authentically do not engage teachers, students-of-color and their parents. In collaboration with Ms. D, a 7th grade science teacher, a core group of parents and their student, we seek to answer the following research questions: 1) What are some novel impacts of enacting a youth and community-focused engineering curriculum in middle school vis-à-vis teacher, student and parental participation and learning outcomes? 2) How does familial engagement impact teacher-student-parent relationalities toward a more rightful presence in STEM teaching and learning? New modes of participation by the students and the importance of family engagement were found as novel impacts from the collaboration. Improving the sustainability of the community through design and construction, having adequate materials/human resources for the learning environment, legitimization of the student as an expert in the eyes of the parent, students wanting their parents to be informed of their curricular activities, and a dialogic approach of parent-student-teacher learning, are examples of novel impacts discovered in the classroom and RPP meetings. Guided by the Rightful Presence framework, we identified and traced how these novel impacts allowed the teacher-student-parent relationalities to be reauthored.

Stand-Alone Paper

Cycles of Co-Design: Linking Instructional Materials Revisions to Shifts in Engineering Teaching Practices

Katy Nilsen*, WestEd, USA

Aaron Soo Ping Chow, WestEd, USA

Sara Salisbury, WestEd, USA

Ashley Iveland*, WestEd, USA

ABSTRACT

Declining biodiversity poses the greatest threat to human communities; however, this environmental problem offers unique opportunities for youth to leverage learning and local action in ways that are relevant and accessible to them. Threats to biodiversity include factors that youth can identify and remedy, impact all types of communities, are observable to students, and have potential for building student knowledge and agency. This study explores

how the Community and Sustainability Education project, using problem-based learning sequences and teacher professional learning, influences teachers' engineering design instruction and students' identification and mediation of local problems. After engineering design was meaningfully integrated into materials as part of an iterative co-development process in between the project's two implementation periods, teachers more frequently incorporated all aspects of engineering design in their instruction. For students who were taught in this second cohort, some did different activities to help the environment, particularly related to doing something at their school. Students identified local problems affecting biodiversity in their community and described how to solve these problems, including through environmental restoration and raising awareness. This study has implications for the importance of developing and revising an intervention mid-project to affect teacher and student outcomes.

Undergraduate Research Experiences: Student Experiences and Instructor Roles
Strand 5: College Science Teaching and Learning (Grades 13-20)
22-Apr-26, 9:00-10:30
Location: Juniper (L2)

Stand-Alone Paper

From knowledge to action: Instructor decision-making when teaching science practices in Course-based Undergraduate Research Experiences

Alexandra Cooper*, University of Georgia, USA

Danielle Philo, University of Georgia, USA

Tessa Andrews, University of Georgia, USA

Erin Dolan, University of Georgia, USA

ABSTRACT

Course-based undergraduate research experiences (CUREs) have been championed for increasing opportunities for students to conduct research and make scientific contributions. However, we know little about how to effectively teach these courses. Teaching a CURE is distinct from other forms of instruction as instructors must act as both a teacher and research mentor who flexibly responds to their individual students' scientific inquiries. This requires instructors to draw from their teaching knowledge, including their pedagogical knowledge and pedagogical content knowledge, to make real-time decisions to support student engagement with science practices. We characterized instructor decision-making by conducting semi-structured interviews where experienced instructors reasoned through teaching scenarios that reflected common challenges students face in CUREs. We used a combination of deductive and inductive content analysis to investigate instructor actions and the rationales behind their actions. We characterized 25 distinct instructor actions aimed at supporting students in conducting science practices, accomplishing classroom tasks, and navigating the psychosocial dynamics of research. We also characterized four instructor rationale themes that followed from either the instructor's prior knowledge or the

instructional goal behind their intended action. This study emphasizes the important role of instructor knowledge for teaching science practices and describes how instructor knowledge manifests in CUREs.

Stand-Alone Paper

Increasing Wildlife Career Preparedness: Comparing an Inquiry-based and a Course-based Undergraduate Research Experience Wildlife Course

Danielle Gay*, Texas State University, USA

Carrie Bucklin, Texas State University, USA

Kristy Daniel, Texas State University, USA

ABSTRACT

Wildlife career fields need candidates with strong critical thinking, communication, and teamwork skills. To prepare students for wildlife careers, academia should focus on advancing scientific literacy, competency in scientific practices, and enhancing technical skills. Inquiry-based learning experiences (ILEs) are active and hands-on, encouraging students to learn through inquiry and discovery. Whereas, Course-based Undergraduate Research Experiences (CUREs) promote inquiry and discovery while engaging students in novel research that is relevant to science. There is limited research investigating the nuanced differences between CUREs and ILEs for their impact on student learning outcomes. This study explores how participation in two different laboratory experiences (ILEs; CUREs) influences students' demonstrated research skills, research self-efficacy, and their perceptions of wildlife career preparedness within and between each learning experience. The preliminary results from this ongoing study found that students perceived the ILE as collaborative and felt their research skills improving. However, their demonstrated research skills decreased, suggesting the necessity of CUREs to provide students with opportunities for research skill development. Future qualitative analysis may identify the specific aspects of the ILE that led to these outcomes. This study can provide clarity on the differences between ILE and CUREs in preparing students for a future in wildlife careers.

Stand-Alone Paper

Conceptual model for analyzing instructor decision-making during development and implementation of course-based undergraduate research experiences

Laura Rios*, California Polytechnic State University, USA

Carolina Alvarado, California State University, Chico, USA

ABSTRACT

Course-based undergraduate research experiences (CUREs) are high-impact practices that bolster students' conceptual learning and retention in STEM. Faculty perspectives on CURE development are limited and lack broader theoretical or conceptual framing for how instructors employ their varied expertise. It would behoove researchers and instructors to develop thorough conceptual frameworks for analyzing decision-making during an intensive, complex process such as CURE development. We present a novel conceptual model that

simplifies instructional decision-making while uniquely characterizing it. The model is composed of three axes that connect the “why” of a decision ultimate goal (why are we trying to achieve something?); the “how” of a decision to its purpose (how are we going to achieve the value?); and the “what” of a decision to its function (what are we going to do to achieve the purpose?). The model is a major finding of a 5-year longitudinal, multiple case study across STEM courses. The conceptual model was developed using a narrative analysis approach, combining ideas and frameworks on hierarchical knowledge, expertise, and epistemology. We illustrate how the conceptual model captures complexity in instructional decision-making processes, and include a description of how the conceptual model may be used in other research contexts.

Stand-Alone Paper

Redefining success during a summer undergraduate research experience at an ecological field station

Anna Grinath*, Idaho State University, USA

ABSTRACT

The focus on science practices has advanced conceptualizations of authentic disciplinary engagement in science to recognize varied ways of participating in science practices. Importantly, students have epistemic agency to expand the ways of participating that are celebrated as successful in their science practice communities. I conducted a single naturalistic case study to examine how undergraduate students redefine their metrics for success during a summer research experience at an ecological field station and the mentoring moves that support this expansive work. I conducted participant observations, surveys, and interviews with 31 undergraduate researchers and 10 mentors and took a constructivist grounded theory approach to identify instances when participants discussed changes in how they recognized their own or others' moments of success in research. Findings indicate that undergraduate student participants redefined their metrics for success during several parts of the research process such as study design, data collection, and interpreting findings. The mentors for the undergraduate students' summer research experience described explicit goals to help their mentees redefine their metrics for success throughout the program. The findings have implications for supporting mentors with specific moves to help their mentees recontextualize research failures as success.

Communities as Sites of Resistance, Imagination, and Transformation in Science Education

Strand 6: Science Learning in Informal Contexts

22-Apr-26, 9:00-10:30

Location: Columbia (L4)

Related Paper Set

"Don't take away the good things people love": Ideological Tensions in Youths' Community Designs

Hannah Ziegler*, Vanderbilt University, USA

Heidi Carlone, Vanderbilt University, USA

Lauren Connelly, Vanderbilt University, USA

ABSTRACT

This paper proposes a framework for imaginative placemaking as a practice that supports youth in negotiating dominant ideologies in science education. Using data from an AR-urban design project, we analyze how middle school youth's visions for a thriving community are shaped by ideological contestations--specifically related to safety, beauty, and sustainability. This analysis provides a new lens for understanding how youths' meanings of socioecological thriving is constrained by dominant ideologies. We conclude by arguing that science education must actively support youth in addressing these tensions to foster collective hope, agency, and transformation.

Related Paper Set

Cultivating Reciprocity in an Informal K-12 Science Education Partnership

georgie schaffer*, Drexel University, USA

ABSTRACT

University-community partnerships (UCPs) are a common form of engagement for informal science education. Many UCP scholars have advocated for thinking more critically about the idea of reciprocity in such relationships; however, few have brought this lens specifically into informal science education UCPs. This paper describes a participatory design research (PDR) study of a university-sponsored informal science education program focused on supporting high school girls in science. Specifically, this study engages twelve affiliates of the program (managers, alumna, and community members) in community design circles to unpack partnership challenges, tensions, and benefits, with specific attention to the role of reciprocity in such dynamics. A variety of qualitative data is collected and analyzed including video and audio data of group sessions, one-on-one meeting notes, and individual memos. The two main findings of the study highlight the role of reciprocity in (1) program managers' relationships with the university and the community and (2) the primary researcher's role in this study as it pertains to the participatory methodologies and design. This study contributes novel perspectives about how reciprocity impacts community-based informal science education UCPs and highlights the importance of critical approaches to such work.

Related Paper Set

Fostering Latina Youth Science Identity Through Community-Based Experiences

Jaquelina Schmittlen-Garbocci*, University of Tennessee-Knoxville, USA

ABSTRACT

This study examines how community-based, interest-driven science experiences influence Latina youth's science identity construction. Grounded in decolonial feminist theory and conceptualizing science identity as a “landscape of becoming,” the research challenges traditional deficit narratives that have historically marginalized communities of color in science education. The qualitative study participants are four Latina adolescents that co-developed and implemented a summer science club curriculum centered on their expressed interests in hair and cosmetology. Data collection included focus groups, field notes, identity boards, and presentation artifacts.

Analysis revealed three interconnected dimensions of science identity construction: asset-based identity development, resistance to colonial educational structures, and emotional engagement through joy. Participants progressed from positioning themselves as “not science people” to assuming expert roles, actively challenging traditional power dynamics and transforming learning spaces. Their emotional responses shifted from disengagement with school-based science to expressions of wonder and empowerment.

The findings demonstrate that when science education centers community knowledge, validates cultural practices, and provides opportunities for student agency, marginalized youth can develop positive science identities that resist deficit narratives.

Related Paper Set

Inviting Possibilities: Youth Coding for Joy, Learning, and Imaginative Futures

Jennifer Tripp*, SUNY Geneseo, USA

Xiufeng Liu, University of Macau, Macao

ABSTRACT

Computer Science for All initiatives have underscored that all students should have opportunities to become developers, beyond being mere consumers of technology, where they can create for personal and collective fulfillment and agency. In this case study centered in a coding club at a community high school that exclusively serves refugees and immigrants, we examine youth's community resources informing their participation and contributions, along with the ways they reimagined coding and its role in their futures. We ground this work in framings that youth bring a wealth of resources that can be juxtaposed, leveraged, and combined in new ways for problem solving and coding. Findings examine how youth remixed code, integrated interests into their projects, playtested others' games, and provided peers with advice. Additionally, youth developed as coders through their Coding Club participation; they saw coding as critical in creating better futures. Overall, creating, playing, and sharing games allowed youth to develop as coders and transgress

canonical boundaries in cross-community and inter-disciplinary ways. This work has implications for designing expansive computer science education that foregrounds playfulness, imagination, and community resources in gaming, to reimagine relationships with coding and each other for more inclusive, joyful futures.

