Pre-Conference Workshop: Equity and Ethics Committee (Free – 90 participants max)

Toward Equity & Justice: Scientific Literacy as a Human Right

8:00am – 11:45am, Baltimore Salon A

Organizers:

Enrique Lopez, University of Colorado, Boulder Senetta Bancroft, Grand Valley State University Miri Barak, Israel Institute of Technology Phillip Boda, Teachers College, Columbia University Tam'ra-Kay Francis, University of Tennessee, Knoxville Nam-Hwa Kang, Korea National University of Education Deniz Saribas, Marmara University, Institute of Educational Sciences Jerome Shaw, University of California, Santa Cruz Ibrahim Yeter, Texas Tech University *ABSTRACT:*

With the population that science education is met with continually diversifying, the need to explore new research methods and theories based on these modes of difference is pertinent in moving forward with the civic-minded initiatives supporting 'Scientific Literacy for All.' The Equity and Ethics Committee sponsors this annual pre-conference workshop catered toward scholars from minoritized backgrounds that have traditionally not been well represented within science education research and practice, as well as individuals interested in equity and social justice.

This year participants will engage deeply and constructively with the call for science education to be seen as a civic-minded process and confront the need for scientific literacy as a human rights initiative. Discussions by leading scholars will expound both the benefits and limitations of scientific literacy as articulated in the literature as of yet. Workshop participants will engage in roundtable and panel discussions facilitated by eminent scholars with varied research interests in science education. Sharing their experiences of scientific literacy, human rights, and their impact on research, practice, and policies within equity and social justice initiatives, participants will immerse themselves in the theme of this year's NARST conference advocating a reflection on what constitutes *quality* science teaching and learning and for whom does it benefit the most.

Pre-Conference Workshop: Research Committee Student Membership and Non-collegiate Educator Membership Free All other member categories \$25 40 participants max Supporting the Success of Latin@ Scholars in Science Education 8:00am – 11:45am, Maryland Ballroom F Presenters: Alejandro Gallard, Georgia Southern University Alberto Rodriguez, Purdue University Alberto Rodriguez, Purdue University Katemari Rosa, Federal University of Campina Grande María Araceli Ruiz Primo, University of Colorado Denver Regina Suriel, Valdosta State University Ingrid Sánchez Tapia, UNICEF Latin America and Caribbean ABSTRACT:

This workshop aims to be a space for Latin@ doctoral students and early career scholars to receive advice on mentorship, publication, and funding from other Latin@s who are successfully established in the science education research community. The session is designed for new scholars to establish supportive relationships

with knowledgeable mentors and with each other, thus increasing their repertoire of strategies for successfully navigating academia. The workshop will be combine panel sessions when participants can ask questions to senior and emerging scholars, with small group discussion where participants will share their experiences in greater depth and receive more specific advice. The discussions will focus on three areas: 1) Advice to get the mentoring you want and becoming an effective mentor, 2) Obtaining funding for research in science education with Latin@ communities, and 3) Writing and publishing about our research with Latin@ students. Small group discussions will be conducted in the preferred language of the participants (Spanish, Portuguese, English, or any combination of them). Overall, the workshop aim to provide all participants with positive and constructive mentoring experiences, since having access to veteran and supportive mentors is a key aspect for Latin@ doctoral students and early career scholars to feel empowered to succeed in their roles as researchers and science teacher educators.

Pre-Conference Workshop: Research Committee (Free – 40 participants max)

Videocase-based, Analysis-of-Practice for Teacher and Student Learning: How To's from a 10-year Line of Research

8:00am – 11:45am, Maryland Ballroom B

Presenters:

Jody Bintz, BSCS Chris Wilson, BSCS Kathy Roth, California State Polytechnic University Molly Stuhlsatz, BSCS Connie Hvidsten, BSCS Betty Stennett, BSCS

ABSTRACT:

This interactive workshop will develop participants' expertise in designing, implementing,

studying and taking to scale a video-based, analysis-of-practice experiences to support the kinds of teacher learning needed to reach the vision of the Next Generation Science Standards. This "how to" session will draw from an extensive BSCS line of research and development that examines impact of videocase-based, analysisof-practice PD on student learning in various contexts: elementary and high school settings; face-to-face, online, and blended settings; and

district-focused implementation vs. cross-district. Results from this 10-year line of research show significant impact on student learning, teacher content learning, teacher PCK, and teacher practice. Participants will engage in two key components of the videocase-based, analysis-of- practice PD approach: (1) video analysis of classroom science teaching and learning through the lens of a research-based Conceptual Framework that focuses on a small set of carefully selected teaching strategies, and (2) video analysis of a teacher study group that is engaged in analysis-of- practice under the guidance of a PD leader. Before and after engaging in these activities, participants will examine key design aspects of professional development, materials development, and research in the context of taking this program to scale.

Pre-Conference Workshop: Research Committee (Free – 40 participants max) *Science and Art-Research for Creativity and Inclusion*

8:00am – 11:45am, Maryland Ballroom A **Presenters:** Nathan Carnes, University of South Carolina Eddie Goldstein Emily Hestness, University of Maryland Phyllis Katz, University of Maryland HollyWalter Kerby, Fusion Science Theater J. Randy McGinnis, University of Maryland Lucinda Presley, Innovation Collaborative Robert Root-Bernstein, Michigan State University Harvey Seifter, Seifter Associates

ABSTRACT:

Creativity is essential for problem-solving and is an inherent human characteristic. Creativity also connects science and art, expressed through varied cultures. This connection can open doors to inclusiveness and empowerment in STEM. Arts-based methodology invites those for whom science seems daunting and thus yields a greater inclusiveness which can lead to greater equity. In developing theory, designing experiments, and considering explanations, STEM requires creativity to generate new insights for innovation and often a willingness to take the lead. This workshop enriches the verbal/literary communication skills of NARST participants by focusing on the critical thinking skills developed by kinetic communication in science education through the arts. It will expose participants to new research theories, methodologies and strategies through participation and discussion in this cutting edge research. Both formal and informal educators present their contexts and their research in music, visual art, drama, and engineering. From utilizing drawings as data through music, performance and craft, the presenters will engage participants in the physical acts of creativity that they are researching within science education, allowing for experiential discussion with more depth than a paper session. The workshop will aim to generate additional research questions and potential partnerships among participants. Participants will take away new collegial acquaintances, full project descriptions, research papers, CD, DVDs (where appropriate), as well as their workshop-generated ideas for research.

Pre-Conference Workshop: Research Committee (\$25 fee – 30 participants max)

Building an Equity-Focused Knowledge Base for NGSS by Fostering Partnerships between Research Practice

8:00am – 11:45am, Kent **Presenters:** Philip Bell, University of Washington Bill Penuel, University of Colorado Boulder Peter McLaren, Achieve Dan Gallagher, Seattle Public Schools Tammy Clegg, University of Maryland, College Park June Ahn, University of Maryland, College Park *ABSTRACT:*

This workshop, co-facilitated by science education researchers, a practitioner focused on broadscale implementation of NGSS, and a district science coordinator will provide guidance to researchers and practitioners about how to develop joint projects to fill gaps in knowledge and resources needed to implement the Next Generation Science Standards successfully from an educational equity perspective. The workshop will provide participants with concrete strategies for: (1) identifying persistent problems of practice from both practitioners' and stakeholders' perspectives, (2) developing a collaborative design process for implementation resources that leverages the expertise of practitioners, researchers, subject matter experts in science, and other stakeholders, and (3) formulating design goals that foreground supports for implementation, equity, and diversity.

Pre-Conference Workshop: Publications Advisory Committee and NSTA Research Committee (Free – 60 participants max)

Publishing for Practitioner Audiences – Disseminating Your Research to Create Broader Impacts 10:00am – 11:45am, Baltimore Salon B

Presenters:

Phillip Bell, University of Washington Bill Penuel, University of Colorado Boulder Deborah L. Hanuscin, University of Missouri John Tillotson, Syracuse University

ABSTRACT:

Researchers are under pressure both to publish as well as to create broader impacts—this hands-on workshop will focus on identifying productive ways to meet those goals through a variety of publication venues and genres that offer opportunities for researchers to speak to practitioner audience in ways that can influence classroom practice. Attendees are encouraged to bring a laptop and identify a piece of published research that they can use to develop a practitioner-friendly research brief, podcast, or other product during the workshop.

Pre-Conference Workshop: International Committee (Free – 60 participants max)

How to Conduct Cross-culture Science Education Research

10:00am – 11:45am, Maryland Ballroom E

Organizers:

Hsiao-Lin Tuan, National Changhua University of Education Binaben Vanmali, Arizona State University May May Hung Cheng, The Hong Kong Institute of Education **Presenters:** Norman G. Lederman, Illionis Institute of Technology Judith Lederman, Illionis Institute of Technology Katrin Englen, Leibniz Institute for Science and Mathematics Education Mariona Espinet, Autonomous University of Barcelona Hye-Eun Chu, Macquarie University Sonya Martin, Seoul National University David Treagust, Curtin University Jennifer Park, Seoul National University Wanjoo Ahn, Seoul National University Dayeon Kang, Seoul National University *ABSTRACT:*

In the past decade, more and more international science educators shared similar interests in students' science learning and teachers' science teaching. Thus, how to conduct cross-culture or international science education research became important issue. The purpose of this preconference workshop is to present various kinds of cross-culture studies conducted by research teams from Europe, Asia and US. Norm Lederman and Judith Lederman will introduce an ongoing international study to recruit science educators from 12 countries to investigate seventh grade students' understandings of scientific inquiry. Katrin Englen will introduce a European project, Mascil, and teachers' perceptions of math and science inquiry-based teaching from 13 European countries. They want to uncover the political context for implementing inquiry-based learning and factors influenced teacher's teaching practice in different societies. Mariona Espinet will introduce how to use a complex and dynamic case study inquiry methodology in her cross-countries projects of CoDeS (School Community Collaboration for Sustainable Development).Hye-Eun Chu and her team members will introduce two cross-culture collaborative studies on students' conceptual change and classroom interaction. Finally these

presenters will discuss the benefit, challenge and solutions they faced while conducting cross-culture science education research.

Concurrent Session #1 2:40pm – 4:10pm

Research Committee

Administrative Sponsored Symposium - The Role of Peer Review and Critique in Strengthening Science Education

2:40pm - 4:10pm, Maryland Salon F

Presenters:

Irene Neumann, Leibniz-Institute for Science and Mathematics Education (IPN) John Settlage, University of Connecticut Matthew Benus, Indiana University Northwest Felicia Moore Mensah, Teachers College, Columbia University Julia V. Clark, National Science Foundation David F. Treagust, Curtin University Jomo W. Mutegi, Indiana University *ABSTRACT:*

This Research Committee sponsored session is aimed at initiating a discussion within the NARST community about (a) the importance of peer review and critique to the advancement of our discipline, (b) the various forms that peer review takes, and (c) the hallmarks of professionalism in giving and receiving peer review. The session discussion will center around the various spaces where peer review is enacted (including: conference proposals, discussions during and after conference sessions, guidance of doctoral students' work, review of submitted journal articles, critique of published articles, literature reviews, review of grant proposals, review of initial hires, and review of promotion and tenure dossiers). Given the many professional spaces where our work is reviewed, and given the impact that peer review has on our professional lives, the panelists and audience will address: consequences, codes of conduct, and cultural differences associated with providing and receiving peer review and critique. The session will also explore strategies for using critique to cultivate professional growth.

Strand 1: Science Learning, Understanding and Conceptual Change

Developing an Understanding through Models and Modeling

2:40pm - 4:10pm, Watertable Salon C **Presider:** Christopher Wilson, BSCS

Middle School Students' Modeling of Projectile Motion Nam-Hwa Kang, Korea National University of Education Heesook Jeong, Korea National University of Education ABSTRACT:

The purpose of this study was to examine the degree to which students learn modeling and the nature of models students develop on a topic in Newtonian motion. Special attention was paid to specific features of models due to the nature of the topic. A total of 37 8th grade students from two afterschool classes participated in the study. The study involved three lessons that consisted of introduction to scientific modeling, modeling of projectile motion, and revision of models. The modeling task was about throwing a dart. It was initially completed individually in writing. After completing the activity, students shared each others' models in groups and then with the whole class. During the time, students had opportunities to revise their models. The findings showed

that the students developed an understanding about models and modeling in the areas of their practice during the task as much as those reported in the literature. In terms of the nature of models that students developed, three types were categorized: phenomenological model, qualitative relational model, and quantitative relational model. The more sophisticated models demonstrated features of models in physics that indicated the need for domain-specific research on student learning of models.

Relating Evidence and Models in Genetics: Students' Argumentation Strategies

Veronica L. Cavera, Rutgers University Rozaliya Seryapov, Rutgers University Kira J. Belkin, Rutgers University Ravit Golan Duncan, Rutgers University Clark A. Chinn, Rutgers University

ABSTRACT:

The Framework for K-12 Science Education and the NGSS emphasize a view of science as knowledge-building endeavor. Scientific knowledge (theories and models) is developed in the context of a community of practice with shared norms about what counts as valid and reliable evidence, claims, and arguments. Evidence, and reasoning about evidence, is at the core of this process and plays a major role in the generation and evaluation of competing models. Research suggests that student struggle to reason with and about evidence. Students commonly do not address counter evidence, they rarely entertain more than one plausible explanation or offer rebuttals of such. We report on our analyses of written arguments from high school biology students who were asked to evaluate and select one of two competing models about a genetic disorder using six provided evidence pieces. We found that overall the majority of the students selected the correct model, and over half used between two-four pieces of evidence, and only 9% did not use any evidence. Moreover, we characterize four persuasive strategies that students employed in their arguments. Two of these specifically focused on refuting the competing model either by finding flaws with it or through rebuttal with evidence.

Synthesis Modeling as a Way of Learning through Model Revision

Daniel K. Capps, University of Georgia Jonathan T. Shemwell, University of Maine Edward Lindsey, Old Town High School Lisa Gagnon, Old Town High School Jeffrey Owen, Orono High School **ABSTRACT:**

Due to their explanatory and predictive powers, models are essential to the production of scientific knowledge. An important question for science education is how to support students in revising models to be more general and informative. Drawing on literature about learning through contrasting cases, we present a novel approach to model revision called synthesis. In synthesis, learners compare two or more different component models with distinct surface features, but similar underlying structure, to produce a single, more general model. We show the synthesis process and its effectiveness for learning in the context of high school earth science classrooms. We use audio-recordings to illustrate what synthesis modeling looks like and how students engaged in synthesis grapple with the idea that models are deliberate representations, distinct from the phenomena they represent. We also provide quantitative evidence showing that students engaged in synthesis tend to: (1) construct effective general models of a phenomenon, (2) learn how to construct general models, and (3) understand that general models should apply to multiple situations. These findings suggest that synthesis is a useful new strategy for supporting students in revising models toward greater generalization.

Strand 2: Science Learning: Contexts, Characteristics and Interactions Affective and Emotional Engagement in STEM 2:40pm - 4:10pm, Baltimore Salon A

Presider: Tonjua B. Freeman, University of Central Florida

There's this Appreciation of Just Wondering": The Role of Meta-Affective Learning in Science Jennifer A. Radoff, Tufts University Lama Jaber, Florida State University ABSTRACT:

In this paper, we present the case of a freshman student, Marya, to illustrate the substantive role of affect in her learning experiences within a reformed introductory physics course. Marya described how, through this course, she shifted from being intimidated by physics to feeling excited about and empowered to do physics. We claim that at the heart of Marya's transformation is a shift in her attitudes and dispositions with respect to struggle, confusion, and uncertainty in the doing of science. We see this shift as an example of meta-affective learning—i.e., the development of productive feelings and dispositions for navigating intellectual challenges. Marya described how she came to see physics as a pursuit of understanding rather than about getting the right answer. Correspondingly, she shifted from feeling anxious about "being wrong" to taking pleasure in exploring ideas and making discoveries. By the end of the semester, physics became "too tempting" to leave behind, so she considered pursuing a physics minor in addition to her environmental engineering major. Marya's transformation invites us to attend carefully to the role of meta-affect in science, and to foster students' productive dispositions with respect to struggle, confusion, and uncertainty as an important target in science education.

Science with a Smile: Humor as Antidote to Perceived Difficult Science Concepts in Nigerian Schools Peter A. Okebukola, Lagos State University Olatunde Lawal Owolabi, Lagos State University Sunday Banjoko, Lagos State University Khadijat Ige, Lagos State University Temitope Anuoluwapo Michael Ahove, Lagos State University Foluso Okebukola, Lagos State University Hakeem Akintoye, Lagos State University Grace O. Oshun, Lagos State University *ABSTRACT:*

In the quest for a more potent tool for improving achievement and attitude of students to perceived difficult concepts in science, this study investigated the impact of humor and amiable science using 253 Nigerian senior secondary students in experimental and control classes. Results of the MANCOVA applied on the achievement and attitude data of boys and girls in the sample showed significant Wilks' lambda (F=10.24; p<.05). On the achievement measure, experimental and control groups were significantly different (mean score for experimental= 21.3; control=18.5; F=23.05; p<.001). Similar trend was found for the attitude scores (mean score for experimental= 32.1; control=24.6; F=18.06; p<.001). No significant main effect was found for gender on both achievement and attitude. Interaction between group and gender also failed to attain significance on attitude (F=0.76; p>.05). Qualitative data from field notes and videotaped class transactions showed the positive effect of the combination of non-distractive, content-specific humor and amiable science on lowering tension in class, elevate class participation and promote students' enthusiasm to learn science. Implications of the findings for science teacher preparation and further research are drawn including a call for further testing of the combination therapy of amiable science plus humor.

Secondary School Science Teachers' Ideas About Emotions in their Science Classrooms Elizabeth Hufnagel, University of Pittsburgh ABSTRACT:

As part of a larger study on high school students' cognitive, emotional, and behavioral engagement in STEM, this study details the themes that emerged from in-depth interviews with six secondary science teachers about emotions in their classrooms. Drawing from emotion theories from psychology and the sociology of emotions, teachers' ideas of emotions were analyzed using open, iterative coding (Strauss & Corbin, 1990). Four themes within and across transcripts of the interviews were identified: 1) students' emotions as "achievement" emotions (Pekrun, 2006), 2) a disconnect between emotions in the classroom and emotions in science 3) an ambiguous relationship between emotions and action, and 4) more attention to negative than positive emotions in their teaching. These themes and the implications of these findings on teacher education are discussed.

Students' Engagement in Different Steps of the Engineering Design Process in a Design-Based Biology Activity Miancheng Guo, University of Massachusetts Amherst

Martina Nieswandt, University of Massachusetts, Amherst

Elizabeth H. McEneaney, University of Massachusetts, Amherst

ABSTRACT:

This study explored whether gender grouping (all-female groups vs. mixed-gender groups) affected female students' engagement (behavioral, emotional and cognitive) in design-based science small group work in high school biology. Our preliminary data analysis showed that girls' emotional and cognitive engagement was closely related to two factors: the gender composition of their group and the step of the engineering design process (minds-on vs. hands-on steps). Their behavioral engagement was not obviously linked to group gender composition or the specific design step, but seemed to be more influenced by how their peers (regardless of their genders) responded to them and their common performance goal. This study provides a "microscopic" perspective for teachers to observe and understand female and male students' interactions and engagement in small group work in design-based science activities, based on which they can provide support and/or interventions accordingly. Also, this study shows how researchers can adopt a temporal perspective for analyzing students' design process.

Strand 3: Science Teaching--Primary School (Grades preK-6): Characteristics and Strategies Related Paper Set - Exploring Epistemic Practices of Engineering in Elementary Classrooms 2:40pm - 4:10pm, Baltimore Salon B

ABSTRACT:

A Framework for K-12 Science Education (NRC, 2012) and Next Generation Science Standards (NGSS Lead States, 2013) call for the inclusion of engineering in science classes. The new focus on integrating engineering into disciplinary core ideas, crosscutting concepts, and scientific and engineering practices invites an examination of how such integration can occur in elementary classrooms. This session focuses on how to engage students in epistemic practices of engineering across multiple contexts of elementary engineering education. Each study identifies some unique features of epistemic practice in engineering and how engagement in such practices often entails core disciplinary ideas and crosscutting concepts. The topics studied include the articulation of a set of epistemic practices of engineering, the value of failure and students' perceptions of it, students' responses to supports designed to help them meet the language and literacy demands of collaborative planning during engineering design, students' reasoning and justification as they engage in engineering design, and the interactions of agentic narratives, moral reasoning, and social responsibility during engineering design.

Epistemic Practices of Engineering Christine M. Cunningham, Museum of Science, Boston Gregory J. Kelly, Penn State University

Fifth Graders' Perceptions About Failure and Mindsets Before and After Learning to Engineer Pamela S. Lottero-Perdue, Towson University

Exploring Ways to Help Urban Elementary Students Meet the Language and Literacy Demands of Collaborative Engineering Design Kristen B. Wendell, Tufts University Christopher G. Wright, University of Tennessee, Knoxville Patricia Paugh, University of Massachusetts, Boston

Elementary Students' Use of Reasoning, Evidence, and Justification During Engineering Design Cathy P. Lachapelle, Museum of Science Christine M. Cunningham, Museum of Science, Boston Gregory J. Kelly, Penn State University:

Agentic Narratives, Moral Reasoning, and Social Responsibility in Elementary Engineering Heidi B. Carlone, University of North Carolina at Greensboro Tess Hegedus, High Point University Megan R. Lancaster, University of North Carolina at Greensboro Jennifer Mangrum, University of North Carolina at Greensboro:

Strand 4: Science Teaching--Middle and High School (Grades 5-12): Characteristics and Strategies *Increasing Learning Opportunities in Curriculum, Assessments and Instruction* 2:40pm - 4:10pm, Homeland

Presider: Edward G. Lyon, Sonoma State University

"It's Happening Now" - Middle School Students' Thinking About Climate Change J. R. McGinnis, University of Maryland Wayne Breslyn, University of Maryland Emily Hestness, University of Maryland ABSTRACT:

In this study we present research on 6th grade middle school students' understandings and perspectives on climate change. Using a complementary methodology at one middle school, we elicited climate change content knowledge using a 16 item assessment instrument (N=31), as well as participant interviews (n=14) before and after instruction. We engaged a separate, purposefully selected group of students (n=15) in individual interviews to gain insight into students' sources of information on climate change (in and out of school), pre-instruction perspectives on climate change, and ideas about how climate change related to their own lives and communities. Our conclusions add to theoretical constructs examining student understanding of climate change. In this way, our study contributes a model for acknowledging and analyzing the potential ways in which learners' diverse contexts may contribute to shaping their thinking about climate change. Findings add new knowledge of learners' thinking about climate change that can be used to inform curriculum, instruction and assessment in climate change education.

Are Textbooks Promoting Scientific Inquiry and Nature of Scientific Inquiry? – the German Situation Christian G. Strippel, Ruhr-University Bochum Lutz Tomala, Ruhr-University Bochum Katrin Sommer, Ruhr-University Bochum

ABSTRACT:

Being able to conduct inquiries and having knowledge about inquiry is strongly demanded in science education in Germany as in other countries. Textbook analyses from the United States have shown that scientific inquiry and scientific methods are not sufficiently represented in US textbooks (Abd-El-Khalick, Waters, & Le, 2008; Chinn & Malhotra, 2002). This study assesses the level and extent to which scientific inquiry (SI) and nature of scientific inquiry (NOSI) are represented in German science textbooks. Ten German science textbooks (biology, chemistry, physics, integrated science) are examined. Qualitative content analysis is used for analysis (Mayring, 2014). Codes for classifying SI and NOSI levels of the content are developed based on the literature (Chinn & Malhotra, 2002; Lederman et al., 2014; Osborne, Collins, Ratcliffe, Millar, & Duschl, 2003; Wellnitz, Fischer, Kauertz, Neumann, & Pant, 2012). Textbooks are grouped using cluster analysis. Results show generally low levels of SI and NOSI than most books. Overall, textbooks do not seem to represent the normative drive for SI and NOSI education. The challenge to introduce SI and NOSI remains largely to be carried by teachers.

Science Education for Learners in Different Academic Streams: Physics Teachers Beliefs and Practices in Singapore

Yuen Sze Michelle Tan, University of British Columbia

Imelda S. Caleon, National Institute of Education, Nanyang Technological University

ABSTRACT:

This study investigated the effects of teacher beliefs and teaching practices on science learning opportunities for students placed in different academic streams. We interviewed twelve Grade 10 in-service Physics teachers (18 hours) and observed their teaching of the topic of electricity (86 lessons) in Singapore classrooms. Four teachers were observed teaching students who scored lower than their cohort in Grade 6 national examinations, and are often labeled as 'low achieving'; the rest were observed teaching students of relatively higher achievement scores. Through thematic analysis, we examined the influence of the national curriculum and differences in the design of the national science practical examinations for different science streams on the teachers' beliefs and teaching practices. The findings reveal a complex irony between the purposes of the differentiated national curricula and assessment formats to cater to the needs for all students, and how these structures have predisposed teachers to various ways of thinking about and enacting teaching that may prematurely close down student learning opportunities. The findings also suggest the teachers' 'implicit resistance' towards the adverse effects of labeling their students, as manifested in their perceptions of ideal student learning despite constraints faced. Implications for promoting an inclusive Science Education are discussed.

Supporting Teachers in Using Three-Dimensional Learning to Foster Academic Success for All Students Jane J. Lee, Michigan State University

Angela D. Kolonich, Michigan State University

Kristin Mayer, Michigan State University

Joseph S. Krajcik, Michigan State University

ABSTRACT:

In this study, we examine how curriculum and instruction aligns with three-dimensional (3D) learning as outlined in the Next Generation Science Standards (NGSS) and how instructors implement curriculum in ways

that help promote academic success for all students. We developed and tested a 3D science curriculum to support students in developing an understanding of electrical interactions at microscopic scales as a foundation for explaining and making predictions about key phenomena at macroscopic scales. Cases were analyzed to examine if and how the materials were used to foster 3D learning. Instructional materials and video-recorded lessons were examined using The Equal Access to Language and Science (EquALS) rubric to determine if the curriculum materials and teacher enactment align to 3D learning. The results indicate that materials can be developed that supports students in 3D learning, provides context that engages students, supports student discourse, and promotes student thinking and reflection. To create supportive environments for all students to engage in 3D learning, it is important to build cohesion between instructional material and teaching. The curriculum and teacher enactment promote equitable learning opportunities for all students when there are specific prompts the teacher can use to give students ownership of their learning.

Identifying a Trajectory for In-service Science Teacher Implementation of Model-Based Teaching Christopher A. Bogiages, Knowles Science Teaching Foundation Christine R. Lotter, University of South Carolina

ABSTRACT:

Model-based teaching is a challenging but effective pedagogical approach to teaching science. A review of the literature on effective model-based teaching identified three important factors that contribute to a teacher's ability to implement model-based teaching; knowledge of scientific modeling, knowledge of the Nature of Science, and the skilled use of teacher questioning that focuses on student ideas. This study investigates how and to what extent these three factors impact in-service teachers' first attempts to implement model-based teaching. Findings of this mixed method, multiple case study indicate that teacher questioning is a central skill that plays a critical role in the success of model-based teachers. Findings also indicate a possible common trajectory teachers follow when beginning to implement model-based teaching in their classroom. Implications for professional development focused on model-based teaching are described.