Related Paper Set

Science Education Toward Socio-Ecological Well-Being: The Potential of Contextualization, Connection, and Agency

Genelle Diaz-Silveira*, Boston University, USA

ABSTRACT

Educational researchers have suggested that attention to relationality is necessary for designing learning environments that challenge hegemonic structures of science and prepare students to imagine and enact more just socio-ecological futures. However, the development of resources and tools that could support educators to teach in this way are only recently emerging. This paper describes a co-design, design-based research study that partners elementary teachers with a community science organization toward creating localized learning experiences that center contextualization, connection, and students' development as agents of change. We trace the joint learning and visioning of the partners as we developed an instructional framework and designed learning experiences together. We found that (1) giving teachers access to the work of community scientists expanded their views of what doing science could entail; (2) teachers experienced tensions between wanting to be more expansive and needing to meet the demands of curricular standards, and this would often constrain their thinking about possibilities; and (3) supporting teachers to adopt expansive views of science education and practices that disrupt dominant assumptions of science likely requires a multi-step approach across many cycles of design and joint visioning work.

AI-Enhanced Science Teacher Learning: From Beliefs to Instructional Design and Classroom Simulation

Strand 7: Pre-service Science Teacher Education

22-Apr-26, 9:00-10:30

Location: Ravenna AB (L3)

Stand-Alone Paper

Epistemic Beliefs and Generative AI Acceptance in Science Teacher Education: Exploring Relationships and Demographic Moderators

Öznur Avcı*, Marmara University, Turkey

Feral Bekiroğlu, Marmara University, Turkey

ABSTRACT

This study investigated relationships between science teacher candidates' epistemic beliefs and their acceptance of generative AI technologies, examining demographic moderating effects. Using Schommer's multidimensional epistemological belief framework, 299 science teacher candidates from physics, chemistry, biology, and elementary science education programs participated in this correlational study. Data were collected using the Scientific Epistemological Beliefs Scale and Generative Artificial Intelligence Acceptance Scale. Non-parametric analyses were employed due to non-normal distributions. Spearman correlations revealed significant positive relationships between epistemic belief dimensions and GenAI acceptance ($r = .10$ to $.35$). Stepwise regression identified Source of Knowledge ($\beta = .254$), Structure of Knowledge ($\beta = .204$), and Learning Process ($\beta = .158$) as significant predictors, explaining 15.1% of variance in AI attitudes. Significant demographic moderation emerged: gender effects were strongest for Certainty of Knowledge dimension, with different patterns for female and male participants. Grade level analyses showed progressive strengthening of relationships across academic years, with third-year students showing strongest associations. Discipline differences favored physics over chemistry and biology in AI acceptance. Findings suggest epistemic beliefs serve as cognitive foundations for technology acceptance, with implications for differentiated AI integration training in science teacher preparation programs. Results highlight the need for theoretically grounded approaches considering epistemological development alongside technology training.

Stand-Alone Paper

GAI-Integrated Pedagogy: Case Study in Pre-Service Science Teacher Development

Xinjia Ma, Shanghai Jiao Tong University, China

Xiaomei Yan*, Shanghai Jiao Tong University, China

ABSTRACT

This case study integrates two generative AI modalities—GPT platforms and pedagogical agents—to develop pre-service science teachers' instructional competencies at one Chinese University. GPT tools facilitated De Bono's Six Thinking Hats framework application for collaborative strategy design, while specialized AI agents enabled practice of questioning techniques through simulated interactions. Implemented within a three-phase Experience-Reflect-Innovate micro-teaching model, these technologies created authentic low-stakes experimentation environments.

Participants demonstrated enhanced self-efficacy in questioning techniques and collaborative strategy application through AI-mediated rehearsal. Qualitative analysis revealed significant pedagogical growth, including unprecedented awareness of affective dimensions and improved feedback proficiency. The virtual platforms enabled iterative refinement unattainable in traditional microteaching.

The research positions GAI as transformative pedagogical spaces that reshape teacher development paradigms. By mitigating authenticity constraints while supporting deliberate practice, these environments effectively bridge theory-practice divides. While offering

compelling evidence for GAI's role in reimagining science teacher preparation, future studies should examine discipline-specific adaptations and longitudinal skill transfer.

Stand-Alone Paper

Authentic or Artificial? Examining the Use of Generative AI Roleplay in Pre-Service Science Teacher Education

Carrie-Anne Sherwood*, Southern Connecticut State University, USA

Mark Wursthorn, Southern Connecticut State University, USA

ABSTRACT

As generative AI tools become increasingly prevalent in educational settings, science teacher educators are exploring their potential for supporting pre-service teachers' (PSTs) conceptual and pedagogical learning. This exploratory study examines fourteen PSTs' experiences using genAI to roleplay science lessons, investigating both the affordances and limitations of AI-mediated teaching practice.

Data analysis reveals a complex landscape where AI roleplay both supports and potentially compromises authentic teaching practice development. Positive elements included realistic student language patterns, appropriate content knowledge levels, and structured feedback that reinforced course concepts. However, several features undermined authenticity: the AI was overly enthusiastic and cooperative, frequently “did the work of the teacher” by anticipating pedagogical moves, and was generally devoid of misconceptions that would challenge PSTs' responsive teaching skills. Technical inconsistencies—including different AI versions and persona inconsistencies—further complicated the experience.

The findings suggest that while AI roleplay offers a safe space for PSTs to practice eliciting and responding to student thinking, it may inadvertently mask important pedagogical challenges, leading PSTs to believe their questioning techniques are more effective than they actually are. This study contributes critical insights for science teacher educators considering AI integration and identifies key design principles for creating more authentic AI-mediated practice experiences.

Building communities of culturally responsive and empowered STEM educators

Strand 8: In-service Science Teacher Education

22-Apr-26, 9:00-10:30

Location: Issaquah AB (L3)

Stand-Alone Paper

Black Women Science Teachers Strive Toward Self-Definition Through a Draw a Science Teacher Activity

Alexis Riley*, New York University, USA

ABSTRACT

As an alternative to traditional professional development, six in-service Black women science teachers came together to be in affinity in a space called The Sista Circle Lab. In the current study, the purpose of having participants engage in a mix between the Draw a Science Teacher and Draw a Scientist activity was to confront internalized stereotypes by building a visual that encompassed their view of an affirmed Black women science teacher, especially after learning about a historical figure such as Sarah Mapps Douglass. Positionality Theory and Self-Definition as discussed in Black Feminist Theory come together to make sense of how the participants visualize and discuss the development of their affirming science teacher identity.

Stand-Alone Paper

Centering Community in K-12 STEM Teaching and Learning: A Framework on Culturally Sustaining Integrated STEM

Khanh Tran*, Utah State University, USA

Lynn Bryan*, Purdue University, USA

ABSTRACT

This paper introduces a framework for Culturally Sustaining Integrated STEM (CSiSTEM) that addresses the persistent marginalization of students' cultural identities, linguistic abilities, community knowledges, and worldviews within dominant models of integrated STEM education. Despite increasing attention to equity-focused practices, most integrated STEM curricula remain static, culturally neutral, and disconnected from students' lived realities. The CSiSTEM framework centers three interrelated principles—cogeneration, coalescence, and mobilization—to position students as co-constructors of knowledge, legitimize multiple epistemologies, and apply STEM learning toward community-defined action. Using an instrumental case study of Mr. Talisman, a rural middle school science teacher, we examine how his two-year iterative redesign of a water quality unit enacted these principles. Data sources included classroom observations, fieldnotes, and narrative interviews analyzed through qualitative coding and pattern recognition. Findings illustrate how Mr. Talisman's pedagogy shifted from fixed, discipline-bound STEM instruction toward dynamic, participatory, and justice-oriented learning that integrated rural students' cultural knowledge, addressed community environmental issues, and fostered advocacy. This study offers implications for teachers, curriculum designers, and researchers seeking to design integrated STEM that sustains personhood, centers plural ways of knowing, and positions STEM learning as a vehicle for community transformation.

Stand-Alone Paper

Supporting Teachers' Contemporary Perspectives on Culture and Community in Science Using Socioscientific Issues

Felisha Dake*, Colorado State University- Pueblo, USA

Cory Buxton, Oregon State University, USA

Melissa Livingston, Oregon State University, USA

ABSTRACT

Science education reform emphasizes the need for professional learning that meets the needs of all students through culturally sustaining teaching. Supporting students to critically engage with and make sense of global socioscientific challenges impacting their lives is essential to this goal. Despite evidence that integrating socioscientific issues into science instruction supports students' science literacy, teachers still struggle to implement this in practice. In response, the STEM in Our Lives project provides professional learning that centers cultural and community connections to science and knowledge building for informed decision making. K-12 teachers are supported to engage with and enact model lessons, practices, and tools in their afterschool STEM clubs. This qualitative study follows participating K-12 teachers over three years of this project, using teacher logs and focus group interviews to examine shifts in teachers' contemporary perspectives on culture, community, and knowledge building in science, and to identify how teachers' use of model lessons, practices, and tools focused on socioscientific issues align with these shifts. Initial findings indicate 1) teachers recognize family and community knowledge as central to students' science learning and 2) teachers cultivate opportunities for students to empathize with and address socioscientific issues in their communities.

Stand-Alone Paper

Empowering STEMM Educators: A Hybrid Model of Intensive PD and Longitudinal Community Building

Matthew Blank*, Baylor College of Medicine, USA

Alana Newell*, Baylor College of Medicine, USA

Nancy Moreno, Baylor College of Medicine, USA

ABSTRACT

This study presents a hybrid professional development (PD) model designed to empower K-12 educators in advancing health literacy through integrated STEMM instruction. Addressing the persistent exclusion of biomedical and health sciences from formal curricula and standards, the STEMM Institute for Change Makers combines two short-term, intensive PD experiences with a longitudinal community of practice (CoP). Grounded in collaborative engagement and CoP theory, the model supports sustained instructional change and fosters cross-disciplinary coherence. Findings suggest that this approach not only enhances

educators' capacity to teach health science content but also builds a scalable framework for cultivating STEMM-focused communities across diverse school contexts. The study contributes to PD research by demonstrating the effectiveness of concentrated, collaborative PD within a sustained support structure. The resulting survey instrument and insights may inform future efforts to promote campus-wide cultural shifts and strengthen school-to-workforce pathways in the biomedical and health sciences. This work addresses a critical gap in STEMM education and offers a replicable strategy for equipping educators—and their students—with the tools needed to thrive in an evolving health science landscape.

Racialized Joy and Play in STEM Learning

Strand 11: Cultural, Social, and Gender Issues

22-Apr-26, 9:00-10:30

Location: Willow A (L2)

Symposium

Racialized Joy and Play in STEM Learning

Terrell Morton, University of Illinois Chicago, USA

Harrison Pinckney IV*, Pennsylvania State University, USA

Jochebed Gayles*, Pennsylvania State University, USA

Nicole Webster*, Pennsylvania State University, USA

Brittany Hunt*, Virginia Polytechnic Institute and State University, USA

Jessica Leeker*, Cornell University, USA

Sandy Cerda-Lezama, Portland State Univ, USA

Viviana Vélez Negrón*, University of Michigan, USA

Channing Mathews, University of Virginia, USA

Teresa Satterfield Linares, University of Michigan, USA

ABSTRACT

This symposium explores challenges and possibilities that coincide with investigating the intersections of race, play, and STEM learning for Black, Brown, and Indigenous youth. These studies raise critical questions about the role of play in STEM learning, specifically play that is critically and culturally situated, and attentive to Black, Brown, and Indigenous onto-epistemologies. Implications for leveraging these perspectives to foster more joyful learning STEM experiences are provided.

Shaping Engagement and Problem Solving in Science Learning through AI and Gameplay Analytics

Strand 12: Technology for Teaching, Learning, and Research

22-Apr-26, 9:00-10:30

Location: Greenwood (L3)

Stand-Alone Paper

Adaptive Training of Physics Problem-Solving Skills

André Meyer*, Leibniz University Hannover, Germany

Gunnar Friege, Leibniz University Hannover, Germany

ABSTRACT

This study explores an adaptive digital learning environment aimed at improving secondary students' physics problem-solving skills within the topic of energy conservation. The intervention combined worked examples with dynamic task adjustment based on student performance. Half of the participants experienced automatic adaptivity, with the system selecting task formats; the other half could override these suggestions, introducing adaptability. A total of 523 students from 12 German schools engaged in a three-session design including pre-tests, training, and post-tests targeting four problem-solving sub-processes. Results showed significant improvement in energy balancing using mathematical operations, while representation, planning, and evaluation skills did not improve. Patterns of task choice and student feedback revealed that the option to adapt learning paths was valued, even when recommendations were followed. These findings suggest that combining adaptivity with learner control may enhance engagement and perceived autonomy, offering promising directions for the design of intelligent tutoring systems in science education.

Stand-Alone Paper

Examining Students' Systems Thinking Through Serious Educational Gameplay

Jongchan Park*, University of Georgia, USA

Georgia Hodges, University of Georgia, USA

Xiaoming Zhai, University of Georgia, USA

ABSTRACT

Elementary students often struggle with systems thinking—related components, their relationships, and integration—especially in interacting human body systems where processes are often perceptually non-salient. Serious educational games (SEGs) can support this by offering authentic, role-based, multimodal, interactive tasks with immediate feedback. However, little is known about elementary students' systems thinking development in interacting body systems through SEGs. Methodological challenges persist; assessments must accommodate item difficulty and changing content and place performance on a common scale. To address these gaps, we implemented Virtual Vet, a classroom SEG that comprises three stages: (1) structure-function (musculoskeletal, gastrointestinal), (2) interactions (nutrition, cardiovascular), and (3) integration (endocrine). 179 fourth and fifth graders completed 16 embedded quizzes. We fit a three-dimensional

longitudinal Rasch model (one dimension per stage) to measure growth. Results showed average systems-thinking increased across the stages, with the largest gain from Stage 2 to 3, consistent with the game's culminating design for systems thinking. Findings provide initial evidence that a staged, authentic, multimodal SEG supports elementary systems thinking and demonstrate a practical way to track longitudinal growth from embedded assessments on a common scale using multidimensional Rasch modeling.

AI-Enhanced Inquiry, Learning Progression, & Engineering Design

Strand 12: Technology for Teaching, Learning, and Research

22-Apr-26, 9:00-10:30

Location: Jefferson A (L4)

Stand-Alone Paper

Enhancing Scientific Inquiry Self-Efficacy in Junior High Students: The Role of a Heuristic-Questioning AI Chatbot

Jiaojiao Hui*, The University of Hong Kong, China

Chen Chen, The University of Hong Kong, China

Zhiping Qiu, Hangzhou Yinhu Experimental Middle School, China

Guojun Xu, Hangzhou Yinhu Experimental Middle School, China

Jiaxin Chen*, The University of Hong Kong, China

ABSTRACT

This study investigates whether and how a heuristic questioning AI chatbot, No-how-bot, influence junior high school students' scientific inquiry self-efficacy. Using a mixed-methods research design with 61 eighth-grade participants, this study compared an experimental group interacting with the No-how-bot during scientific inquiry activities to a control group engaged in traditional inquiry. Quantitative results revealed a significant positive effect on scientific inquiry self-efficacy, with the experimental group showing higher post-test scores. Qualitative interviews highlighted three themes: scaffolding reasoning through guided questioning, confidence building via affirmative feedback, and promoting cognitive autonomy. Students perceived the chatbot as a thinking guide that fostered deeper conceptual understanding and reduced uncertainty. The findings suggest that Socratic-style AI interactions can enhance students' scientific inquiry self-efficacy by encouraging independent thinking and iterative hypothesis refinement, offering valuable insights for integrating AI tools in science education.

Stand-Alone Paper

Impact of an AI Enhanced Inquiry Sequence on Students Integration of Ideas about Energy Transfer

Allison Bradford*, University of California, Berkeley, USA

Libby Gerard, University of California, Berkeley, USA

Marcia Linn*, University of California, Berkeley, USA

ABSTRACT

We explore how an AI-enhanced Inquiry Sequence (AIS) helps secondary school science teachers guide classes of 30-35 students to collaboratively answer complex, real-world science problems. The AIS features AI Dialogs and a teacher-customized Think-Pair-Share collaborative learning activity. Students draw on their prior experiences, interactions with peers and class instruction when grappling with a real world science problem. This exciting array of student ideas within a classroom offers valuable resources that can enrich sense-making and encourage curiosity. The web-based AI Dialog with an Avatar encourages students to express ideas they might be hesitant to share in class, ideas that they think might turn out to be irrelevant, or ideas they worry could be wrong. An experienced science teacher uses tested guidance questions and customized collaborative learning activities to encourage students to discuss their ideas with each other. We found that students added more ideas during the AI Dialog and that the teacher-led Think-Pair-Share activity helped students value mechanistic ideas and consolidate their understanding of the real-world problem. Teachers new to teaching a science topic are often challenged to guide student collaboration. We describe how the AIS can help every teacher leverage their students' ideas to strengthen classroom inquiry.

Articulating Ecological and Political Crises and a Crisis of Ethics in Science Education

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

22-Apr-26, 9:00-10:30

Location: Seneca (L4)

Symposium

Articulating Ecological and Political Crises and a Crisis of Ethics in Science Education

Matthew Weinstein*, University of Washington-Tacoma, USA

Jesse Bazzul*, University of Regina, Canada

David Blades*, University of Victoria, Canada

Shakhnoza Kayumova*, University of Massachusetts Dartmouth, USA

Sophia Jeong*, The Ohio State University, USA
Andrea Henrie*, Vanderbilt University, USA
Heather Johnson, Vanderbilt University, USA
Teo Keifert, University of North Texas, USA
Ashlyn Pierson, The Ohio State University, USA

ABSTRACT

This interactive symposium explores novel frameworks for ethics in the face of the underdeveloped role of ethics in science education, especially as it is defined or appropriated by rising reactionary/fascist politics and the global ecological crises from which they arise. This symposium explores the possibilities and limits of ethics and through dialogue between panelists and audience members in the hope of deepening our knowledge about ethics in a wide range of contexts. In particular, we examine the boundaries between ethics and politics through the troubling of western ethics by indigenous (writ broadly) and post-humanist reframings of ethics and politics. This panel seeks to move toward a pragmatics of the axiological: namely, how does ethics inform action in the face of contemporary violence and regressive political/scientific policy and practice, especially, in the U.S. context? How can such action manifest in the science curriculum? How do we navigate normative ethics in the face of social (etc.) multiplicities and contestations? How are boundaries between ethics and politics or science and ethics produced and transgressed? Lastly, how do we invite others (students, teachers, and community members) into ethical reflections, dialogue, and imaginings?

Sustainability Education and Student Agency in K-12 Contexts

Strand 14: Environmental Education and Sustainability

22-Apr-26, 9:00-10:30

Location: Jefferson B (L4)

Stand-Alone Paper

Bringing Sustainability Issues into the Classroom: Interdisciplinary Challenge-Based Learning in Secondary Education

Bart Schutte*, Eindhoven University of Technology, Netherlands

Duru Bayram, Eindhoven University of Technology, Netherlands

Johanna Vennix, Eindhoven University of Technology, Netherlands

Jan van der Veen, Eindhoven University of Technology, Netherlands

ABSTRACT

Societies now face complex sustainability challenges requiring multiple perspectives, which do not align well with the fragmented structure of secondary education. Interdisciplinary teaching, particularly through challenge-based learning (CBL), engages students with open-ended challenges and prepares them for life beyond graduation. Despite its benefits, teachers often make pragmatic choices due to rigid school structures when attempting

interdisciplinary teaching. This qualitative study explores how teachers approach implementation of interdisciplinary CBL in the context of education for sustainable development. Data were collected through semi-structured interviews (n = 12) and document analysis. The results revealed three scenarios for implementing interdisciplinary CBL in Dutch secondary schools. In the first scenario, projects were implemented within a single discipline, with teachers working in isolation and few connections to other subjects. In the second, projects were carried out across subjects, with teachers collaborating under a broad sustainability theme. In the third scenario, full integration was achieved during project weeks or within inherently interdisciplinary subjects, where disciplinary boundaries faded and the challenge became the central focus. While each scenario reflects a deliberate choice, the findings offer insights to help educators and school leaders ease the burdens of interdisciplinary teaching and better support sustainable development education.

Stand-Alone Paper

Science Teachers' Beliefs and Contributions to Children's Access to Biodiversity Within the School Day

Allison Antink-Meyer*, University of Missouri-St. Louis, USA

Soo Won Shim, Illinois State University, USA

Ryan Brown, Illinois State University, USA

ABSTRACT

The aim of this study was to examine relationships between the science teacher role, age of students, teachers' beliefs about nature and the importance of access to nature, and the type interactions that students have with biodiversity during the school day. Fifty-five teachers completed the Children, Nature, and Biodiversity Survey-Teachers Version. The mean differences between teachers of adolescents and teachers of children with regard to their interest in nature and nature affinity were not significant, but their beliefs about the importance of outdoor time for their students was significant with teachers of children holding stronger beliefs. The mean differences between science teachers and teachers of other subjects in their beliefs about the importance of outdoor time for their students was not significant. However, significant differences in their personal interest in nature and their nature affinity were observed. Using Marselle et al.'s typology of experience with biodiversity, teachers indicated if they fostered indirect, direct, incidental to another activity, or intentional engagement with biodiversity within the school day. Analyses showed a significant difference and an association between more direct and/or intentional interaction with biodiversity among students of science teachers.

Stand-Alone Paper

Opportunities for Student Agentic Action in K-12 Sustainability Education: A Systematic Review

Michelle Jordan*, Arizona, USA

Emmanuel Adeloju*, Arizona State University, USA

Andrea Weinberg, Arizona State University, USA

ABSTRACT

Despite the urgency of sustainability and climate challenges, formal K-12 education experiences often fail to connect science learning with meaningful action, perpetuating a gap between knowledge and action. This systematic review synthesizes global research on opportunities for student agentic action in formal K-12 sustainability and climate education, aiming to guide educators in fostering student participation in creating sustainable and just futures. Using state-of-the-art review methodology and expanded PRISMA protocols, the review analyzes peer-reviewed empirical literature published since 2015 to explore (a) the extent and ways in which students are invited to take agentic action, and (b) the roles students enact as contributors to sustainable futures. The Action-Oriented Pedagogies (AOP) framework guided analysis, emphasizing students as active participants who imagine preferred futures, plan for shared impact, and engage authentically in transformative roles. From an initial pool of 1,104 documents identified through database and hand searches, 24 empirical studies met inclusion criteria for in-depth coding and analysis. Findings reveal both the potential and the current limitations of pedagogical practices in supporting student agency within sustainability education. The review offers key insights for advancing action-oriented science education and outlines future research needs to better support students as co-creators of sustainable change.

Inspiring Science Participation Among All Ages and Backgrounds: Evaluations From NASA's Science Activation Program

Strand 15: Policy, Reform, and Program Evaluation

22-Apr-26, 9:00-10:30

Location: Capitol Hill (L3)

Related Paper Set

Aviation Weather Mission: Evaluating Data Collection Efficacy in a Youth Citizen Science Project

Matt Nyman*, Oregon State University, USA

Heather Fischer*, Oregon State University, USA

Theresa Schwerin, Institute for Global Environmental Strategies, USA

Marilé Colón Robles, NASA Langley Research Center, USA

Shannon Babb, Civil Air Patrol, USA

ABSTRACT

The Atmospheric Weather Mission (AWM) was a collaborative youth citizen science project between the CAP and a science education and research collaborative focused on collecting real-time atmospheric data and airplane flight data which, when combined with collocated satellite data, can be used to better understand contrail formation and potential forecast models. Participating youth included CAP cadets and senior members. We learned from formative program evaluation that ~50% of participants had experience collecting data and

that training materials were successful at building confidence and skills for data collection and detailing project goals. Data from summative evaluation show that over 90% of youth participants felt they had been successful at collecting data and submitting that data to the research branch of the science education collaborative. We speculate that the increase in self-efficacy related to data collection may be related to the focused nature and clear goals of the project, excitement of collaborating on a project that motivated participants, and the sense of working within a tight and supportive community that is foundational to the CAP.

Related Paper Set

Reflecting on a Stratospheric Ballooning Education Project's Implementation With Participatory and Empowerment Evaluation Approaches

Beth Covitt*, University of Montana, USA

Angela Des Jardins, Montana State University, USA

ABSTRACT

The Nationwide Eclipse Ballooning Project engaged 53 teams of students from across the United States to fly experiments on high-altitude balloons for the 2023 annular and 2024 total solar eclipses. To better understand what could be improved for similar future projects, this study utilized participatory and empowerment evaluation approaches to engage 34 project partners in examining strengths, challenges, and recommendations across four topics: project structure, education and research approach, broadening participation, and funding. Analysis of the topics was completed through written comments followed by remote focus group discussions. The project director and evaluator then synthesized the written and focus group comments to provide the results shared here. Key recommendations include the need for real-world interdisciplinarity, a leadership group that reflects team types, a robust communication platform used at all levels, a modular approach for participation levels and time lengths, and flexibility in funding choices.