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

Advancing Understanding Through Varied Pedagogy

2:40pm - 4:10pm, Maryland Salon E **Presider:** Carina M. Rebello, Purdue University

Comparing the Effect of Visual Cues and Video Solutions on Conceptual Problem Solving in College Physics Tianlong Zu, Purdue University Elise Agra, Kansas State University John Hutson, Kansas State University Lester Loschky, Kansas State University N. Sanjay Rebello, Purdue University

ABSTRACT:

College students' difficulties in solving physics problems have been widely studied. Most students have difficulty in solving physics problems even after learning using worked examples. We investigated the effect of visual cues, video solutions and their combination on students' performance on near and far transfer tasks. N=39 students in an algebra-based physics class participated in an interview containing two sets of tasks each with one initial task, a training session, and a near and far transfer task. For the training, students either watched one video, two videos, and/or received visual cues depending on the condition to which they were assigned. We compare students' reasoning patterns and correctness in the three conditions. We found that groups that viewed the video solutions outperformed the group that only received visual cues on the near transfer tasks, but that there was no difference between the conditions on the far transfer task.

Alleles: Limiting Factors in Mechanistic Explanations of Evolution

Steve Bennett, Michigan State University

Amelia Wenk Gotwals, Michigan State University

Tammy Long, Michigan State University

ABSTRACT:

Secondary and post-secondary students' struggles with mechanistic explanations of evolution are well documented. Model-based instruction is one technique for helping students learn the complex process of evolution. We observed three cooperative groups of students throughout a semester-long introductory biology course for science majors to track their progress in understanding evolution. Instruction emphasized the role of alleles in evolution and modeling the process of evolution using box and arrow plots. Students demonstrated a basic understanding of alleles, but struggled to integrate mutations, proteins, phenotypes and population characteristics into their understanding of alleles. Clicker responses and written explanations showed little student understanding of alleles as elements of evolution, while students' models contained more elements of evolution and showed much greater improvement throughout the course. Identifying the molecular, cellular and organismal elements of evolution. Coordinating the elements of evolution lends itself to modeling, because by using a model, students can see how and where the different micro-scale elements contribute to a macro-scale outcome. Some modeling activities are more effective than others at generating deep understanding. This research can inform model-based instruction by grounding it in coordination class theory.

Should GMOs Be Labeled? A Comparison of Students' and Experts' Ideas

Shannon Burcks, University of Missouri

Marcelle Siegel, University of Missouri-Columbia

Michelle Leigh Klosterman, University of Missouri

Christopher D. Murakami, University of Missouri-Columbia

ABSTRACT:

In this study we compare students' and experts' ideas on labeling Genetically Modified Organisms (GMO) to learn what students consider when formulating their stance on GMO labeling, and how that relates to expert thinking. In our study experts in four areas described their stance and related views regarding labeling GMOs. Then students in an undergraduate non-science major's course participated in a Socio-Scientific Issues (SSI) unit with a focus on the science and societal implications of GMO corn. We use SSI and Media literacy (ML) theoretical frameworks (Zeidler, Sadler, Simmons and Howes, 2005; Sadler, 2009) to address the research question: How do experts' and undergraduate non-science major students' reasons regarding GMO labeling compare after students participate in a SSI activity? Our findings are organized using the emergent expert conceptual framework: Choice, Impact, and Responsibility. Alignment of students' and experts' ideas revealed a variety of stances on GMO labeling that can inform learning goals.

The Effects of Scientific Argumentation on the 11Th Grade Students' Critical Thinking Skills

Nejla G. ltepe, Dr., Dumlap University, Turkey

Ziya KlÁ, Prof.Dr., Gazi University, Turkey

ABSTRACT:

This study aimed at observing the effects of scientific argument centered teaching method, on the critical thinking development of students, comparing it with those of traditional approach in chemistry classes. The study lasted for 28 weeks with 11th grade students in two groups. In the experimental group, argumentation-centered instruction activities, which were based on Toulmin's argument model, were conducted. Data were obtained through written and oral argument activities and Watson Glaser Critical Thinking Skill Scale applied as pretest and posttest. The exam was assessed through repeated t-test and MANCOVA. With regard to the

results, critical thinking skills of experimental group students made progress but there was not a statistically significant difference between the scores of pre and post tests of control group students in relation with critical thinking sub-skills, except inference. According to the results of MANCOVA, there was a statistically significant difference with regard to the five dependent variables, except for deduction and interpretation skills, between control and experimental groups.

Strand 7: Pre-service Science Teacher Education

Preservice Teachers Learning About Science: Subject Matter Knowledge, Socioscientific Issues, NOS, and Science Skills (Argumentation, Reasoning)

2:40pm - 4:10pm, Kent

Presider: Brian J. Plankis, Indiana University Purdue University Indianapolis

Assessing Pre-Service Teachers' Mathematics and Science Content Knowledge, Perceptions of Self-Efficacy and NOS Conceptions

Tonya D. Jeffery, Texas A&M University - Corpus Christi Cherie McCollough, Texas A&M University-Corpus Christi, Life Sciences Kim Moore, Texas A&M University-Corpus Christi, Mathematics *ABSTRACT:*

This mixed-methods study investigates elementary and secondary pre-service teachers' (PSTs) (n=38) mathematics and science content knowledge, self-efficacy in teaching mathematics and science, and conceptions of nature of science (NOS) following the first two years implementation of a STEM site-based professional development program in an urban school district. Pre- and post-test data from math and science content exams assessed changes in content knowledge. Pre- and post-test scores from the MTEBI (Enochs, Smith, & Huinker, 2000) and STEBI (Riggs & Enochs, 1990) were analyzed to assess PSTs self-efficacy in teaching math and science. The VNOS-C (Lederman, Abd-el-Khalick, Bell, & Schwartz, 2002) instrument provided data regarding participants' perceptions of NOS before and after the intervention. Findings in this study may offer insight regarding fostering and developing PSTs content knowledge, self-efficacy, and

understanding of NOS in teacher preparation programs.

Perceptions of Students in Teaching Credential Program on Socio-Scientific Issues

Yilmaz Kara, Karadeniz Technical University

ABSTRACT:

Perceptions of Students in Teaching Credential Program on Socio-Scientific Issues The purpose of study was to examine the perceptions of students for teaching credential program on SSI, adaptation SSI into the science curriculum, and teaching about such issues in their classrooms. Twenty three teaching credential program students were studied over the course of one semester. Participants completed a questionnaire including openended questions exploring perceptions of students and experiences with SSI addressing such issues instructionally in the classrooms. Responses to the open ended items were read, coded, and analyzed for themes and categories. Participants had low personal science teaching efficacy beliefs related to teaching about SSI. They perceived the lack of instructional time and the unavailability of relevant materials as the primary obstacles that hindered the teaching of SSI. Implications for science teacher education and the design of curriculum materials in respect to SSI are discussed. As a consequence, curricular goals and priorities have to be changed according to the sort of skills and understandings associated with teaching about SSI. In the same vein, science educators and scientists have to aim not only at producing more scientists but at helping all citizens develop functional forms of scientific literacy for science education. Pre-Service Science Teachers' Epistemological Beliefs, Knowledge Level and Trustworthiness on Information Sources Regarding Socioscientific Issues

Asli Saylan, Erciyes University

Ozgul Yilmaz-Tuzun, Middle East Technical University

ABSTRACT:

The aims of this study are to investigate how pre-service science teachers (PSTs) evaluated trustworthiness of different information sources given about three socioscientific issues (SSIs): climate change, nuclear energy, organ transplantation and donation; their criteria of trustworthiness; epistemological beliefs; accumulation of knowledge about SSI topics; and whether there is a relationship among PSTs' epistemological beliefs, knowledge levels about SSIs and evaluation of trustworthiness on different sources. During 2012-2013 spring semester, 630 PSTs from four public universities participated in the study. Data were collected through Schommer's Epistemological Questionnaire, Knowledge Test, and Trustworthiness Questionnaire. Multivariate analysis of variance, correlational analysis, and mixed-design analysis of variance were conducted. The analyses revealed that PSTs displayed relatively sophisticated epistemological beliefs; 45%, 41% and 23% of them had an adequate knowledge of climate change, nuclear energy, and organ donation and transplantation respectively. Averagely, PSTs put less emphasis on author while reading texts about climate change and nuclear energy, whereas they put less emphasis on publication date of the texts written about organ donation and transplantation. The results revealed that high achiever PSTs found all texts more difficult to comprehend, and gave more importance to the content while evaluating the trustworthiness on sources than low achievers did.

Scientific Reasoning and Achievement of Prospective Science Teachers in an Argumentation-Based Guided Inquiry Course

Amer Acar, Kocaeli University Bruce Patton, The Ohio State University *ABSTRACT:*

This study examined if an argumentation-based guided inquiry course helpful in closing scientific reasoning and achievement gaps among prospective science teachers having different scientific reasoning levels. Results were reported for 114 prospective science teachers. Results demonstrated that there were pretest scientific reasoning and achievement gaps among concrete, formal, and postformal reasoning prospective science teachers. Furthermore these gaps were still observed at the end of instruction. However results also demonstrated that posttest gaps were statistically lower than the respective pretest gaps. Implications were discussed according to these findings.

Use of Structured Formative Assessment Assignments to Engage Preservice Teachers with Life Science Concepts

Jaime L. Sabel, University of Nebraska-Lincoln Cory T. Forbes, University of Nebraska-Lincoln Laura Zangori, University of Missouri-Columbia *ABSTRACT:*

Undergraduate preservice elementary teachers often have limited science subject matter knowledge. In order to effectively engage students in scientific practices and connect students' ideas about science to appropriate instructional strategies, teachers should learn disciplinary concepts and how to apply their content knowledge to elementary classroom environments with proven instructional practices, such as formative assessment. However, the use of formative assessment practices is not widespread in part because teachers may not understand formative assessment or have enough science content knowledge to effectively engage in the practice. To address this concern, we developed an innovative course for elementary preservice teachers built upon two pillars—life science content and formative assessment. As a part of the course, preservice teachers

engaged in formative assessment assignments that provided structure to engage them in each step of the formative assessment process and to support them in considering their own and elementary students' life science understanding. Here, we will present results of an embedded mixed methods study designed to evaluate how engaging in these assignments provided opportunities for preservice teachers to gain content knowledge and the ability to productively engage in formative assessment for science.

Strand 8: In-service Science Teacher Education

Related Paper Set - Exploring the Challenges and Successes of Integrating Robotics in K-12 Learning Environments

2:40pm - 4:10pm, Fells Point

Presider: Timothy A. Goodale, North Carolina State University

ABSTRACT:

This paper set explores various aspects of integrating robotics curricula and projects in formal K-12 learning environments. Perspectives that are investigated include the utility of teacher professional development and its subsequent impact on the incorporation of robotics, integrating the Next Generation Science Standards and the challenges within robotics curriculum development and the value of robotics projects to influence secondary science student's ability to collaborate and enhance their efficacy and content knowledge. Unique viewpoints are offered across the various stakeholders that implement robotics at the school level. First, teachers are important because they are the ones that will facilitate the projects in their classrooms. It is important to gauge their efficacy and comfort on utilizing robotics and where they find value in professional learning opportunities. Subsequently, curriculum development and standards alignment is also crucial. If robotics projects do not reach content standards they risk becoming "extra-curricular" and therefore many students could potentially miss the opportunity to be exposed related STEM careers and academic pursuits. Lastly, two papers that investigated the utilization of classroom robotics projects preview the utility and challenges that exist in this emerging field.

Competition in Robotics Curriculum: Examining Motivation, Self-Efficacy, and Science Content Knowledge Christine Schnittka, Auburn University TJ Nguyen, Auburn University

The Influence of a Robotics Workshop on Science Teacher Self-Efficacy Timothy A. Goodale, North Carolina State University

Curriculum Developers' Design Challenge: Integrate Engineering and Science Via Robotics Mike Ryan, Georgia Tech Marion Usselman, Georgia Tech Jessica Gale, Georgia Institute of Technology - CEISMC

Understanding K-8 Robotics Teams' Collaborative Behaviors and their Performance Muhsin Menekse, University of Pittsburgh Christian D. Schunn, University of Pittsburgh Ross Higashi, University of Pittsburgh Emily Baehr, University of Pittsburgh

Strand 8: In-service Science Teacher Education *Teachers' Professional Learning* 2:40pm - 4:10pm, Maryland Salon B **Presider:** Mary K. Nyaema, University of Iowa

Understanding the Impact of Conceptual Change Models and Discourse Through Teacher Professional Develoment

Tracy L. Huziak-Clark, Bowling Green State University Toni A. Sondergeld, Bowling Green State University John Laird, Bowling Green State University Jacob Burgoon, Bowling Green State University *ABSTRACT:*

Over the past four years our professional development program has engaged more than 100 teachers in sustained content and pedogogy instruction. Teachers engage in the conceptual change process to help themselves and eventually their students accurately explain their understanding through critical dialogue. Engaged practice, time for reflection and peer sharing as well as effective implementation of the professional development likely contributed to the observed gains in teachers' content knowledge as well as their teaching beliefs and practices. Findings have shown that in each year of the program teachers significantly improved their content knowledge about physics and chemistry. In addition to improving their content knowledge, teachers also increased their emphasis on reform-based teaching practices, as well as their confidence to use reform-based teaching practices. Most teachers reported a high level of implementation during the school year. Furthermore, the classroom observations generally demonstrated teachers' effective and complete use of the professional development approach.

A Trajectory of Science Teacher Learning: Charting the Course Path for Researchers, Educators, and Teachers Julie A. Luft, University of Georgia

Brooke A. Whitworth, Northern Arizona University Shannon Dubois, Valparaiso University Vanessa Kind, Durham University Mandi Berry, Leiden University

ABSTRACT:

Science teacher professional development is complex. There are different times in a teacher's career that necessitate different professional learning opportunities, and there are different knowledge bases, practices, and cognitive attributes that need to be cultivated during these times. This paper recognizes these variations and conceptualizes teacher learning in a way that educational researchers and policy makers can better contribute to this process. This paper also recognizes the need for science teacher educators to have a roadmap that can better support the professional development of science teachers. Drawing upon existing research pertaining to the professional learning of science teachers, this paper suggests a conceptual framework that can be used by researchers, educators, and teachers to support the ongoing learning of teachers. Results of studies and experiences of teachers can guide policy makers in their decisions. This conceptual framework acknowledges that teachers can change over time; that knowledge, practices, and cognitive attributes are involved in this change; and that the situated position of teachers contributes to this change. By articulating this framework, researchers can begin to better understand the crucial components of science teacher development, which can help guide program development, teacher learning, and potential policy decisions.

Contribution of Lesson Study for the Professional Learning of Physics and Chemistry Teachers Teresa Conce, Institute of Education, University of Lisbon MÛnica Baptista, Institute of Education, University of Lisbon

Jo Pedro da Ponte, Institute of Education, University of Lisbon *ABSTRACT:*

Lesson study, with a collaborative and investigative nature and centred on teaching practice, is a promising model for teachers' professional development. In a lesson study, the participants raise a question of their interest, related to their students' learning, and plan a research lesson in order to address that question. Then, this lesson is taught by a teacher while the others observe and take notes. Afterwards, the teachers meet together to analyze and reflect on the notes that they gathered and revise the lesson. The aim of this study is to know the professional learning experienced by physics and chemistry teachers on the topic buoyancy, as well as their perspective about the contribution of collaboration and reflection to their professional development. The research methodology is qualitative and interpretative, based on naturalistic observation and the participants are four physics and chemistry teachers. Data was gathered by taking field notes, audio recording of sessions, plus individual interviews and teachers' final written reflections. The results show that in this lesson study the teachers learnt about the topic, leading them to acknowledge its complexity. Besides, results also show that the teachers gave a high value to reflection and collaboration for their professional development.

Understanding Shifts in the Beliefs and Practices of One Science Teacher

Kimberly A. Lebak, Stockton University

ABSTRACT:

This case study examines the complex relationship between beliefs, practice, and change related to inquiry based instruction of one science teacher teaching in a high needs urban school. Transcribed collaborative dialogue sessions, written self-reflections, and videotapes of lessons were used to identify and isolate the belief systems that were critical to the teachers' decision making as a teacher of science. The Interconnected Model of Professional Growth was used to trace the trajectories of change of the individual belief systems through participation in a video supported reflection professional development process. Analysis of the data revealed that multiple beliefs interacted, with some beliefs more salient than others, to influence practice. Furthermore, this research indicates that shifts in belief systems occurred through the video-supported reflection process.

Vertically Articulated Professional Learning Communities: Developing Collaboration and Practice in a K-12 Science Teacher Professional Development Program.

Amanda M. Gunning, Mercy College

Peter C. Hillman, Mercy College School of Education

Meghan E. Marrero, Mercy College

Arthur Eisenkraft, University of Massachusetts Boston

ABSTRACT:

This qualitative case study of 19 teachers enrolled in a two-year fellowship examines effective vertical team collaboration between practicing K-12 science teachers. The focus of this paper centers on professional learning communities that are orientated to align with the vertical progressions of knowledge emphasized in NGSS. NGSS represents a major shift in the way the science is taught and learned in schools. One major part of this shift is the emphasis on a progression of scientific knowledge from K-12, which is a target of our professional development model. Using qualitative methodology embedded in a constructivist theoretical framework, we describe our use of vertically aligned groups of science teachers constructed around a particular content area (earth science, biology, chemistry or physics). We present an overview of three major emergent themes that we have identified from our data analysis to date: improving practice, supporting student success, and NGSS implementation. As evidenced by our findings, we argue that vertically aligned professional learning communities of science teachers provide a solid platform on which to support and develop in-service science teachers and provide critical support and guidance during the transition to NGSS.

Strand 10: Curriculum, Evaluation, and Assessment

Symposium - Methodological Approaches to the Development of Earth and Space Science Learning **Progressions**

2:40pm - 4:10pm, Maryland Salon A **Presider:** Seungho Maeng, Seoul National University of Education **Presenters:** Seungho Maeng, Seoul National University of Education Julia Plummer, Pennsylvania State University Scott McDonald, The Pennsylvania State University Kiyoung Lee, Kangwon National University Christopher Palma, The Pennsylvania State University Young-Shin Park, Chosun University Richard A. Duschl, Penn State University Tanya Furman, The Pennsylvania State University

ABSTRACT:

Learning progressions (LP) describe how the sophistication of students' understandings develops within big ideas in science across multiple years. LPs describe a coherent view of how students' learn science, which may lead to curriculum and standards that support a deep and interconnected understanding of science. Yet, much diversity exists in how research groups define and validate LPs in science. This symposium provides a unique context to explore methodological differences in LP development. The symposium includes four research groups developing Earth and Space Sciences (ESS) LPs: two groups for astronomy LPs and two groups for geology LPs. Each domain pair draws on different theoretical frameworks, either cognitive or socio-cultural perspectives, which in turn shape their methodological approach to LP design. By presenting these contrasting cases of LPs in the same domain with different methodologies, we will explore the affordances and constraints of each perspective and discuss how diverse methodological perspectives may be an important step towards supporting ESS education.

Strand 10: Curriculum, Evaluation, and Assessment

Symposium - Correlating Student Drawings and Texts to Assess Understanding of the Particle Model of Matter

2:40pm - 4:10pm, Watertable Salon A

Presenters:

Joi Merritt, Arizona State University Elon Langbeheim, Arizona State University Jennifer Chiu, University of Virginia Sevil Akaygun, Bogazici University Jie Chao, Concord Consortium

ABSTRACT:

This symposium will examine the evaluation of students' pictorial and written realizations of the particle model of matter. It will be based on empirical data from four different studies that examined student drawings and written explanations of the particle model across a variety of age groups and contexts. It will focus on the significance of student-made drawings, and their alignment with the written text that they produce, The findings from these studies will be used to develop a nuanced set of guidelines for evaluating students' conceptual understanding of the particle model.

Strand 11: Cultural, Social, and Gender Issues *Effective Science Teaching for ELLs* 2:40pm - 4:10pm, James

Presider: Gillian U. Bayne, Lehman College CUNY

A Science-Language Rubric to Assess Visual Representations in Linguistically Diverse Classrooms for Cultural Validity

Preetha K. Menon, UC Santa Cruz *ABSTRACT:*

English Language Learners (ELLs) is the fastest growing segment of the public school population. Today's schools face unprecedented challenges in preparing ELLs as they lack instructional supports and fair and valid assessments to support academic learning in classroom settings. This paper uses data collected in two sixth grade classrooms during a unit in photosynthesis. The main research question guiding this study: How do visual representational tasks support science learning in linguistically diverse classrooms? Using a science and language learning rubric I examine student learning in the classrooms based on students' English learner status and proficiencies in English language arts, science, and vocabulary acquisition and usage. Rubric scoring indicated ELLs had the highest gains in the scores in the visual diagrams, redesignated students had the highest scores in final visual diagram, indicating how ELL status, proficiencies in language arts and science influence the integration of science and language learning. With the advent of NGSS and related assessments, the findings illustrate the importance of using representational tasks to integrate the understanding of science content and language and assessing learning over time.

Stories Told by Underrepresented Scientists of Color: Themes Revealed and Used as Springboards to Increase Participation in STEM

Serigne Gningue, Lehman College of the City University of New York Gillian Bayne, Lehman College of the City University of New York Sunyata Smith, Lehman College of the City University of New York *ABSTRACT:*

Educators are called upon constantly to seize opportunities that will develop and strengthen our current and future scientific community. The research presented in this project is part of a larger one, which involves utilizing the experiences shared by underrepresented scientists of color in a large northeastern urban city to inspire and motivate science teachers and their students to be involved in creating authentic science experiences that resonate with the lives and lifeworlds of urban students. An improved understanding of how to specifically address the educational needs and science interests of diverse children is crucial to not only increasing science competence and fluency, but also to increasing the number of those who will pursue STEM and STEM related professions. Through face-to-face meetings and interviews with the scientists, emergent themes have presented themselves that provide opportunities to strengthen diverse secondary science students' understanding of and involvement in science content. These themes related to culture, capital, identity, gender and race are deeply examined, and theorized through a sociocultural theoretical lens. Students who come from racial and/or ethnic backgrounds that are traditionally underrepresented in the sciences are especially meant to benefit from the results of this research project. Normal.dotm 0 0 1 197 1127 Lehman College 9 2 1384 12.0 0 false 18 pt 18 pt 0 0 false false /* Style Definitions */ table.MsoNormalTable {mso-style-name: "Table Normal"; mso-tstylerowband-size:0; mso-tstyle-colband-size:0; mso-style-noshow:yes; mso-style-parent:""; mso-padding-alt:0in 5.4pt 0in 5.4pt; mso-para-margin:0in; mso-para-margin-bottom:.0001pt; mso-pagination:widow-orphan; fontsize:12.0pt; font-family:"Times New Roman"; mso-ascii-font-family:Cambria; mso-ascii-theme-font:minorlatin; mso-hansi-font-family:Cambria; mso-hansi-theme-font:minor-latin; }

Integrating Science and Language: Engaging Bilingual Middle School Students in Scientific Argumentation and Explanation

Emily J.S. Kang, Adelphi University Lauren H. Swanson, Whittier College Clara V. Bauler, Adelphi University *ABSTRACT:*

As teachers incorporate the NGSS Science and Engineering Practices, they must be aware of the language demands placed on students, particularly English Learners (ELs). This paper explored the integration of science and language instruction during a two-week unit on plate tectonics in a 7th grade bilingual classroom. We asked two questions: 1. How did bilingual learners construct and communicate scientific arguments and explanations in both spoken and written form? 2. What opportunities did the enacted curriculum afford learners to practice argumentation and explanation? We analyzed student written work from the unit's culminating task and analyzed opportunities for argumentation and explanation learners engaged in during classroom instruction. Findings indicated that although students were able to construct arguments grounded in evidence, they had difficulty using language to connect claims with a scientific explanation of how earthquakes occur. Also, while students were afforded multiple opportunities for students to practice transitioning from oral discussion to academic writing. An implication is students should be continuously and consistently engaged and supported in documenting their thinking throughout classroom instruction to tackle the complex language demands of scientific discourse.

STEMELL: Tailoring the STEM Teaching and Learning of ELLs in Mainstream Urban High-Need Secondary Classrooms

Serigne Gningue, Lehman College Gillian Bayne, Lehman College Sunyata Smith, Lehman College

ABSTRACT:

The purpose of this study is to understand and implement critical elements inherent to carefully crafted and enacted pedagogical practices, which are appropriately aligned to meet the teaching and learning needs of English language learners (ELLs) in mainstream urban high-need secondary STEM classrooms. The Science, Technology, Engineering, and Mathematics for English Language Learners (STEMELL) program represents a partnership between an urban college and its local community school districts in the northeastern part of the US. STEMELL encompasses successful elements that are suitable for new teacher induction and epistemological growth. It includes an added special focus on preparing highly qualified science and mathematics teachers to teach ELLs in mainstream urban high-need secondary classrooms. We have developed and are implementing a model for continuing reform of teacher preparation through an innovative school-centered, needs-based 5 year teacher preparation program with integrated professional development and induction support programs to produce demonstrated positive impacts on teacher competency, and on the STEM achievement of high-need, low-performing urban students in grades 7 through 12. This paper presentation will detail the program and share both qualitative and quantitative results that point to improving the teaching and learning of ELLs in high need urban mainstream STEM classrooms.

Strand 11: Cultural, Social, and Gender Issues

Related Paper Set - Integrating Students' Linguistic and Cultural Experiences in an Emergent Science Curriculum

2:40pm - 4:10pm, Watertable Salon B **Presider: A**ria Razfar, University of Illinois at Chicago *ABSTRACT:*

This paper set is an exploration of how teachers can develop a culturally-responsive science curriculum that integrates students' diverse linguistic and cultural experiences with the Next Generation Science Standards. We present a theoretical framework for our larger professional development work with teachers integrating science and math education and language learning through action research in low-income schools with language learners in and around a large Midwestern city. We describe three case studies that represent teachers' work within this framework to design emergent science curricula, focusing on how teachers utilized students' funds of knowledge in the NGSS categories of Human Impacts, Life Sciences, and Earth Systems in first, third, and fifth grade classrooms. We draw attention to the fact that students' individualized learning progressions do not always match up with the prescriptive progressions laid out in existing science curriculum.

Theoretical Perspectives on Teacher-Researchers as Science Curriculum Developers Aria Razfar, University of Illinois at Chicago Adrian L. Allen, University of Illinois at Chicago Christian A. Carstensen, University of Illinois at Chicago Marcine M. Adams, University of Illinois at Chicago

"Water Issues": An Emergent Culturally-Responsive Science Curriculum in a Diverse Third Grade Classroom Adrian L. Allen, University of Illinois at Chicago

What Changes When a Teacher Fully Embraces Culturally-Responsive Science Teaching? Christian A. Carstensen, University of Illinois at Chicago

Clean Water: A Right or Privilege? Making Connections to Students' Community to Better Understand Water Distribution Marcine M. Adams, University of Illinois at Chicago

Strand 11: Cultural, Social, and Gender Issues *Identity and Science Education* 2:40pm - 4:10pm, Pride of Baltimore **Presider:** Sara P. Raven, Kent State University

Empowering Youth of Color as Change Agents: The Importance of a Science Instructor's Pedagogical Vision Tammie Visintainer, University of California Berkeley ABSTRACT:

This study examines how an instructor's "pedagogical vision" of science (e.g. utility) and his students (e.g. race, social positioning) guides the instruction, pedagogy and designed experiences made available while engaging high school students in a community-based scientific research project. This research utilizes qualitative (e.g. interviews) and quantitative (e.g. surveys) data sources to explore the instructor's vision and to document the shifts that occur for students through engaging in scientific research in their community. Findings illustrate how the instructor's goals to empower students as change makers and the resulting pedagogy and designed experiences made available support holistic identity construction (i.e. students' science and racial identities) and

allow their agency and power to come to life. Findings show that engaging in science practices and the accompanying program resources generated new possibilities for students as capable science learners and change agents in their community and illustrates the importance of an instructor's vision in guiding this process. This study demonstrates how youth of color can imagine new possibilities for who they can be in science if their science and racial identities are supported in science learning environments.