Related Paper Set

From Professional Learning to Practice: Educator Implementation of Place-Based, Data-Rich Earth Science Instruction Through PLACES

Stephanie Wilkerson*, Magnolia Consulting, USA

Holland Banse*, Magnolia Consulting, USA

ABSTRACT

The PLACES Project, part of NASA's Science Activation portfolio, builds educators' capacity to implement place-based, data-rich Earth science instruction. This evaluation examined how participation in PLACES professional learning—through Summer Institutes and Communities of Practice—shaped educators' instructional practices, confidence, and use of NASA assets and related strategies. A mixed-methods design included a survey of 27 educators representing grades 5–12 and a range of Earth systems topics, as well as two in-depth educator interviews. The survey included items rating confidence and frequency of use for data tools and strategies, self-efficacy and beliefs about place-based instruction,

classroom integration and perceived student outcomes, and open-ended prompts. Quantitative data were analyzed descriptively, and qualitative data were thematically coded. Overall, results indicate that educators are applying what they learned through PLACES to create classroom environments and learning opportunities that reflect place-based, data-rich science instruction. Many reported integrating NASA assets alongside PLACES-developed classroom instructional strategies. Educators also described students demonstrating confidence in interpreting and discussing data, engaging in collaborative discussions, and using datasets (including NASA assets) to make sense of Earth science systems.

Related Paper Set

Research and Evaluation Practices to Engage with Neurodivergent Teens in STEM Programs

Andrew Grillo-Hill*, WestEd, USA

Rasha Elsayed, WestEd, USA

Kimberly Nguyen, WestEd, USA

Karen Melchior, WestEd, USA

Joshua Valcarcel, WestEd, USA

ABSTRACT

NASA's Neurodiversity Network (N3) program provides NASA resources and experiences to neurodivergent youth. This is accomplished through 1) redeveloping existing NASA resources with input from autistic learners, and 2) offering a summer internship program, mentored by NASA Subject Matter Experts (SMEs), for selected neurodivergent high school students. Resource materials were used by secondary students and educators in formal and informal settings. Internships took place in separate annual cohorts with program materials developed to support both interns and mentors. Participant engagement ranged from a handful of classroom lessons over two to three weeks, one to two week-long day-camp experiences, and the remote summer internship experience ranging from eight to two weeks. The mixed methods evaluation collected both survey and interview data in a variety of context to best fit the program activities and participant engagement. Evaluation questions focused on 1) neurodivergent learners' engagement and confidence in STEM abilities, 2) neurodivergent learners' interest in NASA-related careers, 3) SMEs neurodivergent competency, and 4) educator's competency for working with neurodivergent youth and with NASA related skills. Results of the evaluation showed that in a variety of different contexts SMEs and educators increased their competencies, while neurodivergent learners increased their STEM ability and interest.

***Interactive Communities in Science Education: Educators and Communities
Shaping STEM Learning***

Strand 2: Science Learning: Contexts, Characteristics and Interactions

22-Apr-26, 10:45-12:15

Location: Jefferson A (L4)

Stand-Alone Paper

Balancing Compassion and Accountability: Insights from COVID-19

Melissa Demetrikopoulos, Institute for Biomedical Philosophy, USA

Molly Weinburgh*, Texas Christian University, USA

Andreas Thompson, Institute for Biomedical Philosophy, USA

Zhan Shi, Texas Christian University, USA

John Pecore*, University of West Florida, USA

Dean Williams, Texas Christian University, USA

ABSTRACT

This research extends our prior research focusing on science and mathematics teacher effectiveness during COVID-19 and examines how school shutdowns impacted teacher practices and their students' practices and success. The research highlights challenges related to balancing compassion with high expectations. A series of survey questions asked 22 middle and high school teachers to indicate the frequency of their engagement in a number of teaching practices, their students' engagement in key learning practices, and their students' success. Teaching practices showed the greatest decline during COVID-19, with partial recovery upon reopening. For student practices, there was a dramatic drop in both student class attendance and completion of required work during COVID-19 which persisted upon reopening. There was also a drop in student success in their STEM classes during COVID-19, with partial recovery upon reopening, as well as a drop in student success on standardized science and mathematics tests. This survey data is supported by the interview data whereby teachers often reported that students were not held accountable for completing their work, nor attendance, and that challenges persist with student behaviors and success that teachers attribute to the desire to be compassionate towards the students during COVID-19.

Stand-Alone Paper

Synchrony, Community, and Personhood as Becoming-Together: Understanding Interactive Context in Science Education through Activity Processes

Katherine Bruna*, Iowa State University, USA

Lyric Bartholomay*, University of Wisconsin, Madison, USA

ABSTRACT

This paper details the activity processes of interaction among diverse participants in a summer camp dedicated to the theme of mosquitoes and public health. It describes how a particular routine, the Morning Circle and its rituals, construed activity processes that

nurtured community, including moments of orchestrated synchronization or planned interactive coordination. It further proposes that the activity processes characterizing the emotional climate of Morning Circle reverberated into subsequent Science Time, making possible moments of emergent synchronization, or unplanned interactive coordination. The paper describes the phenomenon of synchronization in relation to experiential personhood, or becoming-together. It asserts that synchronization has utility, especially with youth populations underrepresented in science, in implementing and examining science programming through an equity lens. It encourages more attention to the interactive processes through which synchronization occurs and the relationship between these processes, personhood possibilities, and science identity and outcomes. The paper concludes with directions for future research and planning implications for practitioners.

Stand-Alone Paper

Counselors, Classrooms, and Community: Exploring Rural Educators' Roles in Supporting Project-Based STEM Learning

Devan Jones*, University of South Carolina, USA

Bryndle Bottoms, Institute for Rural Education and Development, USA

ABSTRACT

Project-based learning (PBL) offers a powerful means of engaging students in authentic, real-world problem solving, particularly when integrated with science, technology, engineering, and mathematics (STEM) content. In rural contexts, where strong school-community ties coexist with geographic isolation, limited resources, and restricted access to STEM role models, PBL grounded in local contexts holds unique promise for advancing equity and career readiness. This qualitative study explored how rural middle school teachers and school counselors engage with their local communities to support STEM PBL and how they perceive related assets and constraints. Pre-program, semi-structured interviews with 22 educators from 15 rural schools were inductively coded to identify emergent themes. Findings indicate that educators leveraged local industries, organizations, and workforce expertise to create relevant, career-connected STEM experiences, with school counselors often serving as key connectors to community partners. While participants emphasized relational and cultural strengths, they also cited persistent barriers, including transportation, funding, and limited professional development tailored to rural needs. Grounded in Bronfenbrenner's Ecological Systems Theory, this study illuminates how rural educators and school counselors navigate systemic constraints to design locally relevant PBL STEM learning, highlighting strategies for strengthening science education in under-resourced but community-rich settings.

Teacher Development at the Intersection of Place, Climate, and Justice

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

22-Apr-26, 10:45-12:15

Location: Willow A (L2)

Symposium

Teacher Development at the Intersection of Place, Climate, and Justice

Priya Pugh*, IslandWood, USA

Déana Scipio, IslandWood, USA

Kelsie Fowler, University of Washington, USA

Anastasia Sanchez, Puget Sound Educational School District, USA

Charlene Nolan, Western Washington University, USA

Jordan Sherry-Wagner, University of Washington Bothell, USA

Megan Bang, Northwestern University, USA

Carrie Tzou, University of Washington Bothell, USA

ABSTRACT

Science education is at a critical crossroads in this time of socioecological tremors. While we are experiencing increasing cataclysmic ecological events that are entangled within social and political systems that perpetuate racial and structural injustices, there is a pressing need to reimagine systems of education that can address these complexities while maintaining narratives of possibility and hope (Authors et al., 2022; Whyte, 2020). Science education, we argue, sits at this critical juncture in that it engages students in practices and sensemaking about real world phenomena (NRC, 2012); however there is still much to be done to support students and educators alike in wrestling with the social and political implications and roots of these socioecological phenomena (Puig de la Bellacasa, 2017). Teacher and educator development programs are in a particularly significant position to both imagine and enact change. This symposium brings together researchers and educators who are at this critical intersection – working with preservice and inservice educators to cultivate science instruction, materials, and pedagogy that center issues of climate and climate justice through connections to place, stories, and lived experiences.

Graduate Student Teaching and Professional Development

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

22-Apr-26, 10:45-12:15

Location: Juniper (L2)

Stand-Alone Paper

Graduate STEM mentoring through mentor and mentee perspectives: a qualitative study

Ana-Maria Topliceanu*, Augusta University, USA

Meg Blanchard*, North Carolina State University, USA

ABSTRACT

Science, Technology, Engineering, and Mathematics (STEM) professionals in the United States (U.S.) draw upon students at research universities. The number of domestic and international graduate STEM students has increased, yet attrition rates remain high. Mentoring is a key component of supporting the success of graduate STEM students and increasing retention rates. This qualitative study analyzed data from interviews with eight STEM mentors and twenty of their recently graduated domestic and international doctoral mentees from four large public, research-intensive universities in the southeastern U.S. Yob and Crawford's conceptual framework of mentoring was employed to code the data, and Chandler et al.'s ecological systems theory served as a theoretical framework. Overall, there were similar patterns of descriptions of mentoring behaviors described by mentors and their mentees, with a greater focus on academic versus psychosocial aspects. Recommendations for both mentors and mentees emphasize early career planning, timeline feedback, developing a post-graduation plan, increasing professional contacts and experiences, and balancing workloads. Graduate schools are encouraged to limit mentor loads, provide mentor training, and integrate job search resources that include academic and non-academic career opportunities.

Stand-Alone Paper

Research Experience for Teachers (RET) as a site for graduate students' professional development

Kyle Tomczak*, University of Illinois Chicago, USA

Minjung Ryu, University of Illinois Chicago, USA

ABSTRACT

Research Experiences for Teachers (RET) have been used for years as professional development programs for teachers (Stieben et al., 2021). While these programs benefit teachers, their students, and their schools (Bowen et al., 2021), little work has been done to show the effects of these programs on university scientists, including graduate students, who often facilitate these experiences for teachers. Our work studies the professional development of graduate students in the context of a RET program. Using 21st Century Skills (21CS) as a framework for data analysis, we investigate what skills graduate students learn and use while facilitating a RET program for their teachers. Preliminary findings indicate that graduate students engage in their professional development in all three domains of the 21CS. Of the three, interpersonal skills, including communication, collaboration, and leadership, saw the largest advancement in professional development skills.

Stand-Alone Paper

Departmental Supports or Barriers to Graduate Student Teaching Professional Development (GS TPD): An Interview Study

Heather Green*, Middle Tennessee State University, USA

Eric Akuoko, St. John's University, USA

Alyssa Cotrell, Middle Tennessee State University, USA

Gili Marbach-Ad, University of Maryland, USA

Kristen Miller, University of Georgia, USA

Elisabeth Schussler, University of Tennessee, USA

Grant Gardner, Middle Tennessee State University, USA

ABSTRACT

Attrition in STEM majors remains a concern in the United States (Smith & Willison, 2021). Improving the quality of STEM teaching to combat this attrition has become a priority. One group of critical undergraduate STEM instructors with a potential high impact on undergraduate success and retention is graduate teaching assistants (GTAs). Especially when considering GTAs are possible future undergraduate faculty, GTA professional development (PD) can have a lasting impact on undergraduate education. Despite this potential, many institutions provide little to no GTA PD (Authors, 2011). This study examined departmental supports and barriers to GTA PD implementation. A semi-structured interview protocol was used to probe n=35 experts in GTA PD regarding departmental cultural supports and barriers to development and use of PD. The responses were coded using the four frames model (structures, symbols, people, and power; Reinholz & Apkarian, 2018). The results in each category were then inductively coded into common themes. There were more support themes than barrier themes. The most common themes emerged in the structure and symbol categories for both supports and barriers. Examination of the common themes from these experts can provide guidance on addressing barriers and increasing supports to promote GTA PD at higher education institutions.

Networks, Co-Design & System-Level Change

Strand 6: Science Learning in Informal Contexts

22-Apr-26, 10:45-12:15

Location: Columbia (L4)

Stand-Alone Paper

Program Improvement: Connected Science Learning for Local Socioecological Engagement

Todd Campbell*, University of Connecticut, USA

Rebecca Van Tassell*, University of Connecticut, USA

Laura Cisneros, University of Connecticut, USA

Nicole Freidenfelds, University of Connecticut, USA

Laurel Pehmoeller, University of Connecticut, USA

Jonathan Simmons, Salem State University, USA

Anna Lindemann, University of Connecticut, USA

Heather Elliot-Famularo, University of Connecticut, USA

Cary Chadwick, University of Connecticut, USA

David Dickson, University of Connecticut, USA

ABSTRACT

This proposal introduces the XXX [Removed for Blind Review] connected learning program focused on addressing issues of accessibility to enrich STEAM learning experiences for groups underrepresented in STEM. The program engages groups of students in socioecological-oriented action projects in their community. Through three on campus workshops followed by in-classroom and in-community work in their schools across the academic year, school pods are supported by near-peer mentors, community partners, and university faculty to propose, refine, and implement their action projects. This program is integrated into students' regular school day in collaboration with students' teachers, who are positioned as mentors, to ensure that teens don't have to choose between summer STEAM experiences and paid jobs, aren't excluded from experiences planned in far-off locations, and can take advantage of STEAM networks. This presentation introduces the theoretical framework undergirding our program, as well as findings and program improvements from examining first year data through design-based research methods. We share how we are improving our communication about the program with teachers, better supporting near-peer mentors to take up their roles within school pods, and understanding and sustaining the role of community partners in validating and legitimating the action projects of students.

Stand-Alone Paper

Transforming Informal Science Networks: Using Social Network Analysis to Advance Equity and Collaboration

Anica Miller-Rushing*, Associated Universities Inc., USA

Scott Byrd, Medomak Consulting, USA

ABSTRACT

Global challenges in science learning demand collaborative approaches that transcend disciplinary, institutional, and geographic boundaries. This study examines the development of a global Network of Networks (NON) in astronomy education, engagement, communication, and culture using mixed-methods social network analysis (SNA). The network connects 24 sub-networks across 19 countries, fostering research-to-practice integration in informal science spaces. Data from two annual surveys (N=37 in 2024), network visualizations (Kumu), triad census analysis (NetworkX), and qualitative coding illuminate structural patterns, brokerage roles, and pathways for inclusive growth. Findings reveal strong participant value and excitement, but uneven integration of peripheral members and epistemically underrepresented subfields. Case studies show how individuals function as "floating hubs," "regional connectors," or "subfield brokers," highlighting latent opportunities for triad-building and cross-domain collaboration. This work contributes to informal science learning theory by demonstrating how SNA can surface hidden structural inequities and inform intentional strategies for equitable engagement. Connecting to the NARST 2026 theme, we frame NONs as "joyful transgressions" that disrupt siloed practice and enact radical imagination for science learning. Implications include adaptable models for other

informal science domains seeking to build resilient, inclusive, and transformative global networks.

Stand-Alone Paper

Design Thinking Approach to Co-creating Science Curriculum in Museum-School Partnerships Using the Double Diamond Framework

Wei-Ting Li*, National Sun Yat-sen University, Taiwan

Jen-Yuan Yeh, National Museum of Natural Science, Taiwan

Ying-Ying Liu, National Museum of Natural Science, Taiwan

ABSTRACT

Collaborations between formal (schools) and informal (museums) educational institutions are often hindered by boundaries stemming from their differing missions, audiences, and objectives. This study addresses this challenge by employing the Double Diamond design framework to develop and refine an innovative curriculum co-creation model. This two-stage research first utilized the Delphi method with 29 teachers and museum staff to establish shared guiding principles. Subsequently, a professional learning community of educators from both institutions co-designed and pilot-tested a science curriculum. The findings revealed that schools and museums have complementary roles, with teachers focusing on foundational knowledge and museum staff on experiential learning. The model also proved highly effective in practice, successfully transforming museum resources into a science curriculum that was both engaging and aligned with the dimensions of science education. However, it also highlighted significant institutional constraints, primarily teacher workload and scheduling conflicts. This study concludes that while the Double Diamond framework can break practical boundaries, greater institutional flexibility and mutual understanding are crucial for sustaining these deep, valuable partnerships.

Design Thinking, Phenomena, and Evidence-Based Reasoning: Shaping Future Science Teachers' Instructional Practices

Strand 7: Pre-service Science Teacher Education

22-Apr-26, 10:45-12:15

Location: Ravenna AB (L3)

Stand-Alone Paper

Implementation of Design Thinking on the Subject of Earthquakes: Experiences of Pre-service Science Teachers

Semanur Aras*, Kahramanmaraş Sütçü İmam University, Turkey

Ahmet TEKBIYIK, Kahramanmaraş Sütçü İmam University, Turkey

ABSTRACT

This study explores the integration of Design Thinking (DT) into science education to address earthquake-related problems. Using a qualitative embedded single-case design, nine pre-service science teachers (designers) engaged in a six-week instructional process aimed at developing user-centered solutions for individuals (users) affected by earthquakes. The DT process (empathy, defining, ideation, prototyping, and testing) was implemented through weekly assignments and analyzed using a DT Implementation Tool Set and rubric.

Findings indicate that the empathy stage fostered strong emotional engagement, enhancing participants' motivation and ability to generate relevant solutions. While most designers excelled in ideation and prototyping, some struggled with problem definition and visualization. Proposed solutions ranged from structural safety improvements and portable shelters to smart earthquake kits and animal housing designs. The process highlighted the value of connecting scientific knowledge with real-world needs, enhancing critical thinking, creativity, and collaboration skills.

This study contributes to science education by demonstrating how DT can promote both cognitive and affective competencies while fostering sustainable development and disaster preparedness awareness. The approach holds high potential for adoption in teacher education programs, offering a practical model for integrating disaster-related contexts into science curricula.

Stand-Alone Paper

Building on Strengths: How a Phenomenon-Based Science Course Shapes Prospective Elementary Teachers' Visions of Teaching

Martha Canipe*, Northern Arizona University, USA

Ron Gray, Northern Arizona University, USA

ABSTRACT

Research has documented ongoing challenges in elementary science teacher education, including varying levels of teacher confidence in their science knowledge and preparedness for teaching science. Our study investigated how a phenomenon-based science content course, designed using the Ambitious Science Teaching framework shaped prospective elementary teachers' views of science teaching. Using an asset-based perspective, we examined their ideas about teaching science before and after the course. Through analysis of interviews we found that participants' initial ideas about teaching science aligned with some elements of Ambitious Science Teaching. These initial ideas included using students' ideas as resources; supporting reasoning through talk; anchoring learning in phenomenon; and engaging in scientific practices. We found after completing the course participants had built on and strengthened these ideas. Furthermore, some explicitly linked their ideas about science teaching to experiences from the course. Our findings suggest that in addition to supporting the development of content knowledge, science content courses can also influence prospective elementary teachers' views of science teaching. This study highlights the importance of integrating elements of a teaching model like Ambitious Science Teaching

early in elementary teacher preparation in order to build a foundation that can further developed through methods coursework later in a program.

Stand-Alone Paper

Trends and Gaps in Elementary Science Pedagogical Content Knowledge Research

David Santibáñez*, Finis Terrae University, Chile

Alejandro Vega-Muñoz, Central University of Chile, Chile

Claudia Vergara, Alberto Hurtado University, Chile

ABSTRACT

This study presents a systematic review of international research on Pedagogical Content Knowledge (PCK) in elementary science education, with a primary focus on preservice teachers and comparative insights from inservice contexts. Using PRISMA 2020 guidelines, we analyzed 123 peer-reviewed articles published between 1986 and 2024 in English, Spanish, and Portuguese, sourced from Web of Science and Scopus. Studies were coded using both contextual (country, educational level, disciplinary focus) and conceptual categories (PCK model adopted, methodological approach, knowledge domains). Findings reveal an uneven global distribution of research, with a predominance of studies from the Global North and an underrepresentation of rural, indigenous, and multilingual educational contexts. In preservice teacher education, the literature emphasizes topic-specific content knowledge and instructional strategies, but less attention is given to the syntactic structure of scientific knowledge and to authentic integration of assessment within PCK development. Inservice studies highlight similar trends but exhibit stronger connections to curriculum reform and professional learning communities. The review identifies five persistent research gaps and proposes directions for future work, emphasizing the need for culturally responsive, context-sensitive approaches to PCK in elementary science teacher education. These findings offer implications for both research agendas and the design of teacher education programs.

Advancing Equity and Justice in Science Teaching: From Coursework to Career-Long Development

Strand 7: Pre-service Science Teacher Education

22-Apr-26, 10:45-12:15

Location: Ravenna C (L3)

Stand-Alone Paper

Context-Dependent Equity Framings Across Coursework in Elementary Science Teacher Preparation

Wanjoo Ahn*, Michigan State University, USA

Christina Schwarz, Michigan State University, USA

ABSTRACT

This study explores how preservice teachers (PSTs) in an elementary science methods course engaged with equity-related ideas across three contexts: a critical classroom video reflection, a scaffolded lesson plan, and an open-ended survey. Using Philip and Azevedo's (2017) equity discourses of access and achievement or identities as doers of science, transforming what counts as science, and participation in justice movements, the analysis viewed PSTs' ideas as context-dependent sensemaking rather than fixed dispositions. Access-oriented framings dominated lesson plans, supported by early concrete prompts, while justice framings were more frequent when inequities were explicit, as in the video reflection. Transformative framings appeared mainly in the open-ended survey, where equity was the central focus and design constraints were absent. Across individuals, framings shifted with task purpose, visibility of inequity, and artifact expectations, suggesting PSTs held broader repertoires than any single artifact revealed. Findings highlight how task design and instructional framing influence equity orientations. Implications include coursework that integrates transformative equity framings across varied activities, cycles among design work, classroom interaction analysis, and open critical reflection, introduces justice-connected phenomena earlier, and models balancing curriculum demands, student needs, and equity aims to build equity-centered pedagogical reasoning as a sustained practice.

Stand-Alone Paper

Supporting Equity- and Justice-Seeking Science Teaching Through a Career-Spanning Professional Learning Community

William Lindsay, University of Colorado Boulder, USA

Catalina Arboleda Hernandez*, University of Colorado Boulder, USA

Taylor Marino Fallik, University of Colorado Boulder, USA

Ian Her Many Horses, University of Colorado Boulder, USA

Valerie Otero, University of Colorado Boulder, USA

ABSTRACT

This study examines the design and impact of a career-spanning professional learning community for preservice, induction-stage, and veteran secondary science teachers committed to equity- and justice-seeking instruction. The community met monthly during a university methods course over two academic years and was designed to help bridge the "two-worlds pitfall" between university preparation programs and the realities of K-12 classrooms. Activities included engaging participants in problem of practice and roundtable discussions, examining literature related to equity- and justice-seeking science instruction, and collaborative curriculum design and adaptation. Using a qualitative, multiple-case study design, researchers analyzed community components valued by participants and the perceived impacts of participation on resulting instructional practice. Researchers conducted semi-structured interviews and open-ended surveys with 17 participants ranging from preservice teachers to veteran educators with over two decades of experience. Findings indicate that the community fostered reciprocal learning across experience levels, strengthened participants' awareness of equity- and justice-seeking practices, and supported shifts toward student-centered pedagogies. However, some participants sought

more explicit definitions and actionable strategies for implementing equity- and justice-seeking practices. The study suggests that career-spanning and discipline-specific professional learning communities can bridge theory–practice divides and support the learning of science teachers at various levels of experience.