Dual Identities: Investigating the Nature of STEM-Focused Catholic Schools

Matthew Wilsey, University of Notre Dame Matthew Kloser, University of Notre Dame Erin Lavin, University of Notre Dame Dawn Hopkins, University of Notre Dame Michael Comuniello, University of Notre Dame

ABSTRACT:

Recently, there has been a push for a more deliberate approach to STEM education, which has resulted in the growth of various STEM-focused schools in both the private and public sectors. Most of the limited literature on STEM-focused schools focuses on public and charter schools, but some religious schools, specifically Catholic schools, have begun adopting a STEM focus. There is currently no published research on how the existing Catholic identity and the adopted STEM-focused identity affects the goals and nature of schooling for students in this context. Using a longitudinal qualitative case study approach, we tracked five K-8 Catholic schools seeking to alter their structure from a traditional parish-based school to a parish-based Catholic STEMfocused school. Our data indicates two contrasting positions, with one side perceiving tension in the missions of faith and reason and the other side seeing a strong relationship between science and religion rooted in historical precedent with the Catholic Church. These positions are often tied to the perceptions of key transformational leaders, namely pastors. Understanding the role of stakeholders' perspectives – across various contexts – is essential as the push for STEM-focused school continues to grow.

Rural, High Poverty Middle School Students' STEM Career Explorations and Identification

Meredith W. Kier, College of William and Mary

Margaret R. Blanchard, North Carolina State University

ABSTRACT:

This study follows four eighth grade students in a rural, high poverty middle school in the southeastern US in an effort to understand how they considered different STEM careers during a semester-long STEM career intervention. Case studies were constructed through the analysis of student interviews and classroom artifacts to learn what motivated their interest in certain careers. The data from the interviews led to using the Expectancy-Value (E-V) Theory of Achievement Motivation as an interpretive lens, informed by identity theory. Analyses of the four students highlighted experiences related to race/ethnicity, parent's education, hobbies, family support, and the role of out of school experiences on career interest. Allowing students the time to try on careers as they considered who they are, weighed their interests and goals against the related costs of their choices and recorded decision points as they did so, highlighted their values and the influences on their career intentions. The use of the E-V framework as an analytical tool could provide a useful way to highlight and address gaps in students' career pathways and provide insight into how teachers, guidance counselors, and parents may help students to consider STEM careers in personally meaningful ways.

Setting the Stage: Influencing Sociocultural Consciousness Brenda R. Brand, Virginia Tech Takumi Sato, Virginia Tech Whitney R. Wright, Virginia Tech

Bakar O. Bey, Virginia Tech *ABSTRACT:*

"Setting the stage" in a social justice driven collaborative STEM program is critical to the overall success toward reaching project and research goals. In this investigation, we uncover the sociocultural components of "setting the stage" in the establishment of a four year NSF funded robotics project designed to increase the numbers of students pursuing careers in STEM disciplines from an under resourced region in the Southeastern US. The aim of the project is to positively influence the self-efficacy and identity of students in the robotics program. To set the stage at the outset, the teachers charged with implementing the project were engaged in professional development activities aimed at developing or increasing their sociocultural consciousness. In addition, we analyzed subsequent research team meetings and interviews with teachers. We found that the teachers' sociocultural consciousness was a driving factor in the implementation driving impetus for carrying out the robotics program. The research also indicated a unifying impact of the enhanced sociocultural consciousness for the individual members of collaborative team and established a central purpose for the project.

Strand 12: Educational Technology

Technology and Teacher Practice

2:40pm - 4:10pm, Federal Hill **Presider:** Hillary Z. Lauren, University of Illinois at Urbana-Champaign

Virtual Teacher Learning Community: Developing a Virtual Community of Practice with Google Tools Rebecca D. Swanson, University of Colorado, Boulder Jason Buell, UC Boulder

Erin Marie Furtak, University of Colorado

ABSTRACT:

This paper describes a research project in which we developed and enacted a virtual community of practice in an online environment using Google Tools. This community of practice was composed of novice teachers, experienced teachers, and researchers working together to reflect on teaching practices around formative assessments in secondary science classrooms as a way to help bridge the support gap for novice teachers between their university teacher program and their first years of teaching. Participants engaged in a series of monthly online professional development meetings, as well as interactions in asynchronous online environments. In this paper, we will share how Google Tools facilitated the formation of a community of practice, as well as the affordances and constraints of using Google Tools.

How Teachers and Students See Science Taken Up in a "Making" Fab Lab Course Jennifer Lacy, University of Wisconsin-Madison

ABSTRACT:

Many researchers suggest that "making," a learning process that emphasizes the use of digital fabrication technologies (e.g. 3D printers), has the potential to teach all students the knowledge and practices of STEM. However, early research in K-12 classrooms shows researchers defining science and STEM and determining whether science learning has taken place, not classroom teachers. Knowing how teachers define science and STEM when left to create "making" curricula on their own may affect which students have access to "making," the knowledge and practices valued, and the forms of expression available to students. This comparative case study of a Fab Lab "making" course and an industrial arts course at a public high school examines how the "maker movement" and "making" interact with the structural tensions of schooling including how science and STEM are defined, how the Fab Lab course interacts with the practice of sorting and categorizing of students into academic and vocational tracks, and how the cultural and technological changes to the design of learning

environments and activities by the "maker movement" interact with these tensions. Using research findings, the author discusses how "making" and "making" learning environments can be designed to provide all students with meaningful learning opportunities.

Flipping the Classroom: A Quasi-Experimental Examination of the Effect of Flipped Instruction in STEM Classrooms

Lynne Zummo, Stanford University Bryan A. Brown, Stanford University *ABSTRACT:*

Flipped instruction—the replacement of traditional in-class lecture with at-home, multimedia instruction—has grown increasingly common in schools. However, the existing evidence to support its effectiveness in K-12 science classrooms lacks substantial quantitative data to warrant such an enthusiastic embrace. This quasi-experimental mixed-methods study compared learning outcomes in high school Biology students who experienced a flipped lesson to those of peers who experienced a control, traditional lecture-based lesson on the same topic. Average gains from pre-test to post-test were significantly higher for flipped students. Flipped students' completion of homework was particularly important in this effect. Interview data suggest that the multimedia nature of the homework, as well as its convenience, contributed the significant gains of flipped students.

Teacher Induction Network: Use of Web 2.0 Tools for Developing Reflective Practices

Tasneem Anwar, University of Minnesota

Gillian Roehrig, University of Minnesota

ABSTRACT:

In this study, we explore how the Teacher Induction Network (TIN)- an online mentoring program addresses the challenges of developing online communities, provides subject-specific professional development and promotes reflection on classroom practices for beginning science and mathematics teachers. In particular the use of various web 2.0 tools like videoANT, flipgrid, discussion forum, and reflective journal for reflection on teachers' teaching practices will be discussed. Recent developments in interactive web 2.0 tools make the use of video/audio/text for examining and improving reflective practices increasingly viable within online environments. The integration of Web 2.0 tools into TIN represents a promising practice for teacher educators that promotes the development of reflective practitioners and provides user-friendly on-line platform for sharing and providing feedback on classroom teaching.

Strand 15: Policy

Symposium - Inclusive STEM-Focused High Schools: Enhancing Policies and Practices for STEM Readiness--from States to Students 2:40pm - 4:10pm, Gibson Presider: Barbara Means, SRI International Presenters: Barbara Means, SRI International Sharon J. Lynch, the George Washington University Ann House, SRI International Vanessa Peters, SRI International Michael Ford, George Washington University Shari Matray, George Washington University Lauren Cassidy, SRI International

Rebecca A. Kruse, National Science Foundation *ABSTRACT:*

This symposium will discuss research findings from two major studies on inclusive STEM high schools (ISHSs), attending to their potential for improving STEM education and preparation for STEM majors and careers for students from groups traditionally under-represented in STEM fields (gender, socio-economic status, ethnicity/race, or first generation in family to attend college). An ISHS is a secondary school that students enroll in on the basis of interest rather than aptitude or prior achievement, and that provides all of its students with more intensive mathematics and science preparation than regular high schools with the goal of preparing students to succeed in a STEM college major. The research presented in this symposium relies upon varied methodologies and includes a state-level quasi-experiment comparing student perceptions and outcomes for ISHSs to more traditional schools in North Carolina; a three state cross-case policy analysis on the creation of use attend ISHSs to illuminate how the students experience the STEM curriculum, instruction and school environment, moment-by-moment; and a presentation the introduces an evidence-based logic model that attempts to capture the elements, processes and outcomes of successful ISHSs.

Concurrent Session #2 4:20pm – 5:50pm

International Committee

Administrative Sponsored Symposium - Current Challenges about Epistemic Practices and Scientific **Practices in Science Education** 4:20pm - 5:50pm, Maryland Salon B Organiser: Maria Pilar Jimenez Aleixandre, University of Santiago de Compostela, Spain Chair: Jesus Piqueras, Stockholm University, Sweden Discussant: Jim Ryder, University of Leeds, United Kingdom **Presenters:** Maria Pilar Jimenez Aleixandre, University of Santiago de Compostela, Spain Richard A. Duschl, Pennsylvania State University, United States Anat Zohar, Hebrew University, Israel Sibel Erduran, University of Limerick, Ireland Zoubeida Dagher, University of Delaware, United States Karim Hamza, Stockholm University, Sweden Jesus Piqueras, Stockholm University, Sweden Per-Olof Wickman, Stockholm University, Sweden Marcus Angelin, Stockholm University, Sweden **ABSTRACT:** Abstract: This symposium will undertake a critical examination of epistemic practices and of the challenges,

Abstract. This symposium will undertake a critical examination of epistemic practices and of the chantenges, theoretical and educational, involved in incorporating them into science education. The four papers combine theoretical and methodological approaches (papers 1, 2 & 3), drawing from the literature, with empirical studies focusing on how to enact epistemic practices in the science classroom (paper 4). They share an approach viewing epistemic practices as enacted, rather than as beliefs. Paper 1 examines the characterization of epistemic practices, and the relationships between epistemic and scientific practices, seeking to identify productive ways of engaging students in them. Paper 2 explores the role of metacognition, in particular of epistemic metacognitive knowledge, in fostering students? engagement with epistemic and scientific practices, an issue related to personal epistemologies and to how to teach the Nature of Science (NOS). Paper 3, framed in a reconceptualization of NOS, proposes a science teaching heuristic for the purpose of engaging students in scientific practices, as well as for supporting teachers? understanding of their epistemic, cognitive, and social aspects. Paper 4 reports about the effects, on student discourse, of making the epistemic aims explicit content in the school laboratory; achieved through peer review.

Strand 1: Science Learning, Understanding and Conceptual Change Related Paper Set - Longitudinal Studies of Elementary and Middle School Students' Epistemic Considerations Through Participation in Scientific Practices

4:20pm - 5:50pm, Pride of Baltimore

ABSTRACT:

While the science education community has embraced a shift toward science as practice, scientific practices outlined in NGSS can easily become proceduralized in classrooms. We argue that students should be engaged in practices that are both meaningful to the discipline and to the knowledge building learning community. To do so, students and teachers should consider epistemic aspects of their practices work such as 'What kind of answer should our knowledge product provide?' and 'How does this knowledge product relate to other scientific phenomena and ideas?' Yet classrooms, teachers and researchers do not yet have a strong sense for what these ECs might look like within and across units and how they might develop. This paper set reports on

analysis of longitudinal data of students in classrooms engaged in scientific practices across multiple years to address this need. The paper set shares analysis and findings of how ECs develop from large-scale analysis of written assessments, interviews with focus students across multiple years, and embedded assessments. Results from research in this paper set are critical for the community to better understand how students' practices grow over time to inform future research, work with teachers, and meaningful participation in practices.

Multi-Year Growth in Mechanistic Reasoning Across Units in Biology, Chemistry, and Physics Brian J. Reiser, Northwestern University Jinho Kim, University of California, Berkeley Yukie Toyama, University of California, Berkeley Karen Draney, UC Berkeley

Characterizing Changes Across Model-Based Units and Time in Elementary Students' Epistemic Considerations on Scientific Modeling May Lee, Michigan State University Christina V. Schwarz, Michigan State University Li Ke, Michigan State University

Examining How Middle School Students' Epistemic Considerations Change Across Varying Contexts and Over Time Jeannette Manger, Wright State University Lisa Kenyon, Wright State University

Examining Fifth and Sixth Grade Students' Epistemic Considerations Through an Automated Analysis of Embedded Assessment Items Joshua Rosenberg, Michigan State University Christina V. Schwarz, Michigan State University

Strand 2: Science Learning: Contexts, Characteristics and Interactions *Perceptions of Teacher Practice*4:20pm - 5:50pm, Kent
Presider: Gail Richmond, Michigan State University

Student Persistence in Science: Do Science Teacher Credentials Matter? Adem Ekmekci, Rice University Baki Cavlazoglu, Texas A&M University ABSTRACT:

This study investigates the effects of science teacher-related factors on high school students' persistence in science subjects. Teacher-level factors are related to their professional background and included variables about their educational background in science, training in science teaching, and science teaching experience. Participants included a nationally representative sample of high school students who are surveyed at 9th grade and again in 11th grade as part of High School Longitudinal Study 2009 and their science teachers. As a proxy for students' persistence in science, we used students' motivational beliefs, advanced science course enrollments, and their career plans in science-related areas. Data analyses included multiple stepwise regression analysis. Results showed that the most significant predictor of students' science persistence was the their teachers science teaching experience. Science teaching certification was not a significant predictor of any of the outcomes variables for science persistence. Teachers' college-level science course takings and graduate degree

in science were moderately related to students' science persistence. These results may have implications for science education and science teacher education.

High School Science Teachers' Perceptions of How Others Think Science Should Be Taught Andrew Wild, Stanford University

ABSTRACT:

Improving science teaching through policy has been an elusive goal. This study applies a social norms perspective to provide insight into this problem. Specifically, it describes and explains science teachers' beliefs of how teacher groups (e.g., department members, teachers in professional networks) and non-teacher groups (e.g., parents, students, administrators) think science should be taught. I interviewed the least experienced science teachers from eight high schools (five public, two charter, and one independent) and the most experienced science teachers from six of the same schools. Interview transcripts were coded using a combination of a priori and in vivo codes. Preliminary findings indicate that participants commonly perceived members of society, their science teacher colleagues, parents, and students as believing that good science teaching involves hands-on activities or labs. Additionally, administrators, colleagues, and teachers in professional networks were perceived as valuing class discussions. The findings suggest that perceptions of administrators' and teacher groups' beliefs about teaching science might be leveraged to support the implementation of the Next Generation Science Standards.

Exemplification in Science Instruction: Teaching and Learning Through Examples

Alandeom W. Oliveira, University at Albany, SUNY

Adam O. Brown, Dept. of Biology, University of Ottawa

ABSTRACT:

Although the practice of giving examples is central to the effective teaching and learning of science, it has been the object of little educational research. The present study attends to this issue by systematically examining the exemplification practices of a university instructor and his students' learning experiences during a biology lecture on animal behavior. It is reported that the science instructor provided students with a series of procedural, conceptual, and analytical examples. Each of these three types of exemplification was characterized by a unique focus, form, and functions (inductive articulation of generalities, deductive application of concepts, social positioning, engagement of learners, and opening classroom dialogue). Further, it is also shown that exemplification can shape student science learning experiences in varied ways (positive and negative) depending on how it interacts with parallel instructional activities such as whole-class discussion, text reading, and student writing. Based on these findings, we argue that conceiving of exemplification simply in terms of conceptual illustration does not do justice to this important dimension of science instruction.

Physics Inquiry in the Zone of Proximal Development

Shulamit Kapon, Technion - Israel Institute of Technology

Alon Schapiro, Acheret Center

ABSTRACT:

We present a case study of unique apprenticeship learning, in which students (K11-K12) enrolled in physics at the advanced high school level also engaged in long-term (18 month) open-ended inquiry projects in physic conducted in the school laboratory, and where the project advisor is a physics teacher who is a member of a research community of physics teachers. Some of the investigated topics and research questions were not familiar also to the advisor, and he was supported by the community through a bi-monthly professional workshop. Qualitative data were collected over the whole school year and the analysis was carried out using the Grounded Theory approach. The findings indicate that meaningful research in physics can be done with high school students at school, and that when crafted well, this experience provides students with unique conceptual

and non-conceptual gains. The findings have implications as regards teacher education targeted at developing research mentorship skills. At the theoretical level the study is a preliminary step in the development of a socio-constructivist learning theory for fostering creativity and personal expression in science education.

Strand 2: Science Learning: Contexts, Characteristics and Interactions

Symposium - Students Doing Science: Case Studies of Disciplinary Engagement

4:20pm - 5:50pm, Watertable Salon C **Presider:** Jessica Watkins, Tufts University Presenters: Jessica Watkins, Tufts University Jennifer A. Radoff, Tufts University Anna Phillips, Tufts University Lama Jaber, Florida State University David Hammer, Tufts University

ABSTRACT:

One of the major aims of the science education community is to support students in meaningful disciplinary work, in which they are not just recipients of a particular body of knowledge, but producers of scientific knowledge themselves. But questions still remain about what it means to "do science" in classrooms and how to support it. While many have proposed theoretical conceptualizations of what it means for students to be doing science, there is a need for more empirical examples of classroom scientific engagement. In response to this need, and to satisfy previous NARST participants' request to showcase more instances of students doing science, we present a set of 4 video cases of students' scientific engagement in classrooms to serve as a basis for discussion on what it means to "do science" in classrooms and how students' scientific engagement gets started and sustained.

Strand 4: Science Teaching--Middle and High School, Grades 5-12): Characteristics and Strategies Unpacking Pedagogical Content Knowledge

4:20pm - 5:50pm, Federal Hill **Presider:** Jared R. Allen, Indiana University

Experienced and Beginning Physics Teachers' Pedagogical Content Knowledge and Instructional Practices Imelda S. Caleon, National Institute of Education, Nanyang Technological University ABSTRACT:

This study examined the pedagogical content knowledge and instructional practices of beginning teachers (BTs) and experienced teachers (ETs) in the context of teaching electricity. More ETs expressed greater awareness of their students' conceptual difficulties, but only when their expressed content knowledge agrees with canonical ideas. Regardless of experience, several teachers had limited awareness of the students' difficulties in relation to concepts that are difficult to understand. ETs and BTs had similar quality of content knowledge, but they differed in terms of strategies endorsed and utilized to deal with the students' difficulties in learning electricity. Most of the BTs endorsed transmissionist-oriented strategies (e.g., lecturing; drill and practice) to promote conceptual learning. More of the ETs reported a wide range of preferred teaching approaches for promoting conceptual learning and favoured strategies that involve students' knowledge construction. Most of the teachers enacted the strategies that they described as part of their PCK in their classroom lessons. Only five teachers, mostly ETs, endorsed strategies that include some elements of the conceptual change approach. Longer teaching experience, along with contextual factors, such as the process of ability streaming, enriches the teachers' PCK

and guides or delimits their pedagogical choices and practices. Implications to promote science learning for all are presented.

Experienced Chemistry Teachers' Assessment Thinking: Noticing, Interpreting, and Acting Hannah Sevian, University of Massachusetts Boston Melissa Weinrich, University of Massachusetts Boston Vicente A. Talanquer, University of Arizona Michael J. Clinchot, Boston Public Schools Rebecca Lewis, Boston Public Schools Courtney Ngai, University of Massachusetts Boston Robert Huie, Boston Public Schools Jennifer Lambertz, Boston Public Schools Gregory Banks, Boston Public Schools *ABSTRACT:*

This paper reports an investigation of how experienced teachers of chemistry analyze students' work on openended formative assessments in chemistry. We were interested in characterizing what teachers notice in students' responses, how they interpret what they notice, and what actions they recommend to address issues they identify. Focus groups of teachers discussed their analyses of a variety of students' responses to openended problems about controlling chemical reactions. Transcripts and teachers' written feedback were analyzed for common themes using a 'framework analysis' method. Individual teachers' comments were analyzed to look for noticing, interpreting, and acting. An evaluative stance was favored when problems were more closedended, and was characterized by prioritization, e.g., in relation to correct/incorrect, quantitative/conceptual, and chemistry/physics. In contrast, more interpretive stances (i.e., inference-based, underlying reasoning focused) were observed in teachers' discussions of more open-ended problems. Teachers proposed more laboratorybased and peer-mediated follow-up with the more open-ended problems and when explicit and extrinsic chemical variables were invoked, and more teacher-centered activities (e.g., worksheets, review) with the less open-ended problems and when implicit and intrinsic chemical variables were relevant. Implications are discussed for how formative assessment can be a productive lever to transforming what is emphasized in chemistry.

Factors Influencing Secondary Science Teachers Orientations for Teaching about STEM Careers Jared R. Allen, Indiana University

Meredith A. Park Rogers, Indiana University Adam V. Maltese, Indiana University *ABSTRACT:*

Recent research has shown that student interest in STEM careers is declining. This decline may be due to a lack of awareness of the wide range of careers available to those with a science background or degree. However, raising student awareness in the later years of secondary school has shown to be less effective than introducing these careers in middle or early high school. The purpose of this study was to determine if teachers of entry-level high school science courses perceived it as their responsibility to provide students with information about STEM related career and if so, what orientations they held towards teaching about STEM careers. Using a case study approach twelve teachers were interviewed and placed into one of three representative cases Variation in orientations between these three cases were the result of teachers prior experience with science, knowing someone in a science related career, their self-efficacy for the content they were teaching, and if the curriculum they were using had careers already fully integrated. Factors resulting in these varied orientations will be discussed along with implications for professional development that may assist with addressing these factors.

The Validity of an Instrument to Measure Teachers' Topic Specific Pedagogical Content Knowledge in

Stoichiometry

Stephen Andrew A. Malcolm, University of the Witwatersrand Marissa S. Rollnick, Wits University Elizabeth Mavhunga, University of Witwaterrand

ABSTRACT:

Pedagogical content knowledge has captured the interest of many researchers in education, including South Africa where, due to past inequalities in teacher training, teachers have limited content knowledge. The most recent model for Teacher Professional Knowledge and Skill includes the canonical component of Topic Specific Professional Knowledge that can be measured. The construct of topic specific PCK, developed by South African researchers, and aligned with Topic Specific Professional Knowledge was used to develop a valid instrument to measure TSPK in stoichiometry of science teachers in South Africa. The instrument was designed based on the transformation of content knowledge through pedagogical reasoning through various knowledge components. A mixed methods approach was used since this study focused on instrument design. The designed instrument was validated with a small purposeful sample of practising sciences teachers and the Rasch statistical model to determine validity and reliability, which yielded good validity and reliability measures. A qualitative analysis highlighted that many teachers focus on an algorithmic approach to teaching stoichiometry. The findings of this study suggest that the instrument could be used to measure teachers' TSPK in stoichiometry to identify areas for in-service training to improve teaching this difficult topic.

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

Related Paper Set - Data for Reform: A Comprehensive Examination of Introductory STEM Teaching, Learning, and Persistence at a Primarily Undergraduate Institution 4:20pm - 5:50pm, Maryland Salon A

ABSTRACT:

Four papers report results of a multifaceted examination of introductory STEM teaching, learning, motivation, co-curricular experiences, and persistence of students at a primarily undergraduate institution (PUI). The first paper reports results of a STEM faculty survey and follow-up interviews probing awareness and employment of evidence-based practices, along with classroom observations using the Classroom Observation Protocol for Undergraduate STEM (COPUS; Smith et al., 2013). Faculty were found to more accurately describe teaching behaviors and less accurately describe student behaviors in their classrooms. The second paper reports moderate gains in pre- to post-semester conceptual understanding using course-specific instruments drawn from the literature. These gains were modest despite evidence that most faculty attempt interactive teaching techniques. The third paper reports declines in pre- to post-semester motivation as measured by the Science Motivation Questionnaire II (Glynn et al., 2011). These motivational declines are large and broad, and differences are observed by gender. The final paper examines STEM persistence patterns and reports survey results comparing persisters to non-persisters. All four studies aim to inform efforts for strategic reform of STEM programs to improve introductory student experience and retention. Supported by NSF #1347234

Evidence-Based Practices at a Primarily Undergraduate Institution: STEM Faculty Awareness and Implementation

Joan Esson, Otterbein University Kathryn Plank, Otterbein University Anna Young, Otterbein University Paul Wendel, Otterbein University

Conceptual Gains in STEM at a Primarily Undergraduate Institution: A Cross-Departmental Examination Anna Young, Otterbein University

Paul Wendel, Otterbein University Joan Esson, Otterbein University Kathryn Plank, Otterbein University

Motivational Decline in STEM at a Primarily Undergraduate Institution Paul Wendel, Otterbein University Anna Young, Otterbein University Kathryn Plank, Otterbein University Joan Esson, Otterbein University

Persistence in STEM at a Primarily Undergraduate Institution: Student Characteristics and Experiences Kathryn Plank, Otterbein University Joan Esson, Otterbein University Paul Wendel, Otterbein University Anna Young, Otterbein University

Strand 5: College Science Teaching and Learning, Grades 13-20)
Active Learning in College Science Classrooms
4:20pm - 5:50pm, Fells Point
Presider: Jana L. Bouwma-Gearhart, Oregon State University

Can Active Learning Environments be Created in Undergraduate Biology Classrooms? A Study to Find Out Catherine Martin-Dunlop, Morgan State University

ABSTRACT:

This mixed-methods study assessed students' perceptions (N=355) of their undergraduate biology learning environment at a Historically Black Institution. Perceptions were compared between the two years of the study, and actual perceptions were compared with what students would prefer in an ideal environment. The 50-item Active Biology Learning Environment Survey–ABLES measured seven learning environment variables. Also, two scales assessed students' attitudes and one scale assessed Academic Self-Efficacy. Statistically significant differences (p<0.01) between students' actual perceptions and what they would prefer were found for six scales. Effect sizes were large (0.67-1.14). The narrowest gap (0.20) between actual-preferred scales was for Cooperation. The widest gap (0.94) was for Clarity of Assessment Criteria suggesting that students do not always understand how their academic performance is determined. Attitude Towards Scientific Inquiry, Enjoyment of Lessons, and Academic Self-Efficacy had an average item mean of 3.47 on a 5-point Likert scale. Differences between AY2013-14 and AY2014-15 were surprising with students' preferences for Involvement, Investigation, and Cooperation being higher in the first year. Many suggestions for creating a more active learning environment were heard during instructor and student interviews (e.g., creating rubrics for assignments; incorporating more hands-on activities; better use of clickers).

Measuring the Effectiveness of Using Small-Group, Active Engagement Exercises in a Large-Enrollment Introductory Biology Course Gili Marbach-Ad, University of Maryland Carly H. Rietschel, University of Maryland Eric Haag, University of Maryland Karen Carleton, University of Maryland ABSTRACT:

This study measures the effectiveness of using small-group, active engagement exercises (GAEs) in a large enrollment introductory biology course. BSCI207 (Principles of Biology III--Organismal Biology) is the third introductory core course for Biological Sciences majors. Its curriculum was redesigned to promote an appreciation for the physical, chemical, and evolutionary principles governing the function and diversity of all life, especially multicellular organisms. In Fall 2014, we took advantage of the two sections taught by the same team of instructors to do a comparative experiment. One section (N=198) employed three lectures per week with no discussion or lab sections. The other section (N=136) replaced one lecture per week with a GAE class, whose content corresponded to specific lecture in the other section. The goal of implementing GAEs was to engage students in their learning. We found that on average students in the class that employed GAEs showed higher improvement in content knowledge relative to students in the traditional class. Transfer students and historically low-achieving students obtained lower final exam grades than non-transfer students and historically high-achieving students across class sections. This study can contribute to the teaching and learning community and NARST members by highlighting general and specific recommendations.