Stand-Alone Paper

Reframing Science and Disability in Teacher Preparation: Insights from an Asynchronous Elementary Science Methods Course

Suzanne Patzelt*, Touro University, USA

Danielle Rhemer, Touro University, USA

Ashley Pollitt, The College of New Jersey, USA

Karen Woodruff, Kean University, USA

ABSTRACT

This study sought to better understand how PSTs in a special education generalist alternative certification program engaged in an asynchronous elementary science methods course. We asked two research questions: 1) After participating in an online asynchronous science methods course for SWD in a special education generalist alternative certification program, in what ways did PSTs' conceptions of science change? 2) Which components of an online asynchronous science methods course for SWD in a special education generalist alternative certification program influenced PSTs' conceptual changes around teaching science? The design and analysis of this study explored PSTs' work products for evidence of conceptual shifts in their conceptions of science and disability. Our findings suggest that when PSTs are provided with carefully selected assignments and materials and given opportunities to wrestle with designing instruction that meets state and national standards and practices, their conceptions of science shift from limited to more expansive. Future research should build on our findings and extend data collection to include individual interviews, student-facing work, and classroom observations to identify components of asynchronous courses that support lasting changes in PST thinking about science and how these changes impact the way they teach science to SWD.

Stand-Alone Paper

Building Science Teacher Agency Through Equity, Sensemaking, and Three-Dimensional Learning and Intentional Course Design

Alison Mercier*, University of Wyoming, USA

Meenakshi Sharma, Mercer University, USA

Anica Miller-Rushing, Associated Universities Inc., USA

ABSTRACT

Teacher agency—the power to make purposeful choices aligned with professional values—is essential for effective science education, yet teachers face challenges implementing reform-based practices like three-dimensional learning within traditional structures. This exploratory mixed-methods case study examined how participation in an equity-centered, three-

dimensional science graduate course shaped secondary science teachers' agency. Twelve practicing teachers enrolled in a 16-week graduate methods course completed the Teacher Agency Survey and open-ended reflections. The course integrated equity practices, three-dimensional instruction, sensemaking approaches, and innovative tools. Using a teacher agency framework, we analyzed how course components influenced four expressions of agency: navigating school structures, negotiating science teacher identity, implementing instructional changes, and adopting justice-oriented practices. Findings revealed that participants felt most prepared for agency development through course components focusing on equity (ranked highest for justice orientation), instructional tools, and sensemaking practices. Qualitative analysis identified four key themes: shifting from teacher control to student-centered learning, breaking free from curricular constraints, seeing equity as professional purpose, and viewing authentic science as student empowerment. Results suggest that intentionally designed professional learning experiences can cultivate teacher agency, enabling educators to become transformative advocates for equitable, three-dimensional science instruction despite systemic barriers.

Learning from a Local Longitudinal Network: Building Elementary Multilingual Classroom Cultures of Interdependence and Care

Strand 8: In-service Science Teacher Education

22-Apr-26, 10:45-12:15

Location: Greenwood (L3)

Symposium

Learning from a Local Longitudinal Network: Building Elementary Multilingual Classroom Cultures of Interdependence and Care

Jessica Thompson*, University of Washington, USA

Janaki Nagarajan, University of Washington, USA

Camille Ungco-Santos, University of Washington, USA

Hsin-Jung Li, University of Washington, USA

Ruby Geballe, University of Washington, USA

Grace Cornel Gonzales, University of Washington, USA

Nancy Hernández-Zamarripa, University of Washington, USA

Matt Stewart, University of Washington, USA

Iman Khalaf, University of Washington, USA

Sarah Lee, University of Washington, USA

ABSTRACT

This symposium draws on the expertise of local teachers who participated in a networked professional development program focused on supporting early-career elementary science teachers to build justice-focused classrooms. A set of participating teachers and researcher partners will share stories that demonstrate the work of moving towards interdependence and relational care in teaching, the rightful belonging of students and families in the

classroom, the role of multilingual learning in science, and the processes of teacher learning. The participating teachers and researchers will engage in a discussion of how the program commitments have evolved and how others can learn from and continue to iterate on these themes in further research and learning. This symposium will provide qualitative descriptions of case studies from four teachers' classrooms, serving as a basis for discussion on how the teachers approach justice-centered science teaching, their commitments, and their learning alongside the community of participating teachers. This teacher-driven learning community will share how they bridge theory to practice on a set of cutting-edge linguistic, cultural, environmental, and disability justice commitments for elementary science learning and teacher learning.

Advancing equity and leadership in science education

Strand 8: In-service Science Teacher Education

22-Apr-26, 10:45-12:15

Location: Issaquah AB (L3)

Stand-Alone Paper

District science coordinator frames for equity in STEM

Sara Porter*, University of North Carolina at Greensboro, USA

ABSTRACT

District Science Coordinators are important STEM actors in the school district, whose understanding of equity in STEM education matters for students in classrooms. Yet, there is little research on how DSCs make sense of equity in STEM and the professional learning resources that are needed to support them to do equity work in their contexts. In this presentation, I analyze video data from a professional learning program for DSCs to locate the equity frames they use when thinking about and designing resources for equitable STEM education. Findings suggest that district science leaders use a variety of frames for equity in STEM and that consensus building activities support them to expand their frames for equity to be inclusive of more critical and justice-oriented frameworks.

Stand-Alone Paper

Negotiation of Science Teaching in a 15 Year Research-Practice Partnership

Scott McDonald*, The Pennsylvania State University, USA

Jonathan McCausland*, Iona University, USA

ABSTRACT

Changing science education systems, and in particular the embedded cultural practices of science teaching is difficult to accomplish. Many approaches to this problem focus on macro-scale factors, like policies, that drive institutional change or, by contrast, micro-scale factors like professional learning. In contrast, this study focuses on the long-term, organically

responsive, and relational way that a long term research-practice partnership grew and changed. Drawing from a sociocultural perspective of professional vision whereby people learn by participating in social negotiations to create and recreate cultural practices over time, this paper uses narrative methods to tell the temporally and socially complex story of how the partnership transformed from its early beginnings to its current form. Findings from this paper demonstrate how the partnership iteratively negotiated knowledge objects through talk and practice to improve science teaching practice, and how broader science education infrastructure enhances but is not necessary for research-practice partnerships or the innovation that takes place within them. In a time where funding is increasingly scarce and science education is under threat, this paper proposes a form of scaling that is slow and rooted in creating deep and lasting change for local communities.

Stand-Alone Paper

Talk or Text? Analyzing Science Teacher Mentors' Written and Verbal Feedback to Mentees

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

Katie Glover, North Carolina State University, USA

Khalid Alharbi, North Carolina State University, USA

W. Reynolds, North Carolina State University, USA

Scott Ragan, North Carolina State University, USA

Jason Painter, North Carolina State University, USA

ABSTRACT

Feedback is a central component of mentoring, shaping teachers' instructional practice and professional growth. The modality, written or verbal, can influence how feedback is perceived, processed, and applied. Guided by Hattie and Timperley's (2007) four-level feedback model, this study examined (1) the characteristics of written and verbal feedback provided by mentors, and (2) how these modalities relate. Data included over 300 written comments and 350+ verbal exchanges from recurring mentor-mentee sessions in an NSF-funded teacher development project. Thematic analysis revealed that written feedback was predominantly task-focused and concrete, while verbal feedback contained more reflective elements and greater attention to immediate and future teacher needs. Despite these differences, both forms centered on instructional methods and student engagement. Findings suggest mentors may underuse the reflective potential of written feedback, and that verbal feedback, though more dialogic, often addresses logistical rather than conceptual aspects of teaching. Implications highlight the need for mentor professional development to enhance reflective quality across modalities, contributing to science teacher education by illuminating how mentor communication shapes teacher growth.

Stand-Alone Paper

Gendered Pathways to Leadership: Examining Sources of Support and Challenges to Science Education Leadership

Elizabeth Lewis*, University of Nebraska-Lincoln, USA

Elizabeth Hasseler*, University of Nebraska-Lincoln, USA

Rachel Benzoni*, University of Nebraska-Lincoln, USA

Lawrence McElravy, University of Nebraska-Lincoln, USA

Wendy Smith, University of Nebraska-Lincoln, USA

ABSTRACT

This study examines the development of transformational leadership among secondary science teachers participating in a 7-year National Science Foundation Noyce Master Teaching Fellow (MTF) program. Now in year four, the program supports 23 experienced science educators employed in high-need schools through advanced graduate study (Ed.S. or Ph.D.), leadership certification, and pursuit of National Board Certification. Our conceptual framework integrates science education reform policy, equity-focused teaching, disciplinary expertise, and communities of practice, with feminist theory guiding our analysis of gendered leadership experiences. Using a design-based case study, we analyzed the MTFs' coursework, leadership activities, self-assessments, and intercultural development interviews. Participants demonstrate varied pathways into leadership, with differences in degree backgrounds, paid vs. unpaid leadership roles, and voluntary enrollment in the doctoral program option. Findings highlight supportive factors (peer networks, professional associations, program resources) and persistent challenges (hierarchical school leadership norms, conservative climate, and limited administrative support). Notably, all program attrition has occurred among women. This research contributes to understanding how structured, equity-driven professional development can cultivate science teacher leaders in high-need school contexts. Future work will explore links between intercultural competence and leadership efficacy to inform sustainable models for retaining and empowering science teacher leaders.

Centering Student Voice: Tools for Gathering Experience Data to Inform Science Assessment Design and Practice

Strand 10: Curriculum and Assessment

22-Apr-26, 10:45-12:15

Location: Ballard (L3)

Symposium

Centering Student Voice: Tools for Gathering Experience Data to Inform Science Assessment Design and Practice

Cari Herrmann-Abell*, BSCS Science Learning, USA

Jean Flanagan, BSCS Science Learning, USA

Abraham Lo, BSCS Science Learning, USA
Clarissa Deverel-Rico, BSCS Science Learning, USA
Jeffrey Snowden, BSCS Science Learning, USA
Andy Brubaker, BSCS Science Learning, USA
Melissa Campanella, University of Colorado, USA
Dennis Lee, BSCS Science Learning, USA
Patricia Olson, BSCS Science Learning, USA
Erin Furtak, University of Colorado, USA

ABSTRACT

Current science education reform emphasizes student voice in learning environments, yet assessment practices have lagged behind in meaningfully incorporating student perspectives. This symposium presents three tools designed to gather data directly from students to inform science assessment design and practice. The Student and Community Interest Inventory helps teachers elicit information about students' interests and prior experiences to inform assessment design. The Phenomena Interest Survey gathers student feedback on candidate phenomena for newly developed assessments. The Student Assessment Experience Survey provides students opportunities to share feedback about their experiences with phenomenon-based assessments after completion. These tools represent a shift from viewing assessment as something done to students toward assessment developed with students. Our work demonstrates that students can serve as valuable contributors not just about what they know, but about how assessment experiences impact their learning and engagement. Students provided actionable feedback that informed assessment revisions and phenomenon selection. Teachers who incorporated student voice showed significant improvements in designing assessments that engage student interest and connect to their lived experiences. These approaches help identify and address ways that traditional assessments may privilege some students while creating barriers for others, moving toward science assessments that better serve all learners.

Narrating teacher and scientist identity development in science

Strand 11: Cultural, Social, and Gender Issues

22-Apr-26, 10:45-12:15

Location: Aspen (L2)

Stand-Alone Paper

Investigating affective science teacher identity development among potential science teachers

Emily MacLeod*, McGill University, Canada
Pascale Saint-Denis, McGill University, Canada
Carolina Cruz-Vinaccia, McGill University, Canada
Allison Jardim Gonsalves, McGill University, Canada

ABSTRACT

In this stand-alone paper we address gaps in the current literature and share new knowledge about science teacher shortages through the use of a new affective analytical framework which aims to understand the role of emotions in the choice to (not) pursue science teaching. This aim is achieved through 1) examining a pool of potential, rather than existing, science teachers (science students who volunteer as informal STEM educators), and 2) exploring the role of identity and emotions in considering why people are (or are not) motivated to teach science. To do this we analyse qualitative and arts-based methods data collected with 16 postsecondary science students from across Canada, all of whom volunteer as an informal STEM educator with a nationwide charitable organisation that works to increase STEM engagement among youth. Informed by the work of Zembylas (2002), we conduct genealogies of—in this case, potential—science teachers to examine how emotions are experienced in relation to science teacher identity development at the intrapersonal (i.e., individual) level and the intergroup (i.e., political/sociocultural) level. We find that emotion, or affect, is central to science teacher identity development amongst those who are not yet, but could become, science teachers.