Students' Attitudes, Self-Efficacy and Experiences in a Modified Process-Oriented Guided Inquiry Learning Undergraduate Chemistry Classroom

Venkat Rao Vishnumolakala, Curtin University David F. Treagust, Curtin University Daniel Southam, Curtin University Mauro Mocerino, Curtin University Sheila S. Qureshi, Weill Cornell Medical College in Qatar Katherine Bradley, Weill Cornell Medical College in Oatar

ABSTRACT:

The impact of student-centred active learning intervention like Process Oriented Guided Inquiry Learning -POGIL is more often studied utilising its cognitive constructs than the affective constructs. The evaluation of attitudes and self-efficacy is beneficial to POGIL practitioners on the utility and transferability of the pedagogy in a wide range of classrooms. Consequently, this research was aimed to explore students' attitudes, selfefficacy and learning experiences in undergraduate chemistry classes that used a modified POGIL intervention. The social cognitive theory and the theory of planned behaviour inform this mixed-method research that utilised attitudes towards the study of chemistry (ASCI v2) and chemistry attitudes and experiences questionnaire (CAEQ) in first year chemistry classes. The pre and post-test ASCI v2 and CAEQ data revealed improvement in students' intellectual accessibility, self-efficacy, lecture learning experience, and laboratory class learning experience. Paired samples t-tests when computed were statistically significant for self-efficacy students' learning experience.

When Active Learning is Not Active Learning: Conceptions of Teaching Influence Implementations of Active-Learning Approaches

Stanley M. Lo, University of California, San Diego Rachael R. Baiduc, Northwestern University Su L. Swarat, California State University, Fullerton Denise L. Drane, Northwestern University Greg L. Light, Northwestern University **ABSTRACT:**

Higher education is undergoing a paradigm shift from faculty teaching to student learning. Funding agencies have invested substantially in faculty development programs to encourage faculty to adopt learner-centered practices. While many active-learning approaches have been shown to be effective across contexts, some discrepant results make it challenging to reach definitive conclusions. This study uses a mixed-methods approach to triangulate how different faculty implement the same active-learning approaches. Specifically, we examine the relationship among conceptions, approaches, and practices of teaching in three case-study participants. In contrast to the existing model in the literature, in which conceptions of teaching inform approaches, which in turn inform practices, we propose an alternative hypothesis that both conceptions and approaches directly influence instructional practices. While the decision to use specific active-learning approaches explicitly informs practices, conceptions of teaching implicitly determine how those active-learning approaches are specially implemented. Based on these results, we propose a continuum between a best-practice model of faculty development (focused on active-learning approaches as methods), and a reflective-practice model (focused on deeper understanding of active-learning approaches as methodologies). The best-practice model alone may not be sufficient to yield the desired results in student outcomes, whereas the reflective-practice model may be more effective.

Strand 6: Science Learning in Informal Contexts

Exhibits and Informal Spaces for Learning Science 4:20pm - 5:50pm, Homeland **Presider: A**aron Price, Museum of Science and Industry, Chicago

The Impact of Out-of-School Time Informal Science Education Programs on STEM Trajectories: A Review Bobby Habig, University of Notre Dame; American Museum of Natural History Jennifer Adams, Booklyn College- CUNY Preeti Gupta, American Museum of Natural History

ABSTRACT:

One of the most critical challenges of our time is to develop effective strategies for helping all individuals realize their intellectual potential. Providing opportunities for youth to pursue STEM trajectories is a key strategy for achieving equity and justice on a universal scale. Despite the benefits of pursuing a STEM trajectory, an insufficient number of students are choosing STEM-related majors and careers, especially women and traditionally underrepresented racial and ethnic groups. Here, we apply a conceptual approach based on the theory of identity development and posit the question: How and to what extent do out-of-school time (OST) informal science education (ISE) programs impact participants' awareness, interest, and engagement in STEM-related majors and careers? In a comprehensive review of over 250 studies, our analyses yielded two major findings: (i) long-term participation in ISE programs mediates the trajectories of youth as related to interest, motivation, and ability to pursue and persist in STEM majors and careers; (ii) participation in high school science research programs impacts engagement in STEM trajectories. Collectively, our findings suggest that ISE programs cannot be ignored, and that these programs may play a critical role in fostering equity and justice in the STEM arena.

What Draws Students In? The Particular Aspects of Science Museum Exhibits that Encourage Students' Engagement

Neta Shaby, Ben-Gurion University of the Negev, Israel Orit Ben Zvi Assaraf, Ben-Gurion University of the Negev, Israel Tali Tal, Technion

ABSTRACT:

This research explores learning in science museums through the most common activity in a science museum – interaction with exhibits. The goal of this study was to characterize aspects of the science museum exhibits that have a particular impact on students' engagement during the visit. In order to do so, we used a qualitative method of observation as well as the VEF model, a visitor-based framework for assessing visitors' learning experiences with exhibits in a science center setting. The combined method produced a framework of 9 learning behaviors exhibited during the visitors' interaction with the exhibits, grouped into three categories that reflect

increasing levels of engagement and depth of the learning experience. Our research population consisted of a total 1800 students aged 10-12 (4th - 6th grade) that came to the museum with their class for a visit. We observed 9 exhibits, 200 students in each exhibit. Our observations revealed several characteristics that contribute to engagement with exhibits in science museum. For example, exhibits that facilitate social interaction will increase engagement, designing the exhibit like a game contributes to visitors' interaction, and using a familiar real-world phenomenon will encourage visitors to engage with the exhibit to the highest extent.

Measuring the Effect of Our World Exhibition on Visitors: A Case of a Science Center

Mehmet C. Ayar, the Scientific and Technological Research Council of Turkey

Kubra Bal Cetinkaya, Tubitak

Ahmet Uludag, Tubitak

ABSTRACT:

This study aims at investigating the effect of an exhibition titled "Our World" at a science center on visitors in a Eurasian country. In this study, we explore the effect of "Our world" exhibition at the center on visitors and elicit factors that make visitors revisit the exhibitions. We answer our research question "What is the effect of "Our World" exhibition on visitors?" using quantitative and qualitative methods. Our study participants are middle and high school students. A survey is administered to 366 students and 18 are interviewed. Our analysis indicates that "Our World" exhibition at the science center has a platform to support curiosity and interest in science topics. Students' desire to revisit is associated with crowdedness, lack of time and maintenance during the visit. In addition, "Our World" has diverse and rich-content in nature. Student visitors already consider exhibits as amazing, interesting and thought-provoking. Yet, exhibits do not challenge students to generate questions in minds and seek to answer them even though they want to revisit the exhibition.

Using thermal Cameras to Teach Middle School Students about Energy Dissipation in an Informal Setting Susanne Wessnigk, Leibniz University of Hannover Jeffrey Nordine, IPN-Kiel

ABSTRACT:

As middle school students build ideas about energy, they tend to accept ideas about energy forms, transformation, and transfer but struggle with conservation and dissipation. Energy conservation and dissipation often run counter to everyday experiences; energy often seems to vanish with little apparent evidence that it has dissipated into the surroundings. As such, students may lack a sufficient evidence base to accept ideas about dissipation. Our study investigates the usefulness of thermal imaging cameras for providing the type of vivid evidence of dissipation that will help students accept and apply this idea when making sense of phenomena. In a pilot study, we engaged middle school students in a series of energy learning activities in an informal setting; students used thermal cameras to track short-lived changes in temperature as everyday phenomena unfold. We interviewed 6 participants in a repeated-measures design and gathered reflection forms regarding their experiences with the cameras. Our findings suggest that thermal cameras may provide vivid evidence of energy dissipation and help students to understand and apply the idea of dissipation when making sense of phenomena.

Strand 7: Pre-service Science Teacher Education Preservice Teachers and Mentoring 4:20pm - 5:50pm, Baltimore Salon A Presider: Kadir Demir, Georgia State University

Preservice Elementary Teachers and Science Instruction: Barriers and Supports Katherine P. Dabney, Virginia Commonwealth University Michael R. Scott, The University of Texas at Austin

Amy C. Hutton, Virginia Commonwealth University Shane J. Perry, Virginia Commonwealth University *ABSTRACT:*

Preparation of schoolteachers, much less elementary teachers, in graduate degree programs has received significant scrutiny. Concerns include a focus on preparation of future teachers to become and be effective elementary science teachers. This presentation examines males and females in preservice elementary school programs and elementary teaching positions in order to provide more insight into elementary school teacher experiences with and perceptions of science instruction and factors inside and outside of their graduate program that are barriers or supports toward their development of science instruction skills and self-efficacy. The analysis was examined through a critical realist (Miles & Huberman, 1994) and emergent coding approach regarding science education personal life and graduate school experiences. Results are examined through an extensive literature review and point toward further inquiry and evidence that may impact public policy and educational practices, promoting ways to advance education and opportunities for preservice and practicing teachers in science. 0 false 18 pt 18 pt 0 0 false false false /* Style Definitions */ table.MsoNormalTable {msostyle-name: "Table Normal"; mso-tstyle-rowband-size:0; mso-tstyle-colband-size:0; mso-style-noshow:yes; mso-style-parent:""; mso-padding-alt:0in 5.4pt 0in 5.4pt; mso-para-margin:0in; mso-para-marginbottom:.0001pt; mso-pagination:widow-orphan; font-size:12.0pt; font-family: "Times New Roman"; mso-asciifont-family:Cambria; mso-ascii-theme-font:minor-latin; mso-fareast-font-family:"MS 明朝"; mso-fareasttheme-font:minor-fareast; mso-hansi-font-family:Cambria; mso-hansi-theme-font:minor-latin; mso-bidi-fontfamily:"Times New Roman"; mso-bidi-theme-font:minor-bidi;}

MORE for Teachers: A Research-based Model to Support the Mentoring of Elementary Pre-service Teachers in Science

Daniel Hanley, Western Washington University Tammy Q. Tasker, Western Washington University Joseph A. Brobst, Western Washington University Matthew Miller, Western Washington University *ABSTRACT:*

Our paper focuses on our model of mentor professional development for supporting teacher candidates in elementary science instruction. Model of Research-based Education (MORE) for Teachers is a five-year longitudinal study focused on mentor preparation program grounded in research-based elements of effective science instruction and mentoring. Rather than "one-shot" professional development, the structure of the MORE for Teachers program is grounded in research that cites the efficacy of longitudinal and discipline-focused learning opportunities for teachers who mentor preservice candidates in their classrooms. The program includes opportunities for cooperating teachers to practice mentoring preservice teachers with support over time. Session attendees will learn about this transferable model for effective science mentor professional development and about our mixed-methods, quasi-experimental one-group repeated measures research design for demonstrating the effects of our series of mentoring professional development modules.

Teacher Professional Identity: A Case Study of Pre-service and Mentor Science Teacher Interaction Jan Nourollahi, Georgia State University Kadir Demir, Georgia State University Anton Puvirajah, Georgia State University *ABSTRACT:* The purpose of this study of mentor and preservice science teachers during field teaching assignment

The purpose of this study of mentor and preservice science teachers during field teaching assignments is to gain a further understanding of the influence of the mentor teacher on preservice teacher professional identity development. The main research question is: How do the interactions between the preservice and mentor science teachers influence the professional identity development of the preservice teacher? This question was
explored through a situated learning lens utilizing a descriptive, single case study design. One-on-one interviews of eight preservice and four mentor teachers (N=12) were conducted and analyzed for specific categories on professional science teaching identity: Traditional, Instructive, Transitional, Responsive, and Reform-based (adapted from Fletcher & Luft, 2011). Video-recorded planning sessions, and written reflections of preservice and mentor teachers revealed changes in preservice teachers' views of their professional identity over the course of a semester-long field teaching assignment. The case study narrative that results from the written and verbal communication between the preservice and mentor teachers provides important insight into their relationship and the possible subsequent influences on preservice teacher professional identity. This may have implications for the future development of science teachers and the design of preservice teacher field experiences in science teacher education programs.

Perspectives on Coteaching from the Classroom: Student, Preservice, and Cooperating Teachers' Voices Andrea Drewes, University of Delaware

Kathryn Scantlebury, University of Delaware **ABSTRACT:**

This paper discusses the design, field testing and validation of a coteaching evaluation for teacher candidates and clinical educators. A team of experts (clinical educators, university researchers and teacher candidates), wrote items on coplanning, coteaching, co-respect and coevaluation. A field test, then pilot study were conducted and the evaluation subsequently revised utilizing mixed methods analysis including both qualitative (thematic analysis) and quantitative (confirmatory factor analysis) for construct validation and instrument fidelity. Results for a final version of a coteaching survey for both audiences will be discussed, as well as future directions for this measure in science teacher preparation will be explored

Strand 7: Pre-service Science Teacher Education

Preservice Teachers' Views About the Nature of Science and Scientific Inquiry 4:20pm - 5:50pm, Maryland Salon E Presider: Christopher Wilson, BSCS

Development of Pre-Service Science Teachers' Conceptions About Theories and Models Within a Nature of Science-Seminar

Bianca Reinisch, Freie Universität Berlin Dirk Krüger, Freie Universität Berlin

ABSTRACT:

Theories and models are seen as central forms of knowledge with important function for the generation and validation of new knowledge within biology. However, there is a lack of pre-service science teachers' understanding about the role and status of theories and models. In the context of a nature of science-seminar an intervention has been developed based on pre-instructional conceptions of the participating pre-service teachers (N = 14) as well as on science philosophy literature. The written pre-conceptions were evaluated and changed by the participants themselves after the intervention. Following an evaluative content analysis findings reveal a shift from a rather naive towards a more elaborated view for half of the participants. However, a more detailed evaluation of the data reveals that some of the remaining participants still have small shifts towards scientific perspectives after the intervention, which is not visible in the evaluative analysis due to the limited number of categories. It is inferred that after a refinement of the intervention a philosophy-based intervention can be a promising way to foster pre-service teachers within nature of science-contexts and, hence, is seen as a potential alternative or, moreover, additional approach next to others such as historical oriented methods.

Development and Validation of the Intention to Integrate Nature of Science Questionnaire Gulsum Akyol, Aksaray University Ceren Oztekin, Middle East Technical University Semra Sungur, Middle East Technical University Fouad Abd-El-Khalick, University of Illinois at Urbana-Champaign

ABSTRACT:

This study aimed to develop, and evaluate the psychometric properties of, a questionnaire to explore variables that could potentially explain pre-service science teachers' intentions to integrate nature of science into their science instruction. The theory of planned behavior (TPB) guided the questionnaire development process. The questionnaire included 10 theoretical constructs (intention, attitude toward behavior, subjective norm, perceived behavioral control, behavioral belief strength, outcome evaluation, normative belief strength, motivation to comply, control belief strength, and power of control factor), which were measured by an initial pool of 115 items on a 7-point scale. It was administered to 408 Turkish senior pre-service science teachers. Confirmatory Factor Analysis (CFA) was used to examine the factor structure underlying the responses. The finalized questionnaire comprised 52 items clustering under a 10-factor model with a reasonably good fit [Satorra–Bentler $\chi 2$ (1211, N = 408) = 1400.93, p < .05, RMSEA = .020, CFI = .996, NNFI = .996, SRMR = .052]. Additionally, internal consistency estimates computed by Cronbach's alpha for the ten factors ranged from .75 to .92.

A Holistic Approach to Teaching Science as Inquiry in a Pre-Service Teacher Education Methods Course Jeanette Bartley, University of Chicago

ABSTRACT:

According to the NGSS "Coupling practice with content gives the learning context, whereas practices alone are activities and content alone is memorization. It is through integration that science begins to make sense and allows students to apply the material". If the expectation set forth by NGSS is that students are taught and learn in this way, then we have to ensure that all teachers, particularly pre-service science teachers, are able to teach in this way. Teaching teachers how to teach science as inquiry is a complex task and one that needs to be done in such an explicit way that allows the teachers to not only experience teaching science as inquiry as students, but also analyze, critique and reflect on it as practicing teachers. Pre-service science teachers, particularly at the secondary level, may need explicit exposure and practice with teaching science as inquiry strategies in order to truly transfer their learnings into practice. The goal of this study was to determine if using a holistic inquiry approach in a methods course to teach science as inquiry to pre-service secondary science teachers had any influence of the pre-service teachers conceptions of and ability to teach science as inquiry.

Influence of the NGSS Framework on Pre-Service Teachers' Understanding of Science and Science Inquiry Julie A. Contino, American Museum of Natural History

Rosamond Kinzler, American Museum of Natural History

ABSTRACT:

With the release of the Next Generation Science Standards (NGSS) in 2013, many science teacher preparation programs have adapted their curricula in order to prepare new teachers to understand and implement the three dimensions of the NGSS into their teaching. Our 15-month, graduate-level urban residency MAT program responded by using A Framework for K-12 Science Education (2012) as a guide to modify an existing course syllabus designed to advance pre-service teachers' science literacy and develop their abilities to impact the science literacy of their students. In addition to completing this course, pre-service teachers also completed: (1) 24 graduate-level credits of coursework and (2) Two 5-month teaching residencies in high need schools. In order to answer the question, How does pre-service teachers' understanding of science and science inquiry (nature of science) change after completing a graduate-level course informed by the new framework and

NGSS? We tracked changes in understanding over 10 months using the Student Understanding of Science and Science Inquiry (SUSSI) Questionnaire. Results indicate that pre-service teachers from two cohorts changed their understanding about the methodology of scientific investigation. Preparing science teachers with an accurate understanding about how science works can ultimately lead to a more scientifically literate population.

Negotiating Tensions: Development of Ambitious Science Teaching Practices Arzu Tanis Ozcelik, Penn State University Scott McDonald, Pennsylvania State University ABSTRACT:

Reform-based learning environments require teachers to be able to engage students in scientific discourse and practices. Science teacher education literature recommends research-based ambitious science teaching practices for teacher candidates to help them prepare to teach in those reform-based learning environments. Using sociocultural and situated theories of learning, this study investigated how science teacher candidates (TCs) negotiated tensions around ambitious science teaching practices. Using the case study design, the study utilized grounded theory approach and discourse analysis for the analysis of video records of the science teaching methods course. The participants included six TCs enrolled in the secondary science teaching methods course in large mid-Atlantic university's teacher education program. Findings showed that TCs negotiated: 1) the agency for doing explanations, 2) the nature of what constitutes an explanation, and 3) what constitutes a phenomena and its relationship to the storyline in a unit of instruction. Based on those negotiation points, the study provides implications for science teacher educators for supporting TCs' development of ambitious science teaching practices.

Strand 8: In-service Science Teacher Education

Related Paper Set - Supporting Students' Engagement in Science and Engineering Practices: Exploring Instructional Shifts and Supports for Teachers

4:20pm - 5:50pm, Maryland Salon F

Discussant:

Michael Ford, University of Pittsburgh

ABSTRACT:

Given the challenges posed by supporting students to engage meaningfully in science and engineering practices, how do we help teachers to orchestrate these learning environments? What shifts in teachers' understandings and practice are required? The four papers in this related paper set all seek to address these questions. Each set of authors presents an intervention designed to help teachers reposition students in relation to scientific knowledge, tasks, and authority figures, with the aim of promoting student engagement in meaningful science or engineering practice. In our presentations, we will discuss these interventions and will share our analyses of how teachers made sense of the instructional shifts needed to support disciplinary practices in their classrooms.

Leveraging Uncertainty to Support Students' Engagement in Practice: A Pilot Study Eve Manz, Boston University Enrique Suarez, University of Colorado, Boulder

Epistemic Agency, Aims, and Considerations: Entry Points for Enhancing the Meaningfulness of Students' Knowledge-Building Work Abraham S. Lo, University of California, Davis Preservice Science Teachers' Participation in "Invisible" Science Practices David Stroupe, Michigan State University Amelia Wenk Gotwals, Michigan State University

Leveraging Students' Everyday Engineering Practices in the Science Classroom: A Study of Teacher Learning About Design Instruction Veronica McGowan, University of Washington

Shelley Stromholt, University of Washington Philip L. Bell, University of Washington

Strand 10: Curriculum, Evaluation, and Assessment

Related Paper Set - State of the Art and Viability of Formative Assessment in Inquiry-based STEM Education

4:20pm - 5:50pm, Watertable Salon B **Presider:** Jan Alexis Nielsen, University of Copenhagen **Discussant:** Erin Marie Furtak, University of Colorado *ABSTRACT:*

This set of papers brings together four perspectives on the affordances and challenges of formative assessment in the context of inquiry-based STEM teaching. Together, the four papers provide a comprehensive exploration of this issue. The first provides an extensive literature review documenting that formative assessment only plays a minor role in existing empirical research on assessment in inquiry teaching. The second explores how concrete formative assessment methods can be aligned to competences that are goals of inquiry learning. The final two papers examine extensive multi-country trials of two of these concrete methods. Using case studies from England and Finland, the third paper empirically examines the characteristics of 'on-the-fly' interactions between teachers and students as well as factors which seem to facilitate or impede teachers' attempts to guide students towards inquiry learning goals. The fourth paper explores the extent to which a specific assessment tool for written feedback can guide teachers to diagnose student needs, ascertain level of attainment of a selected competence and provide feedback. Using classrooms in Cyprus, Denmark and Germany, the study analyses the various ways in which students respond to the feedback they receive as well as to a second round of teacher written feedback.

Current State of the Art in Formative Assessment of Inquiry – Results from a Literature Review Silke Roennebeck, Leibniz Institute for Science and Mathematics Education Mathias Popohol, Leibniz Institute for Science and Mathematics Education

Methods of Formative Assessment for Inquiry Learning Regula Grob, School of Education Northwestern Switzerland Peter Labudde, Paedagogische Hochschule FHNW

Formative Assessment in Inquiry-Based Science Education Using Interactions 'On-the-Fly' Pasi Nieminen, University of Jyvskyl Catarina Correia, King's College London

Affordances and Challenges of Written Feedback as Formative Assessment in Inquiry-Based STEM Education Robert H. Evans, University of Copenhagen Mathias Ropohl, Leibniz Institute for Science and Mathematics Education Jan Alexis Nielsen, University of Copenhagen Nicos Papadouris, University of Cyprus Jan Alexis Nielsen, University of Copenhagen Erin Marie Furtak, University of Colorado

Strand 13: History, Philosophy, and Sociology of Science

Symposium - Nature of Science in the Next Generation Science Standards: Translating Recommendations into Practice

4:20pm - 5:50pm, Baltimore Salon B Presider: Kostas Kampourakis, University of Geneva **Presenters**:

Kostas Kampourakis, University of Geneva William F. Mccomas, University of Arkansas Norman G. Lederman, Illinois Institute of Technology Gregory J. Kelly, Penn State University Irene Neumann, Leibniz-Institute for Science and Mathematics Education Alice Siu Ling Wong, The University of Hong Kong Ross H. Nehm, SUNY Stony Brook

ABSTRACT:

In recent years, teaching about nature of science (NOS) has been considered as an important component of science education in reform documents in various countries. Extensive empirical research about how some general aspects of NOS can be effectively taught is also available. However, research in science education has also shown that science teachers fail to effectively teach NOS in their classrooms, even after specific training for this purpose. Therefore, teaching standards and curricular recommendations are not enough; it seems that practical strategies and instructional tools are required in order for teachers to be able to translate curricular recommendations into practice. The aim of this symposium is to explore practical aspects of teaching nature of science (NOS) through the lens of the new Next Generation Science Standards (NGSS Lead States, 2013). Our symposium will bring together experts to reflect upon NOS/NGSS from both US and non-US perspectives. Three presenters from the US will address particular NOS aspects and discuss strategies and challenges relating to the implementation of the NGSS. Then one presenter from Europe (Germany) and one from Asia (China) will describe how the NGSS are taken into account outside the US context and how they can be implemented in the local contexts. The symposium participants include: William F. McComas, University of Arkansas, USA; Norman G. Lederman, Illinois Institute of Technology, USA; Gregory Kelly, Penn State University, USA; Irene Neumann, Leibniz Institute, Germany; Alice Wong, University of Hong Kong, China. Each of the participants will make a 10-minute presentation followed by whole-group discussion.

Strand 14: Environmental Education

Questions of Curriculum 4:20pm - 5:50pm, Watertable Salon A

Presider: Sybil S. Kelley, Portland State University

Bioenergy Science and Engineering as Components of Agricultural Education Curricula Brian Hartman, Oregon State University Kimi Grzyb, Oregon State University Tyson Sorensen, Utah State University

Katherine G. Fields, Oregon State University *ABSTRACT:*

Plant-based energy sources (bioenergy) are a major component of the US renewable energy plan. This plan calls for the introduction of new energy crops to the agricultural landscape such as poplar, miscanthus, and switchgrass. K12 Agricultural science teachers recognize the need to teach about bioenergy and these new crops but lack confidence in their understanding of the field (Christensen, Warnick, Spielmaker, Tarpley, & Straquadine, 2009). This research project addresses this need by developing an expert-based bioenergy framework. Twenty bioenergy researchers were asked to identify key K12 bioenergy concepts through the use of the Delphi consensus methodology. They identified concepts such as energy knowledge, climate change, and plant physiology as important to understanding bioenergy. This framework will be important to developing future curricula in the agricultural science field.

Drawing for Ocean Literacy: A Baseline Study

Meghan E. Marrero, Mercy College Diana L. Payne, University of Connecticut *ABSTRACT:*

The ocean is our planet's largest feature, yet most people do not know much about it, nor the important roles it plays on Earth. Ocean literacy, that is, "an understanding of the ocean's influence on you, and your influence on the ocean," (Carley et al., 2013) is not easy to assess as there is no established instrument to do so. This study used middle and high school students' drawings and written responses to better understand their baseline ideas about how the ocean influences them, and they influence the ocean. Using a coding scheme aligned with the Essential Principles of Ocean Literacy, we analyzed the responses of more than 60 students and identified commonly held ideas, as well as gaps between how students respond and important concepts as set forth in the ocean literacy framework. In order to better design instruction aimed at improving ocean literacy, we must first understand students' mental models about the ocean and their connection to it, and this study is one step toward doing so.

Environmental Education in Israeli Schools: Philosophies, Contents and Pedagogies

Tali Tal, Technion

Einat Peled, Technion

ABSTRACT:

In this study we aimed at understanding how environmental education is implemented in Israeli elementary schools. We selected 10 schools that implement Education for Sustainability programs and analyzed their mission statements and curriculum documents. We observed each school's activities and interviewed teachers. Our analysis shows ambiguity with respect to rationales and theoretical foundations. It shows as well much didactic teaching of contents, strong focus on behavioral outcomes, especially with respect to reducing resource consumption and recycling and some degree of working with the community. The unclear status of EE in Israel in term of structure within the education system, which prevents it from having enough resources for teacher training and curriculum development was suggested as a main cause for this ambiguity and traditional pedagogies.

Secondary Science Students' Knowledge, Skills and Attitudes Towards Data Alan R. Berkowitz, Cary Institute of Ecosystem Studies Tobias Irish, Cary Institute of Ecosystem Studies Cornelia Harris, Cary Institute of Ecosystem Studies ABSTRACT:

The Data Explorations in Ecology Project (DEEP) was designed to address data literacy issues in secondary science classrooms through the development and implementation of curricular modules designed to support

students in gaining proficiency with data exploration practices. The focus of the research associated with this project is on understanding students' knowledge, skills, and attitudes toward these practices across grade levels. The participants include 356, 7th -12th grade students from 14 different schools in the Hudson Valley region of New York State. The data include pre- and post-tests evaluating students' data exploration skills, surveys evaluating student interest and motivation towards data exploration activities, focus group interviews evaluating students' data explorations skills and student critique essays. The findings highlight students' knowledge, skills and attitudes toward a variety of data exploration activities, including interpreting data representations, understanding variability and evaluating claims based on the available evidence. This study contributes to the field of science teacher education by introducing a framework for characterizing critical stages of inquiry processes, thus helping us track how different skills manifest themselves at different stages and across different age groups.