Stand-Alone Paper

The Quilted Lives of Career Change Science Teachers of Color: A Narrative Inquiry

Jonathan Tam*, Teachers College, USA

Felicia Mensah, Teachers College, USA

ABSTRACT

In light of the continuing teacher shortage, non-traditional populations have grown in popularity to meet school staffing demands. Specifically for science teaching vacancies, career changers have emerged as a solution and now comprise nearly one in three secondary science teachers. However, existing literature has focused largely on a singular kind of career changer—career changers who are predominantly White and from former professional science or elite careers. The goal of this study was to detail the lesser-known lived experiences of five career-change science teachers of Color and to examine how race, culture, and power played a role in their transitions. Using a narrative inquiry approach, life history details were captured to describe their former careers, transitions to teaching, and present-day instructional practices. Thematic analysis based on Yosso's Community Cultural Wealth then took place to explore the common routes and barriers they encountered. The analysis revealed three central themes: scientific gatekeeping and a desire to subvert these barriers for students; supportive individuals and mentors salient to their transitions; and social networks that provided needed guidance when navigating the teaching landscape. Implications for preparing, recruiting, and supporting career-change science teachers of Color are discussed.

Stand-Alone Paper

Constructing Science Identities: Insights from Filipino Educators

Dannipog Dennis*, University of The Philippines, Philippines

Katherine Wade-Jaimes, University of Nevada, USA

PrincesRaymunda Gatan, University of The Philippines, Philippines

Loise Angelica Oruga, University of The Philippines, Philippines

ABSTRACT

Although science teacher identity has been of interest in research recently, there is little research exploring the identities of science teachers outside of western contexts. This study builds on the previous base of teacher identity literature to explore the science identities of science teachers in The Philippines. Data collection included interviews of 11 science teachers, across varied grade levels and content areas. Open coding of the data was used to identify three themes: focus on science vs. teaching based on teachers' prior experiences and motivations; and an impact of the type of school or class on science teaching identity. These themes revealed that while participants identified similar constraints to science teaching identity as teachers in other contexts, such as lack of time and resources, they also displayed a confidence and focus on their local contexts and students that supported their science teaching identities. Differences in the identity development between teachers was also seen, based on factors such as previous experience and education in science and motivations to teach. This work demonstrates how teachers in different contexts might interpret similar constraints in varied ways - and that difference could make a difference in whether their teaching identities are supported or not.

Stand-Alone Paper

Investigating the role of scientists' salient identities in navigating failure experiences

Manuela Mejia*, University of Colorado, USA

Sandhya Krishnan, University of Colorado, USA

Lisa Corwin, University of Colorado, USA

ABSTRACT

This qualitative study explores how scientists from diverse backgrounds navigate experiences of failure in academic and professional contexts, focusing on the role of their salient identities. Using a snowball sampling approach, we conducted semi-structured interviews with 25 scientists from various disciplines and identity communities. Our analysis, guided by the Phenomenological Variant of Ecological Systems Theory (PVEST) and an intersectionality lens, reveals that coping with failure is a process fundamentally shaped by a scientist's sense of self and the social structures they are embedded in.

We identify two key themes related to coping with failure: the reliance on established support systems and the development of resilience in unwelcoming STEM environments. We also found that identity plays a pivotal role in shaping support networks and serving as a “code” for interpreting the culture of science. These findings offer a novel understanding of how professionals persist in STEM. This research provides a valuable and positive counter-narrative to traditional discussions of retention and loss of talent, with clear implications for developing interventions and informing educational practices aimed at fostering resilience and persistence among undergraduate students, particularly those from underrepresented minority backgrounds.

AR/VR-Enhanced Science Learning

Strand 12: Technology for Teaching, Learning, and Research

22-Apr-26, 10:45-12:15

Location: Capitol Hill (L3)

Stand-Alone Paper

The Impact of Tangible Augmented Reality on Students' Understanding of Phosphate Runoff

Amber Meeks*, North Carolina State University, USA

M. Jones, North Carolina State University, USA

Caitlin Haedrich, North Carolina State University, USA

Kathleen Bordewieck, North Carolina State University, USA

Tanzimul Ferdous, North Carolina State University, USA

Adrian Kuhlman, North Carolina State University, USA

Toluwalase Salako, North Carolina State University, USA

Madeline Stallard, North Carolina State University, USA

ABSTRACT

This study examines the effectiveness of a tangible augmented reality tool on students' understanding of phosphate runoff compared to a traditional 2D environment. Using a mixed-methods pre-post design, 70 students from a summer engineering camp were randomly assigned to a Tangible Landscape treatment (n=34) and a 2D traditional map learning environment (n=36) to test three phosphate runoff remediation strategies (spray patterns, vegetation buffers, retention ponds) to prevent excess runoff from contaminating a stream on a model farm. To gain insight into students' perceptions of testing strategies in each environment, 45 students from the treatment (n=22) and control (n=23) groups were randomly selected for interviews. Findings indicated that students in the treatment group achieved significantly higher gain scores than the control group. Interview results showed that students identified physical touch and visualization as key affordances of the tool that aided their understanding and decision making. The findings support the use of tangible augmented reality as an effective tool for teaching about phosphate runoff.

Stand-Alone Paper

Immersive Learning Analyzed: An Eye-Tracking Study about a VR-based Physics Experiment

Matthias Klassen*, Institute for Mathematics and Physics Education, Physics Education Research Group, Leibniz University Hanover, Germany

Salome Flegr, Chair of Physics Education, TUD Dresden University of Technology, Germany

Gunnar Friege, Institute for Mathematics and Physics Education, Physics Education Research Group, Leibniz University Hanover, Germany

ABSTRACT

This study investigates how motivation and academic performance influence efficiency during an immersive VR-based physics experiment on converging lenses. 96 eighth-grade students ($M = 13.65$ years, $SD = 0.57$; 50.7 % female) participated in an inquiry-based learning task within a fully immersive virtual environment, while eye-tracking technology measured their visual attention. Additionally, students' gains of conceptual understanding were measured. Efficiency was operationalized as the number of correctly solved tasks divided by gaze transitions per minute between predefined Areas of Interest (AOIs). This measure was analyzed through multiple linear regression. The results revealed a significant correlation between academic achievement and efficiency: individuals with lower grades demonstrated markedly higher efficiency than expected. In contrast, motivation showed only a non-significant trend. Several (12.5% of total) motivated low-performing students displayed high efficiency and task success, suggesting that motivation may compensate for limited domain-specific knowledge. Consistent with this, students' conceptual understanding improved significantly from pre- to posttest. Gaze data indicated high cognitive engagement, with most visual attention directed at task-relevant areas. These findings support the Cognitive Affective Model of Immersive Learning. The study demonstrates that immersive VR environments can benefit low-performing but motivated learners and underlines the value of eye-tracking in identifying learner profiles.

Stand-Alone Paper

Exploring the Materiality of Representation in Chemistry Student Learning with Augmented Reality Molecular Models

Song Wang, California State University, Dominguez Hills, USA

Stanley Lo, University of California, San Diego, USA

Rou-Jia Sung, Carleton College, USA

Thomas Bussey, University of California, San Diego, USA

ABSTRACT

Research on learning with molecular representation in chemistry classrooms has primarily focused on students' competence in interpreting the intended meaning of the representations. This focus on competence often leads to dismissing students' experienced meanings as mistakes due to lack of competence. With a focus on representation, this study works towards a post-humanist framework for investigating student learning with

representations and focuses on the emergence of meaning within representational practices. Weaving together Marton's Variation Theory, Barad's Agential Realism, and Haraway's String Figure (SF), this study re-envision research on how representations become meaningful. Coordinating multiple theoretical constructs and onto-epistemological standpoints produces an analysis that explores the material agency of external representations as active participants in the enactment of meaning.

Stand-Alone Paper

Supporting Geoscience Multimedia Learning With an Intelligent Attention Guidance Technology

Muhammad Rehman, University of Florida, USA

Do Hyong Koh, University of Florida, USA

Priyadharshini Prasad, University of Florida, USA

Nazanin Adhami, University of Florida, USA

Chih Hsuan Lin, University of Florida, USA

Jonathan Martin, University of Florida, USA

Ellen Martin, University of Florida, USA

Kara Dawson, University of Florida, USA

Albert Ritzhaupt, University of Florida, USA

Pasha Antonenko, University of Florida, USA

ABSTRACT

This study utilized eye-tracking technology to design and test an intelligent geoscience-based multimedia learning application that adapts the presentation of learning content based on the learner's visual attention strategies. This technology examines the relationship between eye-tracking features and learning outcomes, as well as the impact of eye movement-based real-time visual object manipulation on learning outcomes. This research aims to test the feasibility of a gaze-driven adaptive multimedia learning solution based on learners' media integration strategies and the resulting visual attention patterns.

CS, CT, Robotics, & Project-Based Computing in STEM

Strand 12: Technology for Teaching, Learning, and Research

22-Apr-26, 10:45-12:15

Location: Virginia (L4)

Stand-Alone Paper

Scalable STEM Education Intelligence Extraction: From Personality Assessment to Comprehensive Professional Wellbeing Analysis

Derric Cox*, Wright State, USA

Tanvi Banerjee, Wright State, USA

William Romine, Wright State, USA

ABSTRACT

Education communities on social media provide rich discourse data revealing collective professional characteristics and discipline-specific challenges. This study extends conversation flow-based learning methodologies to extract community intelligence from STEM education forums, moving beyond personality assessment toward actionable teaching insights. Using fine-tuned transformer models on educator discourse data, we demonstrate how AI captures authentic professional communication patterns and applies structured psychological assessments to understand collective characteristics. Our approach addresses traditional survey limitations by extracting insights from natural discourse rather than explicit self-reporting. Results demonstrate the conversation flow-based approach for personality assessment, showing convergence on educator-appropriate traits aligning with effective STEM teaching characteristics. The framework enables systematic application of multiple assessment instruments, including Big Five personality evaluation, STEM educator health and wellness assessment, and critical professional challenges identification through topic modeling. This methodology transforms unstructured community discourse into quantifiable insights about STEM education stakeholders through a scalable, automated framework, providing evidence-based tools for education policy development, professional development design, and organizational support systems targeting authentic educator needs.

Stand-Alone Paper

Which Computational Thinking Skills Matter for AI-Mediated Science Learning?

Gender-Comparative PLS-SEM Study in Medical Education

Hung-Che Lin*, National Defense Medical University, Taiwan

Chin-Sheng Lin, National Defense Medical University, Taiwan

Min-Hsien Lee, National Taiwan Normal University, Taiwan

Tzung-Jin Lin, National Taiwan Normal University, Taiwan

Chia-Ching Lin, National Kaohsiung Normal University, Taiwan

Jiun-Yu Wu, Southern Methodist University, USA

Chin-Chung Tsai, National Taiwan Normal University, Taiwan

Guo-Li Chiou, National Taiwan Normal University, Taiwan

Jyh-Chong Liang, National Taiwan Normal University, Taiwan

ABSTRACT

Computational thinking (CT) is increasingly central to AI-mediated science learning, yet the role of specific CT subskills and gender-based differences remain underexplored. We modeled five CT dimensions (Abstraction, Decomposition, Algorithm, Evaluation, and Generalization) as predictors of AI actual learning among health science undergraduates in a six-year program (N = 481) at a research university in East Asia. Using PLS-SEM with path weighting and 5,000 bootstrap samples, we estimated separate structural models for the full sample, females, and males. In the full model ($R^2=.353$), Abstraction ($\beta=.294$, $p<.001$), Algorithm ($\beta=.286$, $p=.001$), and Decomposition ($\beta=.333$, $p=.007$) significantly predicted AI actual learning; Evaluation and Generalization were non-significant. For females ($R^2=.370$), Decomposition

showed a strong positive effect ($\beta=.551$, $p=.009$). At the same time, Evaluation was negatively related ($\beta=-.430$, $p=.018$), with Abstraction/Algorithm trending positive ($p<.10$). For males ($R^2=.368$), Abstraction ($\beta=.308$, $p=.001$) and Algorithm ($\beta=.306$, $p=.004$) were key, whereas Decomposition was weaker and non-significant. These findings suggest differentiated instructional strategies: scaffolded decomposition for female learners and abstraction-focused planning for males. Measurement reliability and invariance assumptions were confirmed. The study informs gender-responsive CT curriculum design in AI-integrated science learning.