Concurrent Session #3 8:30am - 10:00am

Equity and Ethics Committee

Administrative Sponsored Symposium – Diversity and Equity in Science Education: Voices From across the Globe

8:30am - 10:00am, Maryland Salon E

Presenters:

Nam-Hwa Kang, Korea National University of Education Jerome M. Shaw, University of California - Santa Cruz Angela Calabrese Barton, Michigan State University Peter Okebukla, Lagos State University, Lagos-Nigeria Melody Russell, Auburn University Orit Ben Zvi Assaraf, Ben-Gurion University of the Negev Israel Jomo W. Mutegi, Indian University Sonya N. Martin, Seoul National University Christina Siry, University of Luxembourg

ABSTRACT:

As science increasingly makes a huge impact on major concerns in the world -- such as human health, food production, clean water, and economic development -- it is critical that we have a world of citizens who can use their science knowledge and skills to make informed choices relevant to everyday life, and to make the world a better place by engaging in STEM-related careers if they so choose. With Globalization, efforts such as education the world over are experiencing rising diversity and consequently facing issues associated equity. While there is an established body of research on diversity and equity around the world, there has been limited discussion of how such issues manifest and are addressed in science education in multiple international contexts. We will explore this topic, exploring similarities and differences and generating ideas for a collaborative international research program where knowledge and insights are shared and further developed.

Strand 1: Science Learning, Understanding and Conceptual Change

Role of Curriculum and Instruction to Support Student Learning

8:30am - 10:00am, Federal Hill Presider: Cathy P. Lachapelle, Museum of Science

Features of Instruction Supporting Students' Construction of Pattern Knowledge Hillary L. Swanson, Northwestern University **ABSTRACT:**

The Next Generation Science Standards charge U.S. teachers with the task of including patterns, as a crosscutting concept, in their science curricula. This study explores the design of curriculum and instruction meant to help students notice and articulate patterns. Patterns are here defined as general behaviors or processes that can be found in a range of phenomena; examples include threshold, equilibration, exponential growth, and oscillation. The study investigates elements of the pattern-knowledge construction process and the features of instruction that support these elements. Findings suggest two important phases of the process: 1) activation and 2) engagement of prior knowledge. A more finely grained picture is then painted, including the elements belonging to each phase and the features of instruction that support these elements.

Investigate Different Achievers' Motivation and Achievement Under Guided Inquiry-Based Instruction Yen-Ruey Kuo, National Changhua University of Education Hsiao-Lin Tuan, National Changhua University of Education

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Chi-Chin Chin, National Taichung University of Education **ABSTRACT:**

This study aims to investigate different achievers' motivation and their achievement performance in six different science units under guided inquiry instruction. Grade 8 students in two schools in Taiwan were the samples and divided to experimental (n=58)and comparison group(n=48). Questionnaires were used to collect quantitative data for two-way ANOVA of students' motivation and achievement, and interviews were conducted to collect qualitative data for deep understanding students' motivation. Results show high and average achievers could benefit from the inquiry instruction cognitively and low achievers could benefit affectively. Implications are discussed.

Mapping Science in Discourse-Based Inquiry Classrooms: A Case Study of Three Urban Science Teachers Demeke G. Yeneayhu, University of Rochester

ABSTRACT:

This study is a naturalistic inquiry video-taped classroom lesson observation study of three urban science teachers. It investigates how discourse-based inquiry science lessons provided opportunities for students to develop a network of semantic relations among core ideas and concepts in science. Analysis of their classroom lesson videos revealed that if teachers are to help students participate in classroom discourse that would enable them meaningfully connects core ideas and concepts in science, teachers could use various discourse tools and pedagogic resources that could fit into their particular classroom realities and contexts. This study also demonstrated that when given the opportunity, students in challenging contexts such as in typical inner city schools are able to engage in scientific processes and develop nuanced understandings of scientific phenomena.

Relating Curricular Content Coherence to Learning: Examining High School Students' Emerging Understanding of Biology

Candice R. Guy, University of California, Davis Julia Gouvea, Tufts University Chris D. Griesemer, University of California, Davis Emily Harris, University of California, Davis Abraham S. Lo, University of California, Davis Cynthia Passmore, University of California, Davis

ABSTRACT:

The purpose of this study was to examine how students organize and relate biological ideas and phenomenon after learning biology through a model-based instructional sequence organized around the unifying theme natural selection. We conjectured that if we if developed coherent curricular resources then students would have opportunities to make connections among disciplinary core ideas (NGSS Lead States, 2013), their related phenomena, and the models that help explain them. We investigated student connections by analyzing discourse elicited during a card-sorting task, utilizing diSessa's (2002) knowledge system framework to illustrate the ways we perceived students to be organizing the questions, phenomena, and models they described. Results indicate students are able to make these connections, providing explanations at varying levels of depth (classes of phenomena vs. specific phenomena) and with increasing complexity. Additionally, our overall findings suggest students are able to draw on a number of phenomena and/or the supporting constructs and models to explain core biological ideas.

Strand 2: Science Learning: Contexts, Characteristics and Interactions

Attitudes and Identity in STEM

8:30am - 10:00am, Maryland Salon B Presider: Mei-Hung Chiu, National Taiwan Normal University

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Measuring Science Curiosity in Learning Environments: Developing an Attitudinal Scale Jennifer L. Weible, Central Michigan University

Heather Toomey Zimmerman, Penn State University

ABSTRACT:

Although curiosity is considered an integral aspect of science learning, researchers have debated how to define, measure, and support its development in individuals. Prior measures include questionnaire type scales (developed primarily for adults) and behavioral measures. To address the need to measure scientific curiosity, the Science Curiosity in Learning Environments (SCILE) scale was created and validated. The scale was developed through (a) adapting the language of the CEI-II (Kashdan et al., 2009) for youth and (b) crafting new science items based on scientific behaviors and attitudes [the Next Generation Science Standards (NRC, 2013) and the K-12 Framework (NRC, 2012)] and the Children's Science Curiosity Scale (Harty & Beall, 1984). The methodology included administering a preliminary set of 30 items to 663 youth ages eight to 18 in two school districts in the United States. Exploratory and Confirmatory factor analysis was conducted to determine the psychometric validity of the SCILE scale. Our analysis resulted in a three-factor model: stretching (six items), embracing (two items), and science attitudes (four items). The findings indicate that the SCILE scale is a valid measure of youth's scientific curiosity for boys and girls as well as elementary, middle school, and high school learners.

Relationship of Context Characteristics and Chemical Content Areas and Its Impact on Students' Situational Interest

Sebastian Habig, University of Duisburg-Essen Helena Van Vorst, University of Duisburg-Essen Elke Sumfleth, Universitaet Duisburg-Essen

ABSTRACT:

One of the major problems of chemistry education at schools is students' little interest in chemistry courses. Context-based science education seems to be an appropriate way to encounter this problem. By embedding chemical contents into life-related learning settings students' interest in science at school can be fostered. In the past decades many studies pointed out these positive effects of context-based science education on students' interest. However, there is few empirical evidence about the specific characteristics of contexts which induce these effects. Based on previous research in this field a reciprocal relationship between the context characteristics relation to everyday life/uniqueness and the underlying content area was assumed. In order to investigate this relationship, a study with 435 ninth-graders of German secondary schools has been conducted. The students rated their situational interest in 20 context-based introductory texts, which differed in the aforementioned context characteristics and their underlying content area. The results affirm our hypothesis that the usefulness of context-based tasks regarding affective dimensions of learning depends on an interaction of context characteristics and the underlying content area.

Student Beliefs: Using Cluster Analysis and Self-Organizing Maps to Understand High School Students' Chemistry Self-Concept

Sara E. Nielsen, Miami University Ellen J. Yezierski, Miami University *ABSTRACT:*

Research on the relationship between the cognitive and affective domains demonstrates the importance of assessing students' attitudes towards learning and beliefs about their ability to succeed in an academic setting. Self-concept is an affective construct that describes a person's beliefs about his or her ability to succeed in a specific domain, such as chemistry. Chemistry self-concept has been measured in college students and shown to connect to achievement. We set out to better understand high school chemistry students' self-concept to help instructors target students at risk of not succeeding in chemistry, which is often an important gateway to all science fields. With a sample of over 500 students from seven teachers' classrooms in four markedly different

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school settings, a repeated-measures study was conducted over two academic years. The Chemistry Self-Concept Inventory was used to assess high school chemistry students' chemistry, math, and academic self-concepts. Self-Organizing Maps (SOMs) helped visualize the data collected for items and composite subscale scores. SOMs use similarities among students to create representations that illuminate trends in the data not often detected with statistical tests. Results of this study will inform research into student beliefs as well as the teaching practices of high school chemistry teachers.

STEM Roles: How Students' Ontological Perspectives Facilitate STEM Identities

Dina Verdin, Purdue University Monique Ross, Purdue University Allison Godwin, Purdue University

ABSTRACT:

Prior work in understanding how students identify with STEM-related subjects has focused on qualitative methods. In some of our prior work, we have developed quantitative measures of high school and early college students' identities in math, science, physics, and engineering. These measures have focused on students' self-beliefs of their performance/competence, interest, and recognition by others in a particular subject and have been found useful in predicting career choices in physics, math, and engineering. However, one criticism of this method has been the lack of understanding of how students interpret what it means to be a math, science, or physics person or engineer. This work explores students' ontological perspectives on what it means to identify as a particular STEM person through interviews with 17 students at two high schools in the U.S. We compare students' descriptions of what it means to be a STEM person, if they identify themselves as a STEM person, and their perceptions of who can be a STEM person through constant comparative coding. Students describe needing performance/competence and interest beliefs for participation in all STEM areas. Additionally, they describe varying levels of access and perceived barriers to identifying with particular STEM fields.

Investigating the Role of Students' Goal Orientations on their Understanding of Chemical Equilibrium Concepts

Esra Sarici, Middle East Technical University Esen Uzuntiryaki-Kondakci, Middle East Technical University *ABSTRACT:*

The purpose of this study was to investigate the contribution of goal orientations to 11th grade students' understanding in chemical equilibrium concepts. A total of 321 11th grade students (177 females, 138 males, and 6 not mentioned gender) participated in the study. Data were collected using Chemical Equilibrium Concept Test and Achievement Goal Questionnaire. Chemical Equilibrium Concept Test consisted of 18 items in multiple-choice formats. It mainly measured students' comprehension of dynamic nature of chemical equilibrium, equilibrium constant, and factors affecting chemical equilibrium. Achievement Goal Questionnaire included 18 items in seven-point rating scale. It had six dimensions based on the 3x2 achievement goal model: task-approach, task-avoidance, self-approach, self-avoidance, other-approach and other-avoidance. Results of multiple linear regression analysis showed that task-approach and self-approach goals were positive predictors whereas other-approach goals are negative predictors of students' understanding in chemical equilibrium concepts.

Strand 4: Science Teaching--Middle and High School, Grades 5-12): Characteristics and Strategies *Related Paper Set - Building Exemplary Teaching Practices: Following the Paths of New Science Teachers* 8:30am - 10:00am, Baltimore Salon B **Presider:** Elizabeth B. Lewis, University of Nebraska-Lincoln

resider. Elizabeth D. Lewis, Oniversity of Neoraska-Eliteoni

Changes in Science Teaching Self-Efficacy from Induction Year 1 to Year 2

Aaron Musson, University of Nebraska-Lincoln Ana Margarita Rivero, University of Nebraska-Lincoln Lyrica Lucas, University of Nebraska-Lincoln Jia Lu, University of Nebraska-Lincoln Elizabeth B. Lewis, University of Nebraska-Lincoln *ABSTRACT:*

There is little research that identifies how contributing factors interact to produce highly-qualified, effective science teachers. We conducted a 3-year study of four cohorts of science teacher program graduates. We analyzed 319 science lessons of new teachers from student teaching to third year post-program to see how teaching practices and self-efficacy changed over time. Analysis of teachers' instruction showed that Year 3 teachers applied more proficient or exemplary inquiry-based approaches when compared with preservice, Year 1 and 2 teachers. Analysis also showed an increase in all discourse factors, which suggests that classroom discourse became more inquiry-based and student-centered over time. Teachers were in the practice of assessing students' understanding and showed increases in use of authentic measures and learning activities to assess students. Teachers provided more content depth and better integration among content and investigation as they became more experienced, but more student-centered opportunities could be provided to have greater executive control over the ways in which they manage scientific information. Finally, we found that teachers' self-efficacy post-Year 1 and 2 was overall positive and that the three categories remained fairly stable; teachers appeared to think that they could positively affect student engagement, classroom management, and instructional strategies.

Instructional Factors and Teaching Self-Efficacy of New Science Teachers Lyrica Lucas, University of Nebraska-Lincoln

Discourse in Beginning Science Teachers' Classrooms Jia Lu, University of Nebraska-Lincoln

Assessment Practices of New Science Teachers Ana Margarita Rivero, University of Nebraska-Lincoln

Curricular Choices of New Science Teachers Elizabeth B. Lewis, University of Nebraska-Lincoln

Strand 5: College Science Teaching and Learning, Grades 13-20)
Argumentation and Discourse in Conceptual Development
8:30am - 10:00am, Watertable Salon A
Presider: Sherry A. Southerland, Florida State University

Affordances of Simulators in Support of Content Knowledge and Argumentation Practice in Engineering Education Yonghee Lee, State University of New York at Buffalo Randy K. Yerrick, SUNY- UB

Carl Lund, SUNY-UB

ABSTRACT:

In this study, we examined whether the use of simulator integrated into active learning instruction supported engineering students to learn engineering content knowledge and to engage in argumentation practice. Case studies were conducted in undergraduate engineering classrooms in a public university in the Northeast U.S. Forty-two upper level engineering students participated in this study over the course of a semester. We collected

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data from multiple sources: pretest and posttests, interviews, classroom observations, survey questionnaires and analysis of students' written argumentations. Results showed simulators engaged students in engineering lessons and fostered them to understand abstract concepts. Additional results indicated simulators contributed to promoting students' argumentation practice by doing experiments with peers. Additional results indicated students' scores of written argumentation significantly improved from pretest to posttest. Simulators appear to influence students' engagement in collaborative learning activities; they also enhance students' oral and written argumentation practices. Implications for teaching and future research are discussed.

Reconciling "Everyday Talk" with "Science Talk" in an Undergraduate Biology Laboratory Course for Nonscience Majors

Anna M. Strimaitis, Florida State University Kirby Whittington, Florida State University Sherry A. Southerland, Florida State University Carolyn Schultz, Florida State University

ABSTRACT:

Recent recommendations for postsecondary biology education describe how effective instruction engages undergraduates in science practices and discourses to learn science. Biology laboratory courses are an appropriate context to do this, however many lab courses are taught by teaching assistants (TAs) with minimal teacher preparation. If TAs are expected to enact effective lab instruction, they need to be supported with a "toolbox" of core practices. The Ambitious Science Teaching practice of eliciting student ideas and using those ideas as a basis of instruction may be an appropriate focus for postsecondary lab instruction. This research examines how biology lab TAs elicit and respond to student ideas during a whole class discussion about trophic relationships. Using a multiple case study design, videos were transcribed and coded for ambitious talk moves (e.g. probing student ideas, pressing for explanation) and framing. Each of the TAs enacted the same conversation differently, and the frequency of ambitious talk moves was positively related to the number of students involved in the conversation and the mean number of words per student conversational turn. These findings have important implications for the design of TA professional development that supports TAs to ask questions that elicit student ideas.

The Role of Undergraduate Modeling Activities in Eliciting Group Interactions, Justification, and Sense-Making

Andrea M.-K. Bierema, Michigan State University Jon R. Stoltzfus, Michigan State University Christina V. Schwarz, Michigan State University

ABSTRACT:

Recent national calls for improving science education (e.g., Vision and Change, AAAS, 2011) emphasize the need to focus on core disciplinary concepts and incorporate scientific practices during instruction. To address this need, we introduced modeling activities to the curriculum of two undergraduate, large-enrollment, introductory biology courses. During these activities, students work in groups of three to create scientific models of biological phenomena. We investigated group verbal interactions, justification and sense-making while students developed their models on digital tablets using a theory-based and inductive approach. We also interviewed students to verify our findings. We found evidence that students were engaged in the activity and worked to make sense of the phenomena while occasionally justifying their decisions. We also found that students tend to agree with one another without argument, which suggests engagement in everyday discussion norms that do not necessarily foster explicit scientific thinking. Therefore, these group modeling activities may foster understanding of core concepts, but need further modification, such as asking students to individually develop written explanations of the phenomenon before working on the model in a group. This might lead to improvement in scientific thinking during these modeling activities.

Relationship between Knowledge and Scientific Argumentation Feral Ogan-Bekiroglu, Marmara University Hanife Hakyolu, Marmara University ABSTRACT:

This research study aimed to analyze the relationship between knowledge and argumentation by examining the interaction between students' prior subject matter knowledge and their production of arguments as well as by comparing students' arguments with their knowledge-in-use during scientific argumentations. In order to establish a relationship between knowledge and argumentation, the theoretical framework for this study is based on Billett's (1996) perspective on situated learning theory and Walton's (2000) dialogue theory. A correlational research design was carried out for this research. Six scientific argumentations were promoted sequently in six weeks. Conclusions drawn from the results indicated relationships between prior knowledge and arguments as well as between knowledge in use and arguments. However, these relations were not stable. Learners start an argumentation with their prior knowledge. Hence, learners' contributions to the argumentation may be affected by their prior knowledge about the subject discussed. However, learners' knowledge change while they are constructing, communicating, and evaluating knowledge claims during the argumentation. This knowledge-inuse during the argumentation and their contributions to argumentation may be influenced by dynamism and characteristics of the interaction among them.

Strand 6: Science Learning in Informal Contexts

Administrative Sponsored Symposium - Global Perspectives on Trends in Informal Science Education Research

8:30am - 10:00am, Kent **Presider:** Gary M. Holliday, University of Akron **Presenteres:** John Falk, Oregon State University Judith Lederman, Illinois Institute of Technology Terry McClafferty, Charles Darwin University, Australia Emma Pegram, Natural History Museum, England Tali Tal, Israel Institute of Technology, Israel Jung-Hua Yeh, National Museum of Natural Science, Taiwan *ABSTRACT:*

Presenters will address the question of what is the current state of research in Informal Science Education (what are the prevailing research agendas), and how do we move forward? We find this question to be of particular importance as we comb through proposals to Strand 6 and look for trends in what is being studied - or not being studied - and what implications this has for research in this area. We hope to move the conversation beyond "how do we define ourselves" to "what will help us move forward."

Strand 7: Pre-service Science Teacher Education

Preservice Teachers and Science Practices 8:30am - 10:00am, Maryland Salon A **Presider:** Gale A. Seiler, Iowa State University

Analyzing Explanation Construction as a Means of Supporting NGSS-Oriented Secondary Science Teaching Leonora Kaldaras, Michigan State University Gail Richmond, Michigan State University

Joyce M. Parker, Michigan State University *ABSTRACT:*

The Next Generation Science Standards call for a fundamentally different approach to learning science. They promote three-dimensional (3D) learning that blends disciplinary core ideas, crosscutting concepts, and scientific practices. In this study we examined explanations constructed by secondary science teacher candidates (TCs) as one of the scientific practices outlined in NGSS and necessary for supporting students' learning of science in this 3D way. We examined TCs' ability to give explanations that include explicit statements of underlying reasons for observed natural phenomena, as opposed to simply describing patterns or laws. In their methods courses, TCs were taught to organize explanations into a what/how/why framework, where what refers to what happens in specific cases, that is data or observations; how refers to how things usually happen and is equivalent to patterns or laws; and why refers to causal explanations or models. We examined TCs' ability to do this spontaneously and in a resource-rich environment as a first step in gauging their preparedness for teaching aligned with the NGSS. We found that TCs give accurate accounts of patterns, but often fail to include causes of mechanisms. The implications of these findings for the preparation of teachers for NGSS-based science instruction are discussed.

Prospective Teachers' Knowledge Development of Engineering Design and Its Teaching Dongmei Zhang, The University of Georgia

Barbara A. Crawford, The University of Georgia *ABSTRACT:*

The new K-12 Science Education Framework (NRC, 2012) and Next Generation Science Standards [NGSS] (Achieve, 2013) emphasize students learning about engineering design in addition to science practices. How to help prospective teachers prepare for teaching in light of new reforms related to engineering is one of the imperative issues faced by science teacher educators in the United States. In this paper, we present findings from a case study (Yin, 2014) that aims to examine 22 prospective middle-school teachers' knowledge development process about engineering design and its teaching. We designed an intervention we call, the "Engineering Design" module in a methods course. Data included a pre-survey, team worksheet, two reflections, field notes, lesson plans, and semi-structured interviews. The inductive category development procedure (Mayring, 2000) was followed to analyze all the data. Findings indicated that experiences in a methods course potentially can be effective for facilitating prospective middle-school teachers in developing their knowledge about engineering design, ideas of learning design, and pedagogical insights of teaching design. The implications of this study for science teacher education are also discussed.

Methods Courses: A Place to Learn Teaching Now or a Place to Learn How to Teach in the Future Mohammad Basir, Assistant Professor

ABSTRACT:

The investigator has piloted a model science methods course in which pre-service teachers have repeated opportunities to teach a Full Option Science System (FOSS) unit to students over a semester as a central component of the course. The design-based implementation research approach (Penuel, Fishman, Cheng, & Sabelli, 2011) was utilized to ensure productive partnership with local schools and sustainability of the outcomes. The questions that guided this study are: how prospective teachers perceived and reacted to the problems that occurred while they were teaching the lessons, whether their teaching practices as a group was effective, and how to improve the effectiveness of the designed methods course. The results suggest that the prospective teachers have slightly progressed in some of the High-leverage practices related to classroom norms and routines. However, High-leverage practices related to revision of instruction based on common patterns in students' ideas have shown no or little improvement. It is conjectured that guiding prospective teachers to investigate about common patterns in students' ideas as students interact with the FOS lessons could improve the effectiveness of the designed methods course.

From Preservice to Inservice: A Longitudinal Study of a Developing Teacher of Science Elisebeth Boyer, Ohio State University

ABSTRACT:

This study examines a teacher of science at the elementary level through her preservice teaching, into her student teaching and through her second year as an inservice teacher. Multiple kinds of data were collected including a self-analysis by the participant of her initial science teaching, video of her teaching, field notes and interviews. The study is grounded by the Situated Learning and Legitimate Peripheral Participation theory of learning. The data was analyzed through several rounds of open coding. The findings are presented as a narrative case description. Major themes include a) how the participant began as an eager learner but a confused practitioner, b) moving toward inquiry yet wanting science to be fun and interesting and c) making sense of science teaching when it is not seen in practice. The themes are discussed in detail using supporting evidence from the data. Implications for future science teacher education are presented alongside a discussion of why this study should be of interest to all science teacher educators and NARST members.

Prospective Science Teachers' Knowledge of the Enactment of Science Practices

Robert C. Idsardi, University of Georgia Barbara A. Crawford, The University of Georgia Maria Romero, Simmons College Daniel K. Capps, University of Maine Jaclyn Murray, University of Georgia James Ammons, University of Georgia

ABSTRACT:

This study focuses on the US Next General Science Standards (NGSS) dimension of science practices (SP), how scientists conduct their work, and new teachers' understandings of scientific work and how to translate it into classrooms. During the final semester of a secondary science teacher preparation program, we investigated how to support prospective teachers' knowledge of science practices (SP). We designed an experience engaging prospective teachers in using a newly developed tool, the Science Practices in the Classroom Matrix (SPCM), combined with written and video scenarios. We used a qualitative approach (pre/post-tests and interviews) to determine participants' self-reported and measured knowledge of SP. In interviews prospective teachers reported enhanced confidence in understanding SP; however, participants were unable to consistently recognize various SP or describe the level of depth of SP in written or video scenarios. Yet, participants were able to consistently recognize the level of student-teacher centeredness in enactment of SP. Our results highlight the need for robust support of prospective teachers in not only understanding the nature of SP, but, perhaps more important, how SP are enacted in actual classrooms at various levels of depth and student-teacher centeredness. Implications highlight the need for substantial support throughout the teacher preparation program.

Strand 8: In-service Science Teacher Education

Teacher Education for STEM Education 8:30am - 10:00am, Watertable Salon B **Presider:** Mary K. Nyaema, University of Iowa

Models of STEM Integration and Student Achievement Gains in Engineering Elizabeth A. Crotty, University of Minnesota Selcen S. Guzey, Purdue University Aran W. Glancy, University of Minnesota

Tamara J. Moore, Purdue University Elizabeth A. Ring, University of Minnesota *ABSTRACT:*

This study aimed to examine how the degree of engineering integration in STEM curricular units correlated to various student outcomes related to a comprehensive representation of engineering as a discipline (Author et al., 2015). NGSS and state standards that incorporate engineering, largely address engineering with a focus on the design process (Author et al., 2015). While the design process is a substantial component of engineering, the Framework for Quality K-12 Engineering Education (Author et. al, 2014) provides more comprehensive criteria for what engineering education might include beyond the design process. The authors of this study contend that increased levels of engineering integration correlate to larger student achievement in engineering, based on assessment items developed from the Framework for Quality K-12 Engineering Education for STEM integration, this study aims to bring light to characteristics and structure of integration within STEM curricular units that are potentially associated with higher student achievement gains in engineering.

Science Teachers' Misconceptions about Science and Engineering Practice

Allison Antink-Meyer, Illinois State University

Daniel Z. Meyer, Illinois College

ABSTRACT:

This study describes the conceptual obstructions (referred to herein as misconceptions) that arose for a group of elementary and high school science teachers' reflections on modern examples of science and engineering research. Four distinct misconceptions were identified. Additional misconceptions arose but only those where at least two participants demonstrated ideas are reported. These four misconceptions were: 1) the long term implications of research define the nature of the practices in both science and engineering research, 2) engineering and science are hierarchical, 3) creativity is a limiting factor, 4) research outcomes cannot be processes.

Shifting Conceptions: Identifying and Understanding Teachers' Conceptual Models of Integrated STEM Education

Elizabeth A. Ring, University of Minnesota Emily A. Dare, Michigan Technological University Elizabeth A. Crotty, University of Minnesota Gillian H. Roehrig, University of Minnesota *ABSTRACT:*

This study investigated the ways teachers' models of integrated science, technology, engineering, and mathematics (STEM) education were influenced throughout an intensive, 3-week-long professional development program. Knowing that teacher conceptions of integrated STEM vary widely in education, we attempt to understand what these conceptions are and the experiences in professional development that can influence them. A STEM Reflection Protocol asking teachers to visually represent their conceptual model of STEM education and report on any influences affecting their model was administered at three different times throughout the professional development. Visual analysis and grounded theory techniques were used to identify seven different conceptual models from this data, and these models were tracked throughout the three separate protocol administrations. Analysis of this data indicates that not only are there various models of STEM integration practitioners hold, but these models tend to be vague and unfocused without participation in professional development on the topic. The data also indicates that it is important for facilitators of professional development related to integrated STEM to recognize that these various models exist and to understand the importance of allowing teachers time to reflect upon their own conceptions of integrated STEM education.

Supporting New STEM Teachers in Urban Schools: Attending to Motivational Self-Talk, Identity, and Agency Stacy Olitsky, Saint Joseph's University

ABSTRACT:

In order to support the retention of STEM teachers in high-need schools, it is important that teachers develop a sense of professional identity. This qualitative study focuses on the role of self-talk in identity development for STEM teachers in high-need urban classrooms. Results show that classroom failures when implementing instructional reforms can undermine teachers' identities and sense of competence. However, sometimes teachers are able to use self-talk to generate internal solidarity, maintaining action-oriented identities in the face of obstacles. Findings suggest that school structures that foster greater teacher autonomy can support teachers in centering self-talk on motivational planning, which can increase confidence and avoid blaming self or students. Teachers can also draw on self-talk strategies that include placing interactional difficulties within the larger context of awareness of educational inequalities and the history of reforms in their districts. This study suggests the importance of teacher education approaches that increase understanding about the contexts of teachers' work, educational inequalities, and the history of reform initiatives. Such approaches provide an important ingredient that can steer self-talk away from deficit thinking and blame and towards motivational planning and agency in advocating for themselves and their students.

Strand 9: Reflective Practice

Administrative Sponsored Symposium - Allowing Our Professional Knowledge of Teacher Education to be Enhanced by Self-Study Research

8:30am - 10:00am, Gibson

Discussant:

Funmi Amosun, University of Western Cape **Presenters:**

Gayle Buck, Indiana University Valarie Akerson, Indiana University Allan Feldman, University of South Florida Norman Lederman, Illinois Institute of Technology Judith Lederman, Illinois Institute of Technology G. Michael Bowen, Mount Saint Vincent University Brenda Capobianco, Purdue University Elizabeth Davis, University of Michigan Brent Gilles, Indianna University Anne Hume, University of Waikato Nidaa Makki, University of Akron Stephen Marble, Southwestern University Karthigeyan Subramania, University of North Texas Amy Trauth-Nare, University of Delaware Maria Wallace, Louisiana State University **ABSTRACT:**

This session will focus on the implications of self-studies in science teacher education for reflection and enhancement of professional knowledge. Self-study in science teacher education is being defined as rigorous, critical inquiry in which we--science teacher educators--research our selves and our practices within the academy. This line of inquiry includes research on science teacher educator identity as well as understandings of our own teaching practices. The goals of the session include to 1) foster meaningful discussions on the complexities inherent in science teacher education and how we, as a professional community, are understanding and confronting those complexities, 2) encourage the constructing and reconstructing of our identities as science

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teacher educators, and 3) provide understanding, encouragement and support for science teacher educators as they question, refine and advance professional knowledge. The discussion topics of the session include self-studies that explore content and methods instructors/instruction, as well as chapters on the practice of preparing future teacher educators, both in the US and internationally. Normal 0 false false false EN-US JA X-NONE /* Style Definitions */ table.MsoNormalTable {mso-style-name:"Table Normal"; mso-tstyle-rowband-size:0; mso-tstyle-colband-size:0; mso-style-noshow:yes; mso-style-priority:99; mso-style-parent:""; mso-padding-alt:0in 5.4pt 0in 5.4pt; mso-para-margin:0in; mso-para-margin-bottom:.0001pt; mso-pagination:widow-orphan; font-size:12.0pt; font-family:Cambria; mso-ascii-font-family:Cambria; mso-hansi-font-family:Cambria; mso-hansi-theme-font:minor-latin;}

Strand 10: Curriculum, Evaluation, and Assessment

Assessment Tools: Development and Validation

8:30am - 10:00am, Watertable Salon C **Presider:** Christopher Wilson, BSCS

Development of a Multiple Choice Test for Measuring Inquiry Skills of Fifth Graders: Inquiry Skills Test, IST) Yalcin Yalaki, Hacettepe University

Gultekin Cakmakci, Hacettepe University Betul Sen Gumus, Science Teacher Derya Yahsi, Science Teacher Ayse Gurel, Science Teacher Gamze Kavak Yuksel, Science Teacher Ipek Ince Sungur, Science Teacher

ABSTRACT:

The emphasis on inquiry based science education is increasing around the world. Large scale projects are being conducted to disseminate inquiry based science education through in-service training. This study was part of a larger study which was aimed to measure the impact of an in-service intervention as part of a large scale international project, named SAILS, supported by the Europe Union. The study had two phases; in the first phase a 20 item instrument about five inquiry skills was developed and used to compare student achievement. In the second phase, the instrument was further developed and used to compare student achievement with a new group of students and a stronger research design. Three middle school science teachers and 119 fifth grade students participated in the first phase of the study while in the second phase, same teachers and a new group of 148 fifth grade students participated. Quantitative data was collected and statistically analyzed. We concluded that the 20 item Inquiry Skills Test (IST) is a reliable and valid test that can be used to measure certain inquiry skills of fifth grade (around 10 years old) students. The test can be used for diagnostic or formative purposes.

What Students Write Versus What they Draw: Implications for Science Assessments

Osman Aksit, NC State University

Courtney Behrle, NC State University

Eric N. Wiebe, North Carolina State University

ABSTRACT:

This study reports the findings of preliminary research that investigated fourth grade students' conceptual understanding about a specific elementary science topic by examining how evidences of student learning were revealed in the artifacts of writing and drawing tasks, individually and collectively. The ECD framework was used in analyzing the existing assessment model and evaluating student work. The findings indicated that students appeared to provide significantly more evidences of their understanding in drawing tasks. In addition, McNemar's exact tests showed that students had more difficulties expressing abstract ideas in writing than drawing and only the evidences of more concrete concepts were equally distributed across the different tasks. A

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multiple regression test was conducted to determine how students' writing and drawing scores predicted their post-test scores. Students' writing scores alone were found to significantly predict the post-test scores although students provided less evidences of their learning in writing tasks. ECD has proven to be a powerful strategy for analyzing and refining an existing assessment model. Considering the rise in the popularity of electronic science notebooks such as the CyberPad, this study is particularly important in understanding of how to leverage different kinds of tasks for assessing student learning.

Mapping, I-MAP) Tool for Evaluating High School Biotechnology Majors Program

Tom Bielik, Weizmann Institute

Anat Yarden, Weizmann Institute of Science

Yael Shwartz, the Weizmann Institute of Science

ABSTRACT:

The recently published NRC framework calls for a shift from teaching inquiry to teaching of scientific practices. Inquiry is considered a key element in the teaching and learning of Science, however many issues regarding the teaching of inquiry remains to be explored, among them the possible gaps between the intended and the implemented curriculum and the inquiry level of scientific programs. Here we present a tool for evaluating inquiry-based programs and activities, entitled the I-MAP (Inquiry-based Teaching and Learning Mapping), that was developed by a team of science education researchers at the Department of Science Teaching at the XXX. The I-MAP tool was used to characterize the inquiry level of a high school biotechnology majors program, the Bio-Tech. Using the I-MAP tool, gaps between the intended and the implemented curriculum were found, mostly in the early stages of the Bio-Tech program, and the Bio-Tech teachers' views regarding the program's inquiry level were exposed.

Development and Validation of the Learning Progression-Based Assessment of Molecular Genetics, LPA-MG) Amber Todd, Wright State University William L. Romine, Wright State University

ABSTRACT:

We describe the development and validation of the Learning Progression-based Assessment of Molecular Genetics (LPA-MG) in a high school context. Items were constructed based on a current learning progression framework for molecular genetics (Shea & Duncan, 2013; Todd & Kenyon, 2015). The 34-item instrument, which was tied to 12 progression constructs, was administered to 65 high school students at three time points across a 23-week period of instruction. The LPA-MG, its 12 constructs, and 34 items demonstrated high reliability and construct validity with respect to the Rasch model as indicated by satisfactory fit. Further, it demonstrated utility in providing both quantitative and qualitative information around how students moved along each construct. Using a repeated measures ANOVA design, we found that students made gains across the 23 weeks that were both large and significant at the 95% confidence level. Students also moved along each construct in qualitatively meaningful ways during the 23 weeks of instruction.

Strand 11: Cultural, Social, and Gender Issues

Related Paper Set - What is Contextualization of Science-Learning Environments After All? an Exploration Across Cultural Contexts

8:30am - 10:00am, Baltimore Salon A **Presider: In**grid M. Sanchez-Tapia, FundaciÛn Yopo **Discussants:** Marlynne Nishimura, University of Illinois

Promoting Student Engagement: A Case Study of a Middle School Science Teacher Making Sense of the NGSS Through Contextualization

Consuelo J. Morales, University of Michigan *ABSTRACT:*

Multiple definitions of contextualization of science-learning environments are found in science education literature. However, there are limited examples of instruction and curricula that illustrate contextualization through the lens of critical pedagogies. In this related paper set we explore how researchers and practitioners committed to critical pedagogies interpret and enact different versions of contextualization. Our exploration spans three educational contexts (teacher initiated in middle school and high school classrooms, science methods courses for pre-service teachers, and curriculum design) and three world regions (United States, Latin America, and Europe). Papers one and two show how veteran teachers apply contextualization strategies to enact the NGSS while serving the learning needs of urban ethnic minority students; paper three focuses on supporting pre-service teachers to engage in place-based scientific argumentation, while paper four show us how novice teachers contextualize a science activity in a multilingual classroom; and finally, paper five proposes five empirically-derived contextualization principles that support indigenous students to learn science as border-crossing. To further concretize the presented examples, our discussant (a science educator with over three decades of classroom experience) will focus on how feasible it would be to enact the ideas presented in the five papers in science classrooms of public schools.

Critical Contextualization: Confronting the Root Causes of Inequity in Science Education Through the Curriculum

Daniel Morales-Doyle, University of Illinois at Chicago

What to Eat Here and Now: Contextualization of Scientific Argumentation from a Place-Based Perspective Pablo Brocos, University of Santiago de Compostela Maria-Pilar Jimenez Aleixandre, Universidade De Santiago De Compostela

Framing, Adapting, and Applying: How Can Novice Science Teachers Construct Authentic Science Learning Contexts for/with Students in Multilingual Science Classrooms? Corey Knox, University of Arizona Ivan Salinas Barrios, CIAE – Universidad de Chile Sara E. Tolbert, University of Arizona

Curricular Contextualization as a Strategy to Support Indigenous Students to Learn About Natural Selection Ingrid M. Sanchez-Tapia, FundaciÛn Yopo Marlynne Nishimura, University of Illinois

Strand 11: Cultural, Social, and Gender Issues
Aspirations, Motivation, and Achievement in Science
8:30am - 10:00am, Pride of Baltimore
Presider: Jacqueline Theresa Mcdonnough, Virginia Commonwealth University

Gender Differences of Motivational Beliefs and Science Achievement in 26 Countries Pey-Yan Liou, National Central University ABSTRACT:

The purpose of the study is to investigate the patterns of three adolescents' motivational beliefs (i.e., selfconcept, intrinsic value and utility value) in learning science and their relationships with achievement by gender at an international scope. Data of the 8th graders from 26 countries participating in the Trends in International Mathematics and Science Study (TIMSS) 2011 were examined. The international results indicated that boys' motivational beliefs are higher than girls'. While boys' motivational beliefs explain more variations of

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achievement than girls, both boys' and girls' self-concept is the most significantly predictive variable for achievement, followed by intrinsic value and extrinsic value. While the patterns are shown internationally, exceptions occur in few countries. This study sheds light on the etic and emic phenomena of students' motivational beliefs by gender across countries.

Peer-Led Team Learning: Improving Achievement for Underrepresented Minorities in Post-Secondary Biology Julia J. Snyder, Syracuse University Jeremy D. Sloane, Syracuse University Jason R. Wiles, Syracuse University ABSTRACT:

We implemented Peer-led Team Learning (PLTL) in the context of a mixed-majors introductory biology course at a large, private university in the northeastern United States with the aim of improving achievement among underrepresented minority students (URMs), particularly those who had elected not to enroll in an optional lab associated with the second course of the introductory sequence. Students who did or did not take the lab course were not found to be statistically significantly different in terms of prior achievement. Results indicate that for URM students opting out of the laboratory course, achievement as measured by final course grades was markedly and significantly improved if they participated in PLTL workshops. There were no statistical differences among other groups indicating that PLTL has the highest potential for increasing achievement among URM students, which may have implications toward recruitment and retention among populations underrepresented in STEM fields.

Who Holds Science Aspirations? Investigating Factors Influencing Science Aspirations Among Students Aged 15/16 in England

Julie K. Moote, King's College London Jennifer Dewitt, King's College London Louise Archer, King's College London *ABSTRACT:*

There are widespread national and international concerns that not enough young people are continuing with science post-16 (e.g. Bennett & Hogarth, 2009), particularly from groups who have been historically underrepresented in science. Indeed, improving participation in STEM remains an international priority for industry, government, and science education policy (Jenkins & Nelson, 2005). Research evidence is building to support the idea that positive attitudes toward science both in and out of school indeed help, but do not always translate into later aspirations and post-16 science participation rates. This paper presents findings from the ASPIRES and ASPIRES2 research, a ten-year study investigating the processes through which students develop their science and career aspirations between the ages of 10 and 19. Through investigating the results from a large-scale survey of a nationally representative sample of the cohort (students aged 15/16, n=13,421, surveyed in autumn 2014), this paper explores who is most likely to hold science aspirations as well as possible factors contributing to these aspirations. Results are in line with the growing body of evidence that peer influences become increasingly important as students progress in secondary school (David-Kacso et al., 2014; Nurmi, 2004).

A Group Story Reflection of Minority Scientist Perspectives on Science Education David Segura, University of Illinois at Chicago Olayinka A. Mohorn-Mintah, University of Illinois-Chicago Janice Mejia, University of Illinois-Chicago ABSTRACT:

This paper explores the past experiences of 3 underrepresented minority STEM graduates as they progressed through their science majors that guided their decisions to study science education. This study uses group storytelling as a form of auto-ethnography (Denzin, 2015) to identify common themes from their experiences in

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STEM fields that impeded their study, as well as those experiences that provided the support to persist. Specifically, this study examines the commonalities that students in various STEM fields (Biology, Chemistry, Engineering) experienced that guided them to address these issues through science education. This paper identified veiled and overt discrimination; science as a separate culture; science as a tool for other humanistic goals; and lack of mentorship as issues in undergraduate science. This paper ends with a discussion on how to overcome these issues for individual students studying STEM as well as the structural impediments in STEM fields, through strategies employed by these students to persist to graduation.

Resisting Racist, Classist Neoliberalism in Science Education: Counter-Stories of an African-American Teacher and Her Students

Jean R. Aguilar-Valdez, Portland State University

ABSTRACT:

Neoliberalism in public education is an ideology of competitive individualism and quantified accountability through standardization of knowledge, high-stakes testing, and sanctions for failure, informed by capitalistic free-market values. In science education, this has led to a devaluation of creativity, innovation, and multiculturalism in learning and doing science, focusing instead on regurgitation of rote canonical science knowledge in dispassionate ways that are irrelevant to students' lives. This study shares the stories of an African-American high school science teacher, Ms. Bowen, and her African-American and Latin@ students in a Title 1 public high school in the Southern U.S. Yearly, 100% of her students pass biology standardized tests and benchmarks, despite expectations that many would fail. Yet, Ms. Bowen's history, growing up as a person of color in the Southern U.S. like most of her students, informs her resistance to traditional meanings of school science "success." Ms. Bowen's story counters dominant narratives of what "achievement" in science education should entail, by naming systems of oppression and being critically conscious to structures of power within today's neoliberal landscape in public schools. Her students also share their stories of injustice due to testing policies in their science education experience that they deem racist and classist.

Strand 12: Educational Technology

Technology and Student Learning 8:30am - 10:00am, Homeland **Presider:** Eva Erdosne Toth, West Virginia University

Developing a Project Based Learning Progression in a Serious Educational Game Design and Development Project

Len Annetta, George Mason University Marina Shapiro, George Mason University Stacia Stribling, George Mason University Anna Menditto, George Mason University Leigh Ann Kurz, George Mason University Sheri Berkeley, George Mason University Amanda Luh, George Mason University *ABSTRACT:*

This paper describes the background of learning progressions and project based learning and their application for learning and instruction for students at age levels that range from the elementary school level to undergraduate college students in STEM career fields. The use of learning progressions as methods of both

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assessment and instruction are also examined. The paper describes both learning progressions and project-based learning individually and then explains how the two can be combined into what we have called a project based learning progression and how this may be beneficial to teaching and learning at the K-12 level. The paper concludes by describing that there may be evidence to suggest that a learning progression occurs through project-based learning paradigms. In particular, this appears when students are engaged in a project-based learning environment, such as Serious Educational Game design or more specifically when participating in the development of a Serious Educational Game.

Psychosocial Factors Affecting STEM Career Selection in Computer Science and Engineering

Richard L. Lamb, Washington State University

Len Annetta, George Mason University

Jonah B. Firestone, Washington State University-Tricities

David B. Vallett, University of Nevada Las Vegas

Reanne Cunningham, Washington State University

ABSTRACT:

Attention and focus on P-20 STEM education specifically in engineering and computer science has increased tremendously in recent years. Many efforts are underway to promote STEM career selection in engineering and computer science across the nation. In the push to develop these programs and pathways to STEM career selection, educational researchers and curriculum developers at the K-12 level often overlook student characteristics that contribute to career selection. This creates a break in the pipeline as they develop curriculum and train the next generation of computer scientists and engineers for the university setting. The purpose of this study is to examine combinations of latent traits that moderate student STEM career selection in engineering and computer science. The analysis methods within this study combine a number of quantitative techniques in an effort to develop a rich understanding of how combinations of profile traits interact to impact STEM career selection. Study participants were 585 students enrolled full-time in a traditional high school. The addition of STEM career selection by 20.8%.

Discovering Children's Intuitive Ideas about Energy Through a Full-Body Museum Game and Multi-Modal Study Design

Christina Silliman, University of Illinois, Urbana-Champaign Sahar K. Alameh, University of Illinois, Urbana-Champaign Robb Lindgren, University of Illinois Urbana-Champaign *ABSTRACT:*

The abstract nature of energy can be a barrier to students' understanding of fundamental concepts in science education. To overcome the complex nature of energy, this study focuses on the impact of full-body immersive digital gaming technology, in particular body-metaphors of science concepts, and a multi-modal interview framework for eliciting children's ideas about energy. The game aims to engage elementary school students in energy transformation and different ways energy can be stored and utilized. The study took place at a large children's museum over 7 consecutive days with a total of 70 participants. The multi-step interview included manipulation of "energy" and "non-energy" items, labeling diagrams, interpreting pictures, and responding to verbal questions before and after game play. Data included students' responses to energy-related questions, completed diagrams about energy, and embodied movement when playing the game. Results showed that students have an intuitive understanding about energy including ideas about electricity and food as source of energy, flow of energy through conductors, and charging energy through batteries. These ideas could serve as precursor models for more complex topics. The multi-modal nature of this study elicited a more dynamic and detailed picture of the students' ideas about energy than targeted questions alone.

Learning Outcomes in an Online Chemistry Simulation: Effects of Visual-Scaffolds and Self-Reported Home

Language, SRL1)

Anna G. Brady, New York University Ruth Schwartz, Quinnipiac University Catherine E. Milne, New York University Jan Plass, New York University Bruce Homer, CUNY Graduate Center Trace Jordan, New York University Susan Letourneau, Brown University

ABSTRACT:

Visual scaffolds in a multimedia chemistry simulation have been previously associated with improved learning outcomes among urban high-school students. In this study we investigated whether these visual scaffolds supported learning outcomes equally well for students whose self-reported home language (SRL1) was Spanish as compared to SRL1 English speakers. Surprisingly, despite the fact that both groups showed similar prior knowledge, similar patterns of simulation use and similar scores on questions assessing comprehension, visual scaffolds boosted scores on transfer questions only for SRL1 English learners and not for SRL1 Spanish speakers. The difference may lie in the method of assessment: While comprehension items were in a multiplechoice format, transfer items required that students provide written responses (including explanations). Assessments that require students write responses to items are similar to "authentic" assessment approaches which are currently encouraged in science education. These results are significant for both research and policy and suggest that moving towards authentic assessment may unintentionally adversely affect the learning outcomes for non-native English speakers.

Strand 13: History, Philosophy, and Sociology of Science

Symposium - Global Perspectives on Nature of Science in School Science Textbooks: Representations,

Methodologies, Contexts, and Implications

8:30am - 10:00am, Maryland Salon F

Presider: Christine V. McDonald, Griffith University

Presenters:

Christine V. McDonald, Griffith University

Fouad Abd-El-Khalick, University of Illinois at Urbana-Champaign

Saouma B. Boujaoude, American University of Beirut

Zoubeida R. Dagher, University of Delaware

Jeanne Brunner, University of Illinois at Urbana-Champaign

Maurice Di Giuseppe, University of Ontario Institute of Technology, UOIT)

Umesh Ramnarain, University of Johannesburg

ABSTRACT:

The development of informed nature of science (NOS) views are considered to be an integral component of scientific literacy, and are a central focus of the majority of national science education reform documents worldwide. This interactive symposium will explore representations of NOS in school science textbooks across the globe- by bringing together leading international science education researchers working from a range of theoretical and methodological orientations, and across the full span of schooling years - elementary, middle, and secondary level. The symposium will showcase selected contributions to the forthcoming volume "Representations of nature of science in school science textbooks: A global perspective" (Routledge), which will provide a synthesis of the state of the field on NOS representations in science textbooks across the major continents of the world. Presenters will provide insights from their empirical studies to help inform the field, and the final section of the symposium will engage attendees in a productive dialogue about effective ways to both assess NOS representations, and improve the quality of NOS representations, in school science textbooks.

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This symposium is relevant and significant for all science educators concerned with improving how NOS is represented in our most heavily utilised curriculum materials – the school science textbook.

Strand 13: History, Philosophy, and Sociology of Science Nature of Science Knowledge and Associated Understanding

8:30am - 10:00am, James **Presider:** Dionysius T. Gnanakkan, Illinois Institute of Technology

Secondary Students' Understanding of Nature of Science in a Socioscientific Issues Context Dawnne M. LePretre, Illinois Institute of Technology-MSED

ABSTRACT:

This study investigated the change in students' understanding on aspects of nature of science (NOS) within a socioscientific issues (SSI) context. Participants were ninth and tenth grade students from the science decathlon team in a public school in the Midwest. Detailed lessons plans were structured around controversial scientific issues to teach nature of science aspects in an explicit and reflective way. Across four sessions, students worked in small teams to discuss different perspectives of a SSI. Each lesson included an introduction and closure to the issue via a yes/no question, a perspective to consider/argue, a class discussion, and individual reflection on NOS aspects. Gathered for analysis and coding were lesson plans, teacher made handouts, classroom observations, student artifacts and results from the VNOS D+ survey. The changes noted most in students' understanding were from naïve to mixed on the aspects of tentativeness, creativity, and observation versus inference, but the gains were not interpreted to be statistically significant at an alpha of <0.05. The results are discussed in light of the relationship between students' understanding of aspects of NOS and the use of explicit-reflective strategies in the classroom.

Quantum Physics, History, Philosophy and NOS in Traditional Physics Classrooms Maria Vetleseter Vetleseter Boe, Norwegian Centre for Science Education Ellen K. Henriksen, University of Oslo Carl Angell, University of Oslo ABSTRACT:

The nature of science (NoS) is advocated as an important element of science education. Quantum physics has been shown to motivate physics students due to its philosophical aspects, making the topic suited for learning activities that foster understanding of NoS and of the history and philosophy of physics. This paper discusses experiences from teaching senior high school quantum physics through such learning activities. Web-based teaching modules let students explore quantum physics through collaborative learning and historical and philosophical contexts. Data consists of seven focus groups with in total 40 participants from seven physics classrooms and one focus group with five teachers. Data were collected in 2014-2015 and analyzed qualitatively using a thematic approach, focusing on history, philosophy, NoS, and physics classroom culture. Although students were motivated by physics history and philosophy, their learning of these aspects and NoS as knowledge in its own right appears to have been limited by their enculturation into a traditional physics classroom oriented towards content knowledge, assessment and exams rather than physics history, context and processes. We suggest that physics history, philosophy and NoS learning goals and assessment criteria should be made more explicit to students, and assessment tools developed for teachers and exam developers.

The Use of NOS Understandings in the Evaluation of Science News by Non-Science Majors Jessica Shuk Ching Leung, The University of Hong Kong Alice Siu Ling Wong, The University of Hong Kong Benny Hin Wai Yung, The University of Hong Kong ABSTRACT:

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Critical evaluation of reports about science news has been a desired outcome from a scientifically literate populace. Without science background as sophisticated as scientists', evaluation of science news proves a challenge to the public. It is generally assumed that understandings of nature of science (NOS) will lead to this desired outcome of scientific literacy. This paper aimed at examining the criteria applied and the capacity in which they were applied by non-science majors in evaluating science news. Sixty-four non-science majors from a local community college completed the Health News Evaluation Questionnaire. Participants focused more on the cognitive aspects of science than the social or epistemological aspect in the evaluation, and news of socioscientific nature elicited more responses pertaining to the social aspect of science than reports of science despite their limited science background. This study demonstrated the use of NOS aspects and the degree and capacity to which they were applied in the evaluation of science in the media by non-science majors, and laid the foundation for future studies to further explore the assumed role of NOS in critical evaluation of science news.

The Effect of Teaching Nature of Science on Students' Acceptance and Understanding of Evolution: Myth or Reality?

Hernan Cofre, Pontificia Universidad CatÚlica de ValparaÌso

Claudia Vergara, Universitty Alberto Hurtado

David Santibanez, Illinois Institute of Technology & Universidad Católica Silva Henriquez

Juan Jimenez, Illinois Institute of Technology

Angel Spotorno, Universidad de Chile

ABSTRACT:

The results of studies about nature of science (NOS), as a factor to enhance the learning of evolution, have been inconclusive. This lack of consensus could be explain because most of the studies have not tested directly the effect of teaching NOS on the learning about evolution, but it has been correlated the participants' understanding of both topics. The main purpose of this study was to test the effect of nature of science instruction to enhance the students' learning about evolution. We used an experimental design with pre-post test, to investigate the impact of teaching evolution with and without NOS in two class with 15-16 years old student randomly assigned to the classes. In order to measure NOS understanding, and acceptance and understanding of evolution we used three different instrument that have been shown to generate reliable and valid inferences in comparable populations (VNOS-D+; ACORNS and MATE). The main results of our study was that, the class in which teaching evolution include nature of science, the students improve their understanding about nature of science (with NOS z=-2.36, p<0.05; and without NOS z=-0.84, p=0.4), and their acceptance of evolution (with NOS z=-3.06, p<0.01; and without NOS z=-0.38, p=0.7) significantly. However, both class increase their understanding of evolution, in spite of the NOS instruction (with NOS z=-3,3 p<0,01; and without NOS z=-1,8, p =0,07). This results support the claim that nature of science could influence the acceptance of students, but do not their understanding about evolution and natural selection mechanism. The importance of these results for literature of teaching evolution are also discussed.

Strand 14: Environmental Education

Sustainability in Secondary and Post-Secondary Education 8:30am - 10:00am, Fells Point Presider: Karen M. Kerr, Queen's University Belfast

Engaging High School Youth in Conservation Biology Science Research Preeti Gupta, American Museum of Natural History ABSTRACT:

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This paper presents findings for exploratory research focused on understanding the role that authentic science research experiences play in supporting youth to develop skills, knowledges and dispositions that encourage them to sustain interests in conservation biology careers. Persistence with during college years is an urgent and critical problem, especially for those underrepresented in the sciences. The field of conservation biology is unfamiliar to many young people and as such, is not on their radar as a potential career choice. The findings describe how particular interventions at the high school level make youth more aware of what the field really is, have cognitive gains in specific topics and develop a keen understanding of what it means to do conservation science research.