Stand-Alone Paper

Exploring Student Experiences in a CS-Integrated, Project-Based Ocean Science Curriculum Using Educational Robotics

Xin Xia*, University of Virginia, USA

Jennifer Chiu, University of Virginia, USA

Kim Wilkens, University of Virginia, USA

ABSTRACT

This study investigates how elementary students engage in computational thinking and collaborative problem-solving within a four-week, project-based learning unit on ocean floor features. Using detailed classroom observation data, we examine how fourth-grade students combined block-based coding with hands-on robotics to design missions simulating how scientists explore the deep ocean. Students worked with low-cost robots and Micro:bit controllers to code sequences, test robot behaviors, and troubleshoot real-world challenges. Preliminary findings highlight how students negotiated coding tasks, collaborated with peers, and developed computational thinking to connect scientific ideas with coding concepts. By documenting these authentic interactions, this work contributes to research on integrated STEM learning and offers practical insights for designing project-based robotics experiences that foster computational thinking in elementary science classrooms and expand the Computational Thinking-PRADA Framework.

Stand-Alone Paper

From Knowledge to Practice: How Professional Learning Shapes CS Teaching in Elementary Schools

Khushbu Singh*, University of Virginia, USA

Jennifer Maeng*, University of Virginia, USA

ABSTRACT

The rapid expansion of Computer Science (CS) education has increased the demand for elementary teachers to integrate CS concepts such as algorithms, programming, and cybersecurity into their classrooms. However, many teachers lack sufficient preparation and support to do so. High quality professional learning (PL) may facilitate teachers' CS instruction. This study used a randomized control trial design to examine differences in treatment ($n = 87$) and control ($n = 83$) teachers' frequency of CS instruction and topics

taught, as well as relationships between teacher CS self-efficacy, CS content knowledge, PL participation, and frequency of CS instruction. Additionally, stepwise linear regression examined whether teacher CS self-efficacy, CS content knowledge, and program participation predicted lesson implementation after controlling for school and teacher characteristics. Results indicated that treatment teachers implemented more CS lessons and taught more lessons within each CS topic. Regression analyses indicated that teacher self-efficacy, content knowledge, and participation in PL were significant positive predictors of lesson implementation. These findings suggest PL participation, CS knowledge and CS self-efficacy may support CS integration at the elementary level. The study provides insights for curriculum developers, teacher educators, and school leaders seeking to design scalable PL programs that enhance teacher CS practices.

Beyond the Competent Outsider: Visions of Science Literacy Shaping Engagement With Science in Everyday Life

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

22-Apr-26, 10:45-12:15

Location: Seneca (L4)

Related Paper Set

Ecologies of Trust and Representation: Rethinking the “Insider” and “Outsider”

Eric Kirk*, Utah State University, USA

Daniel Pimentel*, University of Alabama, Tuscaloosa, USA

ABSTRACT

Feinstein's (2011) idea of the “competent outsider” directs the focus of science education toward helping learners interact with scientific expertise in meaningful ways. Although the intention and impact of the competent outsider framing has had an overwhelmingly positive impact on science education it is not without challenges as the “outsider” framing clashes with efforts to address equity and inclusion, and overlooks the public's role in dictating what science can be done in the United States through political means. To address these concerns, we draw upon an ecological view of the scientific enterprise and a trustee model of representation to articulate a new conceptualization of everyday engagement with science. This conceptualization frames science as a system composed of individuals who occupy different niches and whose unique roles shape the dynamics of the larger system. These roles are conceptualized as a trustee model, whereby science constituents are represented by scientists tasked with acting in ways that balance the desires of their constituents and the representative's own expertise. Based on this framing, we articulate a vision of science literacy which accounts for these the constituent-trustee relationships, and explore the potential for this framing to inform both research and practice.

Related Paper Set

Gotta Catch 'Em All: Fiction and Fandom as a Context for Becoming a Competent Outsider

Lundgren Lisa*, Utah State University, USA

Eric Kirk, Utah State University, USA

Gabriel-Philip Santos, Ramond M. Alf Museum of Paleontology, USA

Earyn McGee, Independent Researcher, USA

ABSTRACT

Preparing learners to engage with scientific expertise as competent outsider (i.e., in skillful ways to meet their personal interests) is an important mission for science educators. To date, much of the research on this topic has been framed around supporting learners' ability to leverage science for practical applications (e.g., making vaccination decisions). Drawing on scholarship on science and nerd identity, we argue that recreational spaces such as comic cons can offer valuable opportunities for developing these skills as well. We accompany this argument with examples of learners interacting with scientific expertise in contexts which deliberately blur the lines between science and fantasy such as discussions about evolution in the Pokemon universe, or exploring local biodiversity through Dungeons and Dragons-based role play. In doing so, learners are afforded an opportunity to be recognized as “science people”, and in the process engage with scientific expertise to enrich their life through personally meaningful activities as competent outsiders.

Related Paper Set

Experiential learning as a bridge between school science and real-world problems for science civic engagement

Amy Dunbar-Wallis*, University of Nebraska, USA

Jenny Dauer, University of Nebraska, USA

Christine Haney Douglass, University of Nebraska, USA

ABSTRACT

Experiential learning (EL), broadly defined as hands-on activities in real-world contexts coupled with reflection, brings the complexity of the real world into classrooms. EL builds on prior knowledge, integrates knowledge across domains, immediate implementation and use, and requires reflection of the learners' own learning processes, experiences, and information (Sawyer, 2005; Talafian 2019). EL in a multidisciplinary college-wide science literacy course brought students together with local partners to address some facet of a socioscientific issue (SSI) of concern. Students could be impacted by EL is by an increasing conception of how they can use science knowledge to support positive change in a community. We used the SCE-SC framework to gain insight into how a student thinks about applying these dimensions outside of the classroom and for a community of concern for the students (Alam et al., 2023; Teshera-Levy et al., 2025). The SCE-SC may be one of many ways to operationalize the idea of a “competent outsider” (Feinstein, et al., 2013), or science

constituent, as it expresses how a student thinks about their own agency and ability to use science to make positive change in the community.

Related Paper Set

Science Teachers as a Public for Science: Living as Insiders and Outsiders to Science
Sam Evans*, University of Wisconsin-Madison, USA

ABSTRACT

How do science teachers engage with science in daily life? This question matters because science teachers are charged with preparing members of the public for interactions with science outside of schools. Teachers' personal capacities and strategies for dealing with science in daily life could influence how they prepare students to do so. Moreover, research on public engagement with science suggests that science teachers, like other members of the public, are likely to interact with science in different ways, shaped by their identities. This complicates recent efforts to develop 'competent outsiders' in science classrooms, since 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.

Understanding how science teachers make sense of science in daily life from both in and outside the classroom will be essential to supporting efforts to develop competent outsiders. Therefore, this study aims to understand how teachers think about the utility of science in daily life as 'insiders' to science (i.e., as science teachers and scientists) and how they think about their own interactions with science in daily life as 'outsiders' (e.g., as parents, athletes, conservationists, etc.).

Place, Culture, and Community in Environmental Science Learning

Strand 14: Environmental Education and Sustainability

22-Apr-26, 10:45-12:15

Location: Jefferson B (L4)

Stand-Alone Paper

From Enjoyment to Engagement: How Place-Based Citizen Science Cultivates Pro-Environmental Dispositions in Youth

Noam Brenner*, Technion - Israel Institute of Technology, Israel

Dalit Lan*, Technion - Israel Institute of Technology, Israel

Tali Tal*, Technion - Israel Institute of Technology, Israel

ABSTRACT

This study examines how enjoyment in place-based citizen science can cultivate pro-environmental consciousness among young people. Drawing on a river restoration project in Israel involving Arab and Jewish high school students, we investigate a sequential pathway linking enjoyment, sense of place, nature-relatedness, and pro-environmental intentions. Using a mixed-methods design, comprising a post-project survey (N = 47) and interviews

with students (N = 18), we examined the relationships between these constructs. Our mediation model integrates the frameworks of Place-Based Education (PBE) and School Participation in Citizen Science (SPICES). The findings confirm that enjoyment indirectly fosters pro-environmental intentions through two key mediators: sense of place and nature-relatedness. Qualitative insights illustrate how students' emotional engagement with hands-on science, social bonding, and outdoor exploration strengthened their attachment to the river and connection to nature, ultimately leading to increased pro-environmental intentions. This research contributes to science education by positioning enjoyment not as a peripheral element but as an emotional entry point into environmental learning and civic engagement. It provides both a conceptual and pedagogical framework for designing citizen science initiatives that are grounded in the local context.

Stand-Alone Paper

Fostering Environmental Justice Consciousness Through Culturally Sustaining STEM Education in Hispanic Border Communities

Uma Ganesan*, University of Texas Rio Grande Valley, USA

Angela Chapman*, University of Texas Rio Grande Valley, USA

ABSTRACT

This empirical study examines how culturally and linguistically sustaining environmental STEM education fostered environmental justice consciousness and scientific agency among Hispanic/Latinx students in Rio Grande Valley high schools. Through qualitative case study methodology, this research explored how teachers in the Raíces y Ciencia project integrated students' cultural and linguistic resources with environmental science learning through water quality investigations. Data from conference presentations, educator surveys, and classroom artifacts were analyzed using thematic analysis, revealing three key themes: linguistic border-crossing as scientific understanding pathways, connecting family knowledge to environmental justice advocacy, and positioning students as community researchers and change agents. Findings demonstrate that validating Hispanic students' bilingual practices, systematically integrating family environmental knowledge, and positioning students as environmental researchers simultaneously enhanced scientific learning and environmental justice awareness. The study extends culturally sustaining pedagogy and translanguaging theory into environmental education contexts while contributing to critical environmental justice frameworks. Results show how environmental education can be reimagined to challenge deficit-based approaches, leverage cultural and linguistic assets, and prepare students for both STEM careers and environmental advocacy. This research demonstrates how environmental education can serve as a pathway to both scientific understanding and social justice advocacy in culturally diverse borderland communities.

Stand-Alone Paper

Connecting Science Learning to Local Contexts: Outcomes from a Multi-Phase, Teacher–Scientist Curriculum Project

Susan Gomez Zwiep*, BSCS Science Learning, USA

Jill Grace*, WestED, USA

Katy Nilsen*, WestED, USA

Aaron Soo Ping Chow, WestED, USA

Ashley Ivelan, WestED, USA

ABSTRACT

High-quality science instruction can improve student outcomes and narrow achievement gaps, yet access remains uneven, especially for historically underrepresented groups. This study examines a multi-year, multi-agency project that developed and tested NGSS-aligned, place-based science units focused on local biodiversity in a large urban California district. Teacher–scientist cadres co-designed problem-based learning sequences that connected core science concepts to students' communities. Units were iteratively field-tested, revised, and expanded through professional learning sessions, supporting both teacher capacity and student engagement.

Data were collected from 385 middle school students across seven schools via pre- and post-surveys measuring perceptions of classroom relevance, community connections, and participation in inquiry. Findings show that students reported increased relevance of science learning to their communities, stronger classroom and school connections, and greater participation in developing investigation questions. While understanding of specific environmental fairness concepts showed limited change, students' awareness of local environmental issues and their role in addressing them increased.

These results suggest that collaborative, place-based curriculum development, combined with sustained professional learning, can enhance student engagement, agency, and perceived relevance of science. The study provides a replicable model for integrating local context into NGSS-aligned instruction and offers evidence-based strategies for connecting classroom learning to students' lived experiences.

Meet the Market: Cultural Connections at Pike Place with the International Committee

22nd Apr 26, 13:00-15:00

Location: Offsite

Social Event

Organizers

Sahar Alameh, University of Kentucky, Lexington, Kentucky, USA

Christelle Fayad, Texas Christian University, Fort Worth, Texas, USA

Abstract

The international Committee at NARST is planning a social event for its members and other NARST conference attendees to connect, socialize and explore the city of Seattle together. The committee wants to organize a cultural guided tour (Meet the Market: Food and Fun Tour) at Pike Place Market. It's a 2-hour guided experience that showcases the cultural and culinary diversity of Seattle through one of its most iconic locations. This activity is a lively and interactive alternative to a traditional sit-down dinner, giving attendees the chance to connect socially all while exploring what Seattle has to offer.

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