Humans as an Integrated Component of Ecosystems: Measuring Ecological Literacy of Natural Resource Management Students

Anne Marie A. Casper, Colorado State University Meena M. Balgopal, Colorado State University Maria E. Fernandez-Gimenez, Colorado State University *ABSTRACT:*

Natural resource management (NRM) decisions have far reaching implications for global ecological change. Because beliefs influence decisions, it is vital that NRM curriculum reflects the shift to include humans as an integrated component of ecosystems to facilitate effective future NRM. Despite the importance of ecological literacy in the literature, we were unable to find existing metrics that assessed a system-level conception of the environment that includes humans, therefore it was necessary to develop our own. We used socio-cultural theory and the conceptual change model as a lens for analyzing the ways NRM students situate humans in relationship to ecosystems. Specifically, we explored how undergraduate NRM students situate humans in relationship to the term ecosystem. We used a constructivist grounded theory approach to analyze coursework artifacts and semi-structured interviews, focusing on how students described the human/environment relationship. From these responses we developed a continuum: exclusion, uncertain-exclusion, uncertain, uncertain-inclusion, and inclusion. Students often initially made a distinction between 'human-influenced' and 'natural' environments, but then struggled to describe a natural environment. Our continuum provides a useful tool to help unpack the complexity of the ecological literacy construct. As part of a doctoral study, will use this continuum to analyze factors influencing conceptual change.

Improving Students' Knowledge of Science and the Environment: Challenges of an International Science Club Collaborative

Brian J. Plankis, Indiana University Purdue University Indianapolis Pamela Martine, Indiana University Purdue University Indianapolis *ABSTRACT:*

It is well documented in the Environmental Education (EE) literature that some best practices include project based learning, topics that are relevant to diverse audiences, and community engagement. However, many education systems are not setup to support these best practices. This paper reports on the first eighteen months of a continuing research study in Kenya and the United States whose aims include: to investigate teachers' and students' understanding of the concept of sustainability and related areas of science and their ability to communicate their scientific knowledge to their peers; development of a model for after school EE Clubs that focus on sustainability improvements at schools; and a design-trial-redesign cycle of project infrastructure that supports the teachers and students as they confront obstacles implementing their clubs. Six schools and roughly 12 teachers and 90 students participated in the first eighteen months of the project. The results showed a wide range of success in implementing the project with some common factors, but also some location specific factors that influenced project achievements. Successes, obstacles, and project refinements are discussed. Implications for other international projects that attempt to link cross-cultural science students and implementation of sustainability focused after school EE Clubs are conferred.

Sustainability and Culture: A Freshman Experience Design Study Cindy L. Kern, Quinnipiac University Rosemary Whelan, University of New Haven Beth Markello, University of New Haven

ABSTRACT:

Sustainability is an increasingly importance global issue resulting in institutions of higher education undergoing transformational changes towards incorporating sustainability education into their common coursework. This presentation is a design-based research of the design and implementation of a university-wide freshman experience course centered on the topics of sustainability and culture. As a design study, the goal of this study is to inform future iterations of this freshman experience and to evaluate the effect of a student-centered, experiential learning course for freshman designed to address student scientific literacy as it relates to issues of sustainability. The following research questions guided this study: How did the Sustainability & Culture Freshman Experience course effect students' beliefs and perceptions about global climate change? How did the Sustainability & Culture Freshman Experience course effect students' reported behaviors related to personal behaviors to help mitigate the effects of climate change?

Understanding Sustainability: Teachers' Representation and Students' Understanding of Sustainability within a Project-Based, Environmental Science Course

Lia Wetzstein, University of Washington Susan Nolen, University of Washington

ABSTRACT:

While calls for K-12 science teachers to contribute to educating for a sustainable future are increasing, tensions and synergies exist between science education and sustainability education (see Stratton et al., 2015). In this study, we explore the interactions of science and sustainability education by examining how the concept of sustainability was presented and developed by teachers within a project-based AP environmental science course with sustainability as an embedded theme. This qualitative case study looks at teachers' (n=7) representations of sustainability and examines their students' conceptions of sustainability and whether it changed over the yearlong course. Findings contribute to an understanding of the relationship between teacher presentation and student conception of sustainability and what served to support or prevent a complex understanding of sustainability. The study also serves as an empirical examination of relationship between science and sustainability education.

Concurrent Session #4 10:15am – 11:45am

Research Committee

Administrative Sponsored Symposium - STEM Education for Liberation: The Key to Achieving Equity and Social Justice for People of African Ancestry

10:15am - 11:45am, Watertable Salon B

Presenters:

Irene U. Osisioma, California State University, Dominguez Hills Melody Russell, Auburn University

ABSTRACT:

The current educational landscape has situated science, technology, engineering, and mathematics (STEM) education to meet the global workforce, warfare, and economic interests and agenda of the US government and corporations. STEM education and research that support these common interests and agenda are not developed and implemented to meet the needs and interests of people of African descent neither do they address issues that

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are relevant and transformative to their descendants in multiple contexts. Rather than draw on African-centered pedagogy, frameworks, and methodologies that are culturally grounded to teach and research descendants of Africa, this form of education and research maintains and sustains global racism/white supremacy and give the illusion that the needs and interest of people of African descent are being met. This presentation uses an African-centered paradigm to critically examine STEM education, policies, and research as it impacts people of African ancestry with the intent to evaluate their effectiveness in meeting their needs and interests. This paradigm is used to describe an African-centered STEM educational achievement framework, situated within Afrocentricity, Kawaida, Maat, and the Nguzo Saba and used to describe how people of African lineage should create STEM education for liberation. Presider: Irene Osisioma, California State University Dominguez Hills, Carson California. Co-Presider: Melody Russell, Auburn University, Alabama. Invited Speakers: Julius Davis, Bowie State University, Maryland.

Strand 1: Science Learning, Understanding and Conceptual Change Learning Progressions and Student Understanding in Chemistry

10:15am - 11:45am, Kent **Presider:** May Lee, Michigan State University

A Study of the Capacity of 9-Year-Olds to Understand and Apply Atomic Theory Carole E. Haeusler, University of Southern Queensland Jennifer Donovan, University of Southern Queensland

ABSTRACT:

Atomic theory is the key to understanding the properties and behaviour of matter but is not a part of most elementary curricula. In this study, the Periodic Table was used as the context for a 10 week intervention in which 9 year old children from two elementary schools were introduced to atomic theory. Analysis of data from semi-structured interviews of the children revealed that a majority understood that all matter is made up of atoms, that elements were made of one type of atom and these atoms were made up of negatively charged electrons and positively charged protons. Most children were able to distinguish metals from non-metals on the basis of conductivity and the difference in behaviour of electrons in metals and non-metals. In addressing two unrehearsed problems, children were able to apply the concept of charge with some children attributing static charge on materials to an excess or deficiency of electrons. This paper challenges the extant practice of leaving instruction about atomic theory until high school.

A Study on Secondary School Students' Understanding of Energy in Chemical Reactions—Based on Learning Progression

Weizhen Wang, Beijing Normal University Lei Wang, Beijing Normal University

ABSTRACT:

This study focused on building a learning progression of energy in chemical education (ECR). Based on the analysis of science history and disciplines knowledge system, international curriculum comparison and interviews with students, a feature model of learning progressions was built. Two progress variables, cognitive objects and cognitive mode, are derived from the model. With these two variables, a sequence of successively increasing sophisticated ways of energy reasoning was figured out as accounting for different levels of ECR learning progressions framework. The EUPA (Energy Understanding Progressions Assessment) was developed as the main instrument to diagnose students' understanding of ECR. Rasch analysis was used to evaluate instrument functioning and validate the learning progression. We utilized this instrument to assess the understanding of N=821 students from three different learning stage, Grade 9, 10, 11-12. Findings provided evidence that students from Grade 9 are good at understanding macroscopic phenomenon of energy transfer. Students of Grade 10 have developed an understanding of the endothermic and exothermic reactions. For the

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students in Grades 11-12, they are able to define the system as needed and to explain the energy conservation between system and its surroundings by digesting the enthalpy change of reactions.

Developing and Validating a Learning Progression on Chemical Reactions

Katrin Weber, University of Duisburg-Essen

Markus Emden, Pdagogische Hochschule Schwbisch Gm, nd

Elke Sumfleth, University of Duisburg-Essen

ABSTRACT:

The study focuses on developing and validating a learning progression on chemical reactions for the lower secondary level. Learning Progressions describe potential ways in which knowledge and abilities can be developed over time. A validated learning progression on chemical reactions can help to design and inform efficient teaching units and curricula. Outlining such a progression a strand map for student abilities in two core concepts of chemistry ("Structure of Matter", "Chemical Reactions") has been suggested. Based on the strand map three stages of progress are assumed for each of the core concepts, which will be validated: Student abilities are surveyed from grade 7-9 students in a paper-and-pencil test in multiple-choice-single-select format. Correlation analyses yield insight into the assumed relations. IRT methodology helps to confirm the assumed stages of progress and to estimate item difficulties. First results show that data fit a three-dimensional Rasch model (p < .001) aligning with the three stages of progress. According to Wright Maps, the easiest items refer to abilities at the bottom of the strand map whereas the most difficult items refer to abilities at the top of the strand map.

Use of a Card Sort Task to Define a Progression for Coordinating Three Levels of Representation in Chemistry Emily J. Borda, Western Washington University Stefan M. Irby, Purdue University

Andy L. Phu, Western Washington University

Todd R. Haskellandy Phu

ABSTRACT:

Expertise in chemistry depends in part on the ability to coordinate understanding of phenomena on three levels: macroscopic (observable), sub-microscopic (atoms, molecules, and ions) and symbolic (chemical equations, graphs, etc.). Here we describe the development, initial validation, and use of a card sort task to measure this "level-coordinating ability" in individuals with varying degrees of formal chemistry training. We have also developed a novel method for generating two-dimensional sorting coordinates which were used to develop a progression for level-coordination ability as well as to investigate the degree of unexpected sorts for each group of participants. Our findings suggest that, with the exception of graduate students, participant groups on average progressed from sorting by level of representation toward sorting by underlying principle. Graduate students unexpectedly sorted primarily by level of representation. We use these data to form initial hypotheses about a typical process for the development of level-coordination ability. In doing so, we demonstrate the usefulness of our task paired with sorting coordinate analysis as a tool to explore the space between novice and expert behavior. Finally, we suggest potential uses for the task as a formative assessment tool at the classroom and program levels.

Strand 2: Science Learning: Contexts, Characteristics and Interactions *The Role of Explanation and Argumentation in Science Learning* 10:15am - 11:45am, Homeland
Presider: Martina Nieswandt, University of Massachusetts, Amherst

Exploring the Relationship Between Native Language Use and Science Learning Jason S. Wu, Columbia University

Kok-Sing Tang, National Institute of Education *ABSTRACT:*

We conducted a mixed-methods study of three multilingual secondary science classrooms in a private international school in Singapore. In the three classrooms examined, it was found that students' self-reported comfort level with English was a primary predictor of in-class science achievement. Survey data revealed that about 50% of students believe using another language besides English helps them to learn scientific English and scientific concepts. With the exception of gender, agreement was consistent across diverse groups in the classroom and did not vary by levels of language proficiency, academic achievement, or majority/minority ethnic group status. Interview data revealed students' acknowledgement of the importance of developing English proficiency, yet also use of the L1 as a resource for understanding. Taken together, these findings reflect what we describe as a content-language tension, driven by competing goals of content learning and language acquisition in the science classroom of ELLs.

Constructing and Critiquing Arguments in Science Classrooms: Perspectives From Both Sociocultural Development and Linguistics

Ying-Chih Chen, Arizona State University

ABSTRACT:

This case study employed a mixed methods research design to examine the development in 5th grade students' practices of oral and written argumentation from one unit to another through argument-based inquiry. This study was conducted in an argument-based elementary science classroom utilizing the Science Writing Heuristic approach for 16 weeks. The results revealed six salient trends in students' development of oral and written argumentative practices over time: (1) Students came to use more critique components as they participated in more rounds of whole-class discussion focused on group presentations of arguments, (2) By challenging each other's arguments, students came to focus on the coherence of the argument and the quality of evidence, (3) Students came to use evidence to defend, support, and reject arguments, (4) The quality of students' writing continuously improved over time, and (5) Students connected oral argument skills to written argument skills as they had opportunities to revise their writing after debating and developed awareness of the usefulness of critique from peers. This study suggests that argumentative practices should be framed through both a social and epistemic understanding of argument utilizing talk and writing as vehicles to create norms of the complex practices.

High School Students' Assessments of Science Concepts and Explanations through Peer Review of Writing Anita Schuchardt, University of Pittsburgh

Christian D. Schunn, University of Pittsburgh Amanda J. Godley, University of Pittsburgh *ABSTRACT:*

Although many studies have explored construction of explanations and arguments in students' science writing (Sampson & Clark, 2008), there has been little research on how students evaluate quality of evidence and argumentation, even though evaluation of others' arguments is positively correlated with production of quality written arguments (Lu & Zhang, 2013). In the context of a web-based peer review system, this paper evaluates student reviewer comments on accuracy of evidence and quality of explanations for one multi-part science writing task. The likely generalizability to other science writing tasks was assessed by extending the analysis to the very distant case of an evidence-based writing task in English Language Arts. Across cases, student reviewers were much less likely to comment on accuracy for the more difficult task, which presumably had more, rather than fewer accuracy problems. Since it is important for students to receive feedback on response accuracy in addition to explanation quality, these findings have implications for science peer-review rubric design, and for providing supports for peer review. There may also be broader implications for interpretation of scientific research by the lay community.

Student Gestures During Shifts from Descriptions to Explanations of Gas Pressure

Robert C. Wallon, University of Illinois at Urbana-Champaign

David E. Brown, University of Illinois

Robb Lindgren, University of Illinois Urbana-Champaign

ABSTRACT:

The Next Generation Science Standards emphasize engaging students in the practice of constructing explanations using disciplinary core ideas such as the structure of matter. Research has identified that students have difficulty both with constructing explanations and with constructing particulate views of matter, and therefore there is a need to research additional ways to support students in these areas. The present study investigated how students used gestures as they shifted from descriptions to explanations of phenomena involving gas pressure. Using case studies based on student interviews, we found that students used gestures differently when they provided descriptions and when they provided explanations. While giving descriptions, students used gestures to represent visible parts of the phenomena. While giving explanations, students used that prompting students to use gestures while explaining phenomena may help improve the quality of their explanations by helping them link phenomena with underlying mechanisms.

Strand 3: Science Teaching--Primary School, Grades preK-6): Characteristics and Strategies Related Paper Set - Supporting Teachers to Facilitate Student Sensemaking in Elementary Science Classrooms

10:15am - 11:45am, Maryland Salon A

Discussant: Cory Forbes, University of Nebraska

ABSTRACT:

Science instruction that integrates scientific content and science practices provides students rich opportunities to make sense of scientific phenomena. Elementary students are capable of making sense of science phenomena through engagement in science practice, and teachers play a critical role in providing these types of learning opportunities for children. However, little is known about how teachers engage in this type of work, and more information is needed about how elementary teachers can facilitate sensemaking in their classrooms. To address this gap, this related paper set aims to describe elementary teachers' teaching practice and learning regarding engaging students in sensemaking in science. Paper 1 considers how preservice teachers learn to notice and reflect on students' ideas and thinking. Paper 2 describes how an inservice teacher plans for and elicits students' ideas in sensemaking discussions foregrounding science explanations. Papers 3 and 4 consider preservice teachers' abilities to plan for and facilitate sensemaking during lessons that involve investigations. Collectively these papers examine different aspects of teaching necessary for supporting elementary students to make sense of natural phenomena.

Examining Videos of their Rehearsals: Helping Teacher Candidates Notice and Reason about Ambitious Teaching

Amanda Benedict-Chambers, Missouri State University Diana Piccolo, Missouri State University Gina Wood, Missouri State University Cindy McMeley, Missouri State University

Lessons from an Experienced Teacher: Using Sensemaking Discussions to Support First Graders' Scientific Explanations Amber S. Bismack, University of Michigan

Leigh A. Haefner, Penn State Altoona Carla Zembal-Saul, Penn State University

Learning to Support Elementary Children to Analyze Data in a Practice-Based Teacher Education Program Anna Maria Arias, Illinois State University

Supporting Beginning Teacher Planning of Investigation-Based Science Discussions Sylvie M. Kademian, University of Michigan Elizabeth A. Davis, University of Michigan

Strand 4: Science Teaching--Middle and High School, Grades 5-12): Characteristics and Strategies *Related Paper Set - Viewpoints on Experimentation from the Perspectives of Teachers and Students* 10:15am - 11:45am, Baltimore Salon A

Discussants: Suparna Sinha, Rutgers University *ABSTRACT:*

Conceptualizing, implementing, and interpreting experiments is a key part of building scientific knowledge (Lawson, 2010; Zimmerman, 2007). The Next Generation Science Standards (NGSS) emphasize understanding and engaging in scientific practices, and underscore the need for additional research into how to help students develop these types of skills (NGSS Lead States, 2013). Students and teachers each bring their own ideas and experiences about how scientific knowledge is established into the science classroom. This set of research studies explores the topic of experimentation from those dual viewpoints in order to inform the development of curriculum and preparation of teachers.

Examining Middle School Students' Pathways through Experimentation Via a Virtual Simulation

Meredith Thompson, Harvard University Patrick Sedney, Harvard University Amy M. Kamarainen, Harvard Graduate School of Education Shari Jackson Metcalf, Harvard University Michael S. Tutwiler, Harvard Graduate School of Education Tina Grotzer, Harvard University Christopher Dede, Harvard Graduate School of Education Suparna Sinha, Rutgers University

Student Understanding of Scientific Practices and Crosscutting Themes Via an NGSS–Targeted Curriculum and Instruction Project Josh Sheldon, Massachusetts Institute of Technology Susan Yoon, University of Pennsylvania Jessica Koehler, University of Pennsylvania

Murat Oztok, Lancaster University Emma Anderson, University of Pennsylvania Ilana Schoenfeld, Massachusetts Institute of Technology Hal Scheintaub, Governor's Academy

Daniel Wendel

Eric D. Klopfer, Massachusetts Institute of Technology

Teacher Views on Experimentation in Ecosystem Science and the Classroom Amy M. Kamarainen, Harvard University David Sabey, Harvard University Tina Grotzer, Harvard University Meredith Thompson, Harvard University Eva Shultis, Harvard Harvard University Ilana Schoenfeld, Massachusetts Institute of Technology Daniel Wendel, Massachusetts Institute of Technology Eric D. Klopfer, Massachusetts Institute of Technology

Authentic Scientific Research Experiences, ASREs) Influence on Teachers' Ideas About Experimentation, Observation, and the Nature of Science, NOS) Meghan Moriarty, Boston University Meredith Thompson, Harvard University Donald DeRosa, Boston University Meredith Thompson, Harvard Graduate School of Education not author, not author

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

Communicating in the Sciences

10:15am - 11:45am, Maryland Salon E **Presider:** Rhea L. G. Miles, East Carolina University

Developing Ecoliteracy Through Photojournals in a Blended Environmental Science Course Lauren Madden, the College of New Jersey

Tabitha Dell'Angelo, the College of New Jersey

ABSTRACT:

As online, blended, and hybrid learning environments become more prevalent in higher education, it is critical that we develop innovative tools for ensuring that our students are able to understand the ways in which science content connects to their lives, future careers, and global issues. In this article we present one strategy to help meet this critical need, creating reflective photojournals. Students enrolled in a blended environmental science course for preservice teachers reflected on their weekly asynchronous learning blocks by creating photojournal entries. We analyzed these entries using a framework developed by Fawcett et al (2002) to best describe they ways in which students were able to describe the context of their environmental science content learning. These entries provided evidence that the students were able to make clear connections between the science content, their personal lives, and global environmental issues.

Engaging Students with Primary Literature Improves Nature of Science Conceptions and Confidence in Reading Science

B. Elijah Carter, University of Georgia Jason R. Wiles, Syracuse University *ABSTRACT:*

This qualitative study explores the experiences of six students enrolled in a special topics biology class that exclusively used primary literature as course material. Nature of science (NOS) conceptions have been linked to students' attitudes toward scientific subjects, but there has been little research specifically exploring the effects of primary literature use on NOS conceptions. Results, based both upon written responses to an established and validated NOS survey taken at the beginning and end of the course and upon reflective essays in which students described in detail their experiences with using primary literature, indicate positive gains in various aspects of NOS conceptions as well as increased confidence with approaching original research. We conclude by suggesting the expanded use of primary literature in biology education.

The Effects of Feedback From Younger Readers in Writing-To-Learn Approach in College Sae Yeol Yoon, Delaware State University

ABSTRACT:

This qualitative research is a part of larger program of research exploring integrated science-literacy enactment in K-12 schools and college that implement a writing-to-learn approach. This study examined the effects of feedback from 43 fifth grade students on 28 college students' understanding of science and use of language in an interactive letter-writing task. In this writing task, college students wrote a letter of science with the consideration of authentic audience (fifth grade students) and revised it with feedback from the audience. For this study, college students' writing and fifth grade students' feedbacks, and college students' perception on this letter-writing tasks were analyzed. Findings suggested that an interactive letter-writing task positively impacted on college students' overall quality of writing, as well as their understandings of scientific concepts, which might be seen as increasing scientific literacy. Drawing from cognitive psychological perspectives, this study emphasizes that appropriate demands will help student learning, and substantial resources for learning are necessary, and poses a question of how to create a learning environment where students can engage in appropriate demands and substantial resources in order to increase scientific literacy.

Strand 6: Science Learning in Informal Contexts

Related Paper Set - Studying and Supporting the Work of Informal STEM Educators

10:15am - 11:45am, Fells Point

Presider: Scott A. Pattison, Institute for Learning Innovation; Oregon Museum of Science and Industry *ABSTRACT:*

Across the world, paid and unpaid professionals facilitate informal STEM learning in a variety of out-of-school contexts, including museums, science centers, zoos and aquariums, afterschool programs, and more. While there is a vast and ever-growing research base on classroom teaching, scholars have only begun to investigate the work and practices of informal educators and how they can effectively facilitate learning for children, adults, and families. In this session, presenters representing a variety of learning contexts will share current research on the work of informal STEM educators, including efforts to define and measure success, identify effective facilitation and teaching strategies appropriate to informal learning environments, and develop and test approaches to professional development and training. The session will particularly highlight current understandings of how the work of informal STEM educators is both similar to and unique from that of classroom teachers. After the presentations, the group will engage audience members in a discussion to help synthesize findings, connect with related efforts across the field, and identify questions and research gaps for future investigation.

Researching the Value of Educator Actions for Learning, REVEAL) Scott a Pattison, Oregon Museum of Science and Industry

Facilitation Research for Engineering Design Education, FREDE) Ryan Auster, Museum of Science, Boston

An Online Video-Sharing Model for Afterschool STEM Educators Sue Allen, Allen & Associates

Using Communities-of-Practice to Support Informal Educators' Professional Development Joe Heimlich, Center of Science and Industry Cathlyn Stylinski, University of Maryland
Sasha Palmquist, Palmquist & Associates, LLC Deborah Wasserman, Lifelong Learning Group

Strand 7: Pre-service Science Teacher Education **Preservice Teachers' Beliefs** 10:15am - 11:45am, Maryland Salon B Presider: Saiga Azam, Memorial University of Newfoundland

Changes in Preservice Elementary Teachers' Science Self-Efficacy Beliefs and Its Relation to Science Conceptual Understandings in a Science Content Course Deepika Menon, Towson University Troy Sadler, University of Missouri-Columbia

ABSTRACT:

Self-efficacy beliefs that relate to teachers' motivation and performance have been an important area of concern for preservice teacher education. This study used a mixed-methods approach to investigate the changes in preservice elementary teachers' science self-efficacy beliefs and its relationship with changes in physical science conceptual understanding. Participants included fifty-one preservice elementary teachers enrolled in two term of the physical science content course. Data collection included implementation of Science Teaching Efficacy Belief Instrument-B (STEBI-B) (Bleicher, 2004) and Physical Science Concept Test as pre- and posttest, two semi-structured interviews with 18 participants, classroom observations and artifacts. A repeated measures multivariate analysis of variance (MANOVA) design was used to test the significance of differences between the pre- and post-surveys across time. Results indicated statistically significant gains in participants' science self-efficacy beliefs. Additionally, the correlational analysis found a positive moderate relationship between science conceptual understandings and personal science teaching efficacy beliefs. These findings suggest that the participants who have higher gains in science conceptual understandings are more likely to develop higher self-efficacy beliefs or vice-versa. Because of the association between science self-efficacy and science conceptual understandings, it is therefore important for science educators to structure integrated courses that blend content and pedagogy together.

Making Learning Visible: Developing Preservice Teachers' Environmental Education Pedagogical Content Knowledge and Teaching Efficacy Beliefs

Greer M. Richardson, La Salle University Ling L. Liang, La Salle University Laurel L. Byrne, La Salle University **ABSTRACT:**

The purpose of the study is to investigate efforts to further align content and methods courses within the Education Department's Early Elementary and Special Education program in order to advance preservice teachers' pedagogical content knowledge and teaching efficacy beliefs related to environmental education (EE). Explicit course instruction focused on EE pedagogical content knowledge and inquiry-based instruction which culminated in unit planning and implementation with an integrated EE focus. The Environmental Education Self Efficacy Scale (EEEBI) was administered as the pre- and post-assessment in the study. Repeated measures ANOVAs were performed on the two subscales, namely Personal Environmental Teaching Efficacy and Environmental Teaching Outcome Expectancy. Both subscales showed statistically significant improvements over time with large effect sizes. Implications for preservice teacher development are discussed.

A Study on Collective Efficacy Among Preservice Science Teachers Volkan Atasoy, Middle East Technical University

Jale Cakiroglu, Middle East Technical University *ABSTRACT:*

Collective efficacy, the belief about group ability to accomplish common task, has been important construct influencing group behavior. Based on this construct, the purpose to this present study was to examine the group including preservice science teachers in terms of collective efficacy. The participants were four junior preservice science teachers who worked in the same group in science method course. This course was selected as the context of this study. In this course, new science teaching methods were introduced each week and it was asked to prepare common lesson plans as a group related to these teaching methods. As a case study, this group was investigated in the present study. Observation, video records, and personal interviews were used to collect data. After analysis, it was founded that collective efficacy was developed in the group, and there were four factors influencing the formation of collective efficacy, namely collaborative work, shared purpose, attitude towards group work, and group cohesion. Based on these findings, it was suggested that science teacher educators took into consideration these four factors in their students' group work to help them form collective efficacy.

Why do Undergraduate Science Majors Decide to Pursue a Science Teaching Credential?

Ashley N. Coon, University of Maryland

Diane Jass Ketelhut, University of Maryland *ABSTRACT:*

If the nationwide shortage of qualified secondary science teachers is to be reduced, schools of education must recruit more undergraduate science majors into science teacher preparation programs. This qualitative study was conducted in order to learn why undergraduate science majors at a large, public research university decide to enter a science teacher preparation program. In doing so, we aimed to reveal the characteristics of undergraduate science majors who are favorably disposed toward teaching and to evaluate whether their reasons for entering a science teacher preparation program align with those reported in the literature. By elucidating the factors that contributed to a cohort of undergraduate science majors with high science GPA's deciding to enter a science teacher preparation program, this study represents a first step toward establishing best practices and policies for the recruitment of "high-quality" undergraduate science majors into science teaching programs.

Pre-Service Middle Grades Teachers' Understandings About Scientific Creativity: Perspectives on Teaching for Student Scientific Creativity

Gary M. Holliday, University of Akron Allison Antink-Meyer, Illinois State University *ABSTRACT:*

This is a descriptive study that aimed to identify and describe the salient features of pre-service middle grades teachers' understandings about creativity in science and their beliefs about pedagogy that support creativity among their students. Given this purpose, 34 pre-service middle grades teachers who were enrolled in two different middle level science methods courses were recruited for participation from two universities (University A and University B) in two states in the Midwestern United States. The analyses of the data suggests that in addition to supporting pre-service science teachers' epistemic understanding about the importance of creativity in science, building their understanding about how their teaching might influence the demonstration and potential development of students' scientific creativity can also benefit from explicit, reflective instruction (Akerson, Abd-El-Khalick, & Lederman, 2000; Khishfe & Abd-El-Khalick, 2002). Student development of creative ability in science classrooms has been demonstrated in other studies (Author 2, 2012) to be related to teacher practice. Such practice has been shown to likely occur in the vast minority of classrooms, however. Improving middle grades' students accomplishment of the performance expectations defined in the NGSS in the U.S. depends on teachers' abilities to support this important scientific skill.

Strand 8: In-service Science Teacher Education *Professional Development Models and their Influence on Learners' Outcomes* 10:15am - 11:45am, Maryland Salon F **Presider:** Mary K. Nyaema, University of Iowa

From Professional Development to Practice: Elementary Teachers' Understandings and Enactment of Nature of Science Instruction

Jennifer Maeng, University of Virginia RAndy L. Bell, Oregon State University Tyler L. St.Clair, Oregon State University Brooke A. Whitworth, Northern Arizona University Amanda L. Gonczi, University of Virginia

ABSTRACT:

This embedded mixed method study explored the understandings of Nature of Science (NOS) ideas and classroom implementation of these ideas for two cohorts of elementary teachers (n=145) following their participation in a statewide professional development (PD). The PD included a summer institute that contextualized NOS instruction within the context of problem-based learning and academic year coaching. Data sources included pre-, post-, and year-end Perceptions survey responses, videotaped classroom observations across four time points, and observations forms that captured contextual information about the observed lesson. Perceptions and observation data were analyzed with descriptive and inferential statistics. Observation data were also analyzed qualitatively for trends in participants' classroom enactment of specific NOS ideas. Results indicated that following the PD, participants' understandings shifted toward more aligned understandings (from 98.6% to 26.9% not aligned) by the end of the academic year following the PD. In addition more participants (40%) understood that NOS instruction needs to be explicit. The majority of participants (69.7%) taught NOS during the academic year following the summer institute. Classroom observation data suggested participants taught the social/cultural NOS ideas and the empirical NOS most often. Implications for PD developers are discussed in light of these results.

Analyzing Teaching Practices in the Korean Science Classroom Utilizing RTOP and SIOP Observational Tools: Implication of Professional Development Model for the Inclusion of Culturally and Linguistically Diverse, Cld) Students in Science

Jennifer Park, Seoul National University Wanjoo Ahn, Seoul National University Sonya N. Martin, Seoul National University

ABSTRACT:

The student population in Korea is shifting and is becoming increasingly more diverse. Research has shown that CLD students are disadvantaged to learn science when teachers lack the ability to support learners to navigate social interactions during group activities or to accommodate the language needs of students with differing levels of proficiency. Programs focused on diversity, multicultural education or Korean as Second Language scarce in Korea, and as a result, teachers are ill equipped with regards to the knowledge, skills, and dispositions needed to effectively teach CLD students. The aim of this study is to develop a classroom-based training and intervention model that can be used to prepare pre-service and in-service teachers to support (CLD) students in science. To meet this goal, we adopted the Reformed Teaching Observational Protocol (RTOP) and Sheltered Instruction Observational Protocol (SIOP) to help provide a baseline analysis of practices commonly enacted during typical science classrooms. Using these observation tools, we identified a variety of strengths and weaknesses in teachers' practices which we then discussed during cogenerative dialogues with teachers and their students to help develop targeted interventions designed to cultivate teachers' strengths in inquiry and language-rich instruction while also providing recommendations to improve weaknesses.

Climate Science Professional Development: Curriculum Design Considerations and Student Learning Outcomes

Andrea Drewes, University of Delaware Chrystalla Mouza, University of Delaware Joseph Henderson, University of Delaware

ABSTRACT:

We used complementary methods to investigate a model of professional development. The context was a yearlong Climate Academy that focused on climate science content, pedagogical strategies for teaching climate change, and outdoor activities. Through a focal case study of a sixth grade teacher, we examined two research questions: 1) How did the teacher integrate climate change in her 6th grade science curriculum following her participation in professional development? and 2) How did climate change instruction influence student reasoning about climate? Data were collected from multiple sources including classroom observations, teacher interviews, pre-post student content assessment, and pre-post student interviews. Findings indicated that the teacher focused on investigating changes in carbon dioxide levels over vast periods of time, including an understanding of how scientists measure carbon dioxide levels in the atmosphere, and the effects of climate change. The topic was introduced using activities and materials introduced during the Climate Academy. In turn, students developed a more complex understanding of climate change causality, particularly around the greenhouse mechanism, while also localizing the implications for humans to their particular spatial context. Findings have implications for the design of professional development programs that foster changes in teacher practice and student outcomes around climate change.

Coteaching in the Outdoors: A Blended Continuting Professional Development, CPD) Model Karen M. Kerr, Queen's University Belfast

ABSTRACT:

This study builds on and contributes to work in the area of coteaching in science teaching and learning in the outdoors. Previous studies have examined issues with teaching and learning science in the outdoors but no studies have used coteaching as model of delivering outdoor learning. As such, this study provides additional insight into how outdoor learning can be used as a vehicle to address curriculum change and confidence in relation to science teaching and learning. The analytic focus on coteaching in the outdoors as part of a blended model of delivery enables another contribution. This study analyses the benefits of outdoor learning within a blended model of delivery across all the cited outcome categories: cognitive, affective, interpersonal/social and physical/behavioural. Although numerous studies have identified the benefits of outdoor learning little analytic attention has been paid to the use of coteaching and curriculum change by demonstrating how this blended CPD model impacts teachers who are 'outside' their comfort zone, draws out the long term benefits of attitudinal change for both teachers and children as well as the environmental gains within and beyond the project.

The Effect of an Analysis-of-Practice, Videocase-Based, Teacher Professional Development Program on Teacher and Student Outcomes

Christopher Wilson, BSCS Joseph A. Taylor, ABT Associates Kathleen J. Roth, Cal Poly Pomona Foundation Molly Stuhlsatz, BSCS Connie Hvidsten, Biological Science Curriculum Study *ABSTRACT:*

This line of research around the [program name] professional development (PD) program is intended to help address the problem highlighted by Borko in 2004, that there is a critical need for studies of teacher professional development (PD) programs, particularly in science education. [Program name] is a year-long analysis of

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practice, videocase-based PD program for elementary teachers that uses lesson video analysis as a context for supporting teachers' learning about science content and effective science teaching. The PD is intended to increase students' science achievement by increasing teachers' ability to attend to student thinking and to the content storyline of science instruction. At NARST in 2015 we presented the results of a cluster-randomized trial of the [program name] PD program on student science content knowledge. At the 2016 conference we extend our analyses to include impacts on teacher PCK, teacher science content knowledge, and teacher classroom practice. In addition to examining direct effects, we present results on how differential effects on teacher outcomes mediated the impacts on student outcomes.

Strand 10: Curriculum, Evaluation, and Assessment

Curriculum Development and Implementation

10:15am - 11:45am, Watertable Salon A **Presider:** William L. Romine, Wright State University

Addressing the Achievement Gap Through Hands-On Brain, Learning, Behavior, and Traits Curriculum for Grades 4-5

Nancy Moreno, Baylor College of Medicine Alana Newell, Baylor College of Medicine Christopher Burnett, Baylor College of Medicine

ABSTRACT:

Engaging students in science at an early age lays a foundation for STEM careers and science, engineering and health literacy. English language learners, underrepresented minority and low socioeconomic status children have fewer opportunities to engage in high-quality STEM activities that would encourage their interest and academic development in these areas. This study evaluates the efficacy of a curricular unit designed to enhance students' content knowledge, science-related skills and interest in STEM fields by teaching them about their brain, learning and inherited traits. The unit was field tested with a diverse student population in a large, urban district, and outcomes from pre- and posttests indicate that the unit is successful in increasing content knowledge. Further, teacher feedback suggests that the lessons increased students' interest and science-related skills.

Curriculum Implementation for Scientific Argumentation: Fidelity to Procedure Versus Fidelity to Goals Katherine L. Mcneill, Boston College

Lisa Marco-Bujosa, Boston College

Maria Gonzalez-Howard, Boston College

Maria Gonzalez-Howard, Boston College

Suzanna Loper, Lawrence Hall of Science/University of California

ABSTRACT:

In the current accountability era, fidelity of implementation (FOI) has received increased attention in calls for funding and research; however, there are numerous ways of conceptualizing and measuring this construct. We explored conceptualizations of FOI in the context of the enactment of a middle school science curriculum focused on argumentation. We coded video for five teachers using two different fidelity coding schemes. First, Fidelity to Procedure targeted teachers' adherence to the order and types of procedures described in the activity structures within each lesson. Second, Fidelity to Goals examined teachers' adherence to the overarching argumentation goals within the curriculum. Application of these two coding schemes resulted in case studies that illustrate distinct patterns in the teachers' curriculum enactments in relation to low versus high fidelity. One case in particular, Ms. Newbury, received a low score for Fidelity to Procedure, but a high score for Fidelity to Goals. She altered a number of procedures during the curriculum to provide her students, all of whom were English Language Learners, with different linguistic supports, but maintained the overarching argumentation

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goals. The results have implications for future research assessing FOI and the design of educative curriculum to support teachers' successful enactments.

Exploring Variation in Curriculum Implementation Through Data Visualization of Teacher Talk Cynthia M. D'Angelo, SRI International

Savitha Moorthy, SRI International Carrie D. Allen, University of Colorado - Boulder Christopher J. Harris, SRI International William R. Penuel, University of Colorado *ABSTRACT:*

This mixed methods study of videos of classroom enactment of a project-based science curriculum looked at how teachers implemented the curricular prompts and guided their students in classroom discussions. Teacher talk was coded for general discourse moves as well as engagement in two science practices. A distinctive feature of our study is the investigation of variation across and within teachers with respect to how they orchestrate classroom discussions and how they make use of the curriculum materials in doing so. Data was collected on two specific lessons in physical science and Earth science across two years. There was a wide range of variation across teachers in how they enacted the lessons. How the teachers took up the curriculum prompts and turned these into productive classroom discussions with their students looked very different across classrooms and lessons.

The Development and Analysis of a Preschool Science Task: Observing and Explaining Sinking and Floating Christina V. Schwarz, Michigan State University

Laurie Van Egeren, Michigan State University

ABSTRACT:

Even though preschool science instruction is rare (4 to 8% of instructional time), preschool science experiences are critical for school readiness and lifelong science learning. Furthermore, young children are capable of learning and engaging productively in science. While some assessments of early conceptual knowledge exist, few early child science assessments focus on aspects of scientific practices and are available for large-scale assessment. This paper shares the development and analysis of a science assessment task in which children were asked to predict, observe and explain what causes objects to sink or float. Analysis of a sample of matched prepost interviews indicates that children's explanations or rationales to why an object sank or floated changed from focusing on fanciful responses or descriptions of the phenomena towards object and environmental attributes - implying that this task may be effective at detecting children's developing explanation practices. This paper will report on analysis of the larger sample and implications of these findings for early childhood science assessment and preschool science instruction.

Secondary Science Teachers as Curriculum Makers: Mapping and Designing Scotland's New Curriculum for Excellence

Carolyn S. Wallace, Kennesaw State University

ABSTRACT:

It has been acknowledged for decades that science teachers are intelligent decision makers who interpret and modify the official curriculum in accordance with what they believe are the needs of their students. In this sense, teachers play a crucial role as curriculum creators. In 2011, Scotland launched a major curriculum reform initiative, Curriculum for Excellence (CfE), that includes achievement objectives, learning experiences, skills and attributes (Education Scotland, undated). Since that time, science teachers in Scotland have been officially required to use the CfE as the basis for their lesson design. The purpose of this qualitative, interpretive, phenomenological study was to investigate how science teachers are responding to the challenge of designing classroom instruction within the context and processes of curriculum innovation. Using Remillard's (1999) framework for teacher as curriculum developer, the study investigates science teachers' composite perceptions

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and experiences of curriculum development, salient characteristics of the CfE influencing their work, and individual experiences in light of their core science teaching beliefs. A greater emphasis on scientific practices in the CfE is causing teachers to be more purposeful about teaching research and communication skills through integrated science topics, rather than discrete pieces of science content. Other implications are discussed.

Strand 10: Curriculum, Evaluation, and Assessment

Statistical Modeling 10:15am - 11:45am, Federal Hill **Presider:** Gavin W. Fulmer, National Institute of Education

Validation of an Instrument for Measuring Students' Understanding of Science in Grades 4-8 Over Multiple Semesters: A Rasch Measurement Study Yang Yang, University at Buffalo Peng He, Northeast Normal University Xiufeng Liu, State University of New York at Buffalo Michelle R. Eades-Baird, State University of New York at Buffalo ABSTRACT:

Recently, the measurement of students' learning outcomes in science subjects is crucial in science education research. For the limitations of using classic test theory to validate the instrument, a more reliable and valid method of measuring students' learning outcomes for interdisciplinary science is needed. The study intends to establish evidence for reliability and validity of an instrument in measuring students' interdisciplinary science understanding from Grade 4 to Grade 8 over multiple years. In TSU instrument, 20 multiple-choice questions covers the concepts of Waves and their Applications in Technologies for Information Transfer, Earth's Place in the Universe, Energy, Motion and Stability: Forces and Interactions, Ecosystems: Interactions, Energy and Dynamics. 1113 students from five schools in northeastern American completed the TSU assessment. The Partial Credit Rasch Measurement Model was used to analyze the stacked data. Results show that all items in the TSU instrument were measuring a single construct of students' understanding of science. The reliability and separation of items was high, but person reliability and separation was barely accepted. The analysis of construct and convergent validity indicated that the TSU instrument has high validity for measuring students' interdisciplinary science understanding from Grade 4 to Grade 4 to Grade 8 in three successive semesters.

Using Stochastic Ordering to Evaluate Changes in Physics Students' Conceptual Understanding Brian D. Gane, University of Illinois at Chicago Lou DiBello, Learning Sciences Research Institute-UIC Chiaka Okoroh, University of Illinois at Chicago Jim A. Minstrell, FACET Innovations James W Pellegrino, University of Illinois at Chicago ABSTRACT:

We apply a stochastic ordering method to perform a quantitative analysis of change in conceptual understanding demonstrated in students' responses to physics items. Using data culled from a larger dataset of middle school and high school students using an online physics assessments (www.diagnoser.com), we analyze whether student responses on successive assessments show evidence of fewer "problematic facets of thinking" and more "goal facets of thinking" on the second assessment. We augment a case study approach focused on characterizing how teachers use assessments in their classroom with a statistical approach used in decision theory to analyze whether different patterns of classroom assessment enactment are associated with differential changes in understanding. This analysis is exploratory, focusing on determining feasibility and limitations of this method, with the aim of potential implementation with a larger portion of the Diagnoser dataset.

Using Rasch Modeling to Investigate a Learning Progression for Energy Ideas Cari F. Herrmann Abell, AAAS Project 2061 George E. De Boer, AAAS Project 2061

ABSTRACT:

Energy is core concept in the teaching of science. Therefore, it is important to know how students' thinking about energy grows in complexity so that elementary, middle, and high school students can be appropriately supported in their understanding of energy. This paper tests the validity of a theoretical model of students' growth of understanding about energy that moves from a phenomenological understanding, to explaining phenomena with energy-related concepts, to explaining phenomena using atomic/molecular explanations. The study examines results from the administration of 372 distractor-driven, multiple-choice items aligned to a wide range of energy ideas from energy forms and transformations, to energy transfers, to energy dissipation and degradation, to energy conservation. Test items were administered to 6,540 students from across the U.S. Rasch modeling provided linear measures of student performance and item difficulty. For most of the energy ideas, an analysis of the item difficulties validated the study's description of the energy concept and how it progresses in conceptual complexity. Additionally, a cross-sectional analysis of student performance revealed that the high school students performed significantly better than the elementary and middle school students.

Testing Validity Inferences for Genetic Drift Concept Inventory Scores Using Rasch and Item Order Analyses

Robyn Tornabene, Stony Brook University Erik Lavington, Stony Brook University Ross H. Nehm, SUNY Stony Brook

ABSTRACT:

Concept Inventories (CIs) are commonly used to assess understanding of scientific ideas, yet the body of empirical evidence supporting the inferences drawn from CI scores is limited and rooted primarily in Classical Test Theory. This study sought to add to the body of evidence that underlies the validity and reliability of inferences generated by the Genetic Drift Inventory (GeDI), a recently developed CI for use in undergraduate biology classes. Our research focused on three areas: (1) GeDI item properties as evaluated using Rasch modeling, (2) item order effects and associated bias, and (3) score generalization validity. Rasch analysis revealed a good fit to the model and showed the GeDI is overall well matched to the ability of most upperclassmen in our sample. Improvement suggestions included incorporation of items to separate top scorers and examination of a few items with redundant or low difficulty levels. Rotating the GeDI's vignette-based test item suites had no impact on scores, implying that each vignette functions independently to elicit knowledge. Similar scores in our sample and other similar but geographically distinct samples provide evidence in support of score generalization validity. Our findings help illustrate how Rasch methods can be used to improve STEM CIs.

Strand 10: Curriculum, Evaluation, and Assessment

STEM Integration in Curriculum and Assessment

10:15am - 11:45am, Watertable Salon C

Presider: Christine M. Cunningham, Museum of Science, Boston

Operationalizing Applied Science: Developing Measures for Elementary Students' Understanding of STEM Dimensions of Food Systems Molly Brandt, University of Nebraska-Lincoln Cory T. Forbes, University of Nebraska-Lincoln

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Jennifer Keshwani, University of Nebraska-Lincoln *ABSTRACT:*

As tomorrow's global citizens, today's K-12 students must learn to confront significant global challenges, not the least of which is feeding a rapidly growing human population. To do so effectively, they need to develop an understanding of the scientific, technological, engineering, and mathematical (STEM) foundations of agricultural and natural resource issues. However, little progress has been made in operationalizing or measuring students' applied STEM reasoning, a crucial element of science literacy. Here, we draw upon multiple sets of integrated STEM and agricultural literacy standards to engage in empirical study of elementary students' conceptions and measurement development work. First, we investigate 3rd-5th grade students' conceptions of the STEM and environmental dimensions of food systems. Second, we develop empirically-grounded assessment items for these constructs using evidence-centered design (ECD - Mislevy & Haertel, 2006). Here, we present analyses and assessment items developed from interviews (n=35) conducted with 3rd-5th-grade students to illustrate trends in students' applied STEM reasoning and the assessment development process.

Evaluation of STEM-Integrated Lessons Using a Modified Rtop

Gillian Roehrig, University of Minnesota Joshua A. Ellis, Michigan Technological University Emily A. Dare, Michigan Technological University Tim Sheldon, University of Minnesota

ABSTRACT:

Recent national documents call for improvements in K-12 STEM education to increase STEM literacy and motivate students to pursue STEM fields (National Research Council, 2011). However, the STEM disciplines are often taught as isolated subjects with few guidelines for creating and teaching STEM-integrated lessons (Authors, 2012). This study considers the lessons of nine middle school science teachers who participated in an NSF Mathematics and Science Partnership designed to promote STEM integration. These teachers created STEM-integrated curriculum units and implemented them in their classrooms during the 2013-2014 school year. A total of 109 lessons were observed, which ranged from single-discipline lessons to STEM-integrated lessons that spanned multiple disciplines. These lessons were assessed using the modified RTOP (Sawada et al., 2002) and an Activity Log that documented the degree of STEM integration of each lesson. Quantitative analysis reveals that the modified RTOP is unable to assess the content present in engineering-only lessons. This is a concern for researchers and practitioners wishing to apply the RTOP or RTOP variants to classrooms that feature STEM-integrated instruction. Findings call for a clarification of the nature of engineering content knowledge and a reassessment of relevant instruments for measuring engineering and STEM content learning.

The Effects of Engineering Integration on Student Achievement in Science, Engineering, and Mathematics Selcen Guzey, Purdue University Tamara J. Moore, Purdue University Michael Harwell, University of Minnesota Mario Moreno, University of Minnesota Aran W. Glancy, University of Minnesota ABSTRACT:

The new science education reform documents call for integration of engineering into K-12 science classes. The study explored the influence of the engineering design-based science curriculum units on learning and achievement among students of different races, special education status, and limited English proficiency status. Treatment and control group students completed pre- and posttest assessments in science, engineering, and mathematics. State-mandated mathematics test scores and teacher variables were also included in the data analyses. Single level regression results for science outcomes favored the treatment for one science assessment but multilevel analyses showed no significant treatment effect. More importantly, we found that quality of the

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integration in the curriculum unit and type of engineering integration impacted student learning and achievement in engineering.

Integrating Science and Engineering Curriculum in Elementary Classrooms

Mandy Biggers, The Pennsylvania State University

Leigh A. Haefner, Penn State Altoona

ABSTRACT:

Integration of science and engineering is an explicit focus of the NGSS. However, no curriculum exists yet that integrates the two. Meaningful integration supports the 3-dimensions of learning (science/engineering practices, disciplinary core ideas, and cross-cutting concepts). Teachers are left to integrate the disciplines using their existing science and (if available) engineering curriculum. This study investigated six elementary teachers across grades 1-6 as they were trained in, implemented, and attempted to integrate new science and engineering curricula. Findings revealed that (1) very little science content was integrated into the engineering curriculum, (2) teachers implemented the new engineering curriculum across a continuum of fidelity to the curriculum, and (3) factors such as (a) alignment of the curriculum units, (b) lack of emphasis on integration during separate science and math professional development, and (c) instructional goals of the teachers made a significant difference in the amount of integration across the two curricula. This study has implications for teacher education, professional development providers, curriculum developers, and eventually (and importantly) classroom practice. It is a first step in understanding if and how teachers can integrate science and engineering content and practices in elementary classrooms in meaningful ways.

Strand 11: Cultural, Social, and Gender Issues

Mobilizing Students' Cultural and Community Resources

10:15am - 11:45am, Pride of Baltimore **Presider:** Jomo W. Mutegi, Indian University

Lasting Impacts of Cross-Cultural Research on Science and STEM Teaching and Research in the U.S. Nicole Beeman-Cadwallader, Project Lead the Way Cassie Quigley, Clemson University Ingrid S. Weiland, Metropolitan State University of Denver ABSTRACT:

Scholarship documenting findings from cross-cultural research often either presents the stories of the place(s) the researcher traveled, for the purposes of speaking to a Western audience, or shares ways in which the research or project "improved" outcomes for the Indigenous community. We find value in moving beyond those "travelers' tales" to reflexively consider the impact of our work on our practice. In this paper, we seek to illustrate the powerful, lasting impacts of our cross-cultural research in Africa on our current teaching and research in science and STEM education. Our shifting conceptions as a result of our cross-cultural research in Africa have changed our teaching and research practice in the United States. Here we share reflective vignettes which reveal the shifts in our conceptions of knowledge, relationship-building, and cross-cultural commitments. In addition to the value of expanding conceptions of knowledge and identifying productive pedagogies in cross-cultural contexts, particularly in Indigenous communities outside of the U.S., we charge science and STEM education researchers to consider the impacts their cross-cultural projects have on our teaching and research practices in the U.S. Doing so can extend the reach of efforts towards more equitable science and STEM education to our home communities.

Building Culturally Relevant Ambitious Science Teaching, CRAST) for Diverse Students Ebenezar M Mbachu, McGill University ABSTRACT:

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Researchers have made a compelling case for using culturally relevant pedagogy to improve the academic performance of students from non-dominant cultural communities (Gay, 2000; Ladson-Billings,1995). The discontinuity/mismatch between minority students' cultures and school science culture may impede these students' learning (Barton & Tan, 2009; Lee & Fradd, 1998). Researchers have responded to this mismatch by arguing for more equitable and inclusive science instruction (Lee & Fradd, 1998). However, to promote science learning with diverse students, there is a need to provide educators with tools they can use to engage youth in ways that mobilize their funds of knowledge in the science classroom (Barton & Tan, 2009; Gonzalez, Moll, & Amanti, 2005). This paper seeks to construct a framework that can help teachers to learn how to identify students' funds of knowledge, and discusses strategies for supporting non-dominant youth in the science classroom. As such, I will explore both culturally relevant pedagogy (Ladson-Billings, 1995) and ambitious science teaching (Thompson, Windschitl, & Braaten, 2010) as effective teaching practices for diverse students, and suggest that these two approaches may do more to "speak to each other" in ways that provide teachers with tools for teachers working with youth of diverse backgrounds.

Family Science Night: Experiencing Democratic Science Education in a Middle School Michelle A. Fleming, Wright State University

Lisa O. Kenyon, Wright State University Leonard Kenyon, Wright State University Bhaskar Upadhyay, University of Minnesota *ABSTRACT:*

The purpose of this study intends to extend the knowledge of democratic practices in science classrooms by describing how democratic practices were practiced in a middle school classroom and how students were able to draw the community into science through the school Family Science Explanation Night. Democratic science themes include: 1) co-constructing meaningful and engaging science through scientific modeling, 2) constructing science knowledge through peer dialogue and sharing, and 3) engaging the students and their community in scientific practices. Participation and engagement of students and their community illustrate the value of democratic science. The viability of including the community in science and providing transformative science experiences to students are described in this case study. Democratic science practices as connected to NGSS scientific and engineering practices will be addressed in the presentation.

Community Organizations' Programming and the Development of Community Science Teachers

Maria Varelas, University of Illinois at Chicago Syeda Raza, University of Illinois at Chicago Daniel Morales-Doyle, University of Illinois at Chicago Carole P. Mitchener, University of Illinois at Chicago David Segura, University of Illinois at Chicago Karen Canales, Harold Washington College *ABSTRACT:*

We explored how programming of non-for-profit, science-related organizations intertwine attention to issues of equity, social justice, and science content, and how high-school, preservice teachers participating in such programming make sense of the goals and nature of science education. Participants included teacher-candidates who participated in the "Toxic Tour," a fieldtrip organized by a community organization to highlight various injustices in the community and the importance of understanding and demanding environmental justice. The teacher-candidates' post-workshop reflections were analyzed in qualitative, interpretive ways using constructs from sociotransformative constructivism and the structure-agency dialectic. The Toxic Tour provided them with the opportunity to engage with the complexity of socioscientific issues affecting marginalized communities, connect science concepts to social justice, and reflect upon their roles as science educators. It also became an empowering structure for not only contextualizing science but also appreciating the strength of the community that has historically been a victim of structural injustices. However, teacher-candidates did not explicitly engage

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in critically examining structural forces and their own positionalities in the larger systems of power and privilege, and some saw social justice as a desirable, not always possible, supplement to science curriculum, pointing to the need for continuous and explicit examination of these ideas.

Strand 12: Educational Technology

Models and Design Using Technology 10:15am - 11:45am, Baltimore Salon B **Presider:** David B. Vallett, University of Nevada Las Vegas

Including Blind Students in Science Education: Sound-Based Computer Models as an Exploratory Learning Environment

Sharona T. Levy, University of Haifa Ran Peleg, University of Haifa Orly Lahav, Tel-Aviv University Noha Chagab, Tel-Aviv University Vadim Talis, Tel-Aviv University

ABSTRACT:

Equity in education has two main dimensions: fairness and inclusion. Although blind students are integrated into public schools, they are often excluded from full participation in science as most learning materials are visual, thus limiting both fairness and inclusion. To overcome this limitation, an existing model-based inquiry-learning environment was adapted by means of sonification. We examine whether perceptual compensation creates a comparable learning environment for blind and sighted students. We assess conceptual learning in science and reasoning about complex systems. Data were collected by pre and post questionnaires and answers to workbook items. The environment not only supported blind students' learning similarly, but even furthered their learning with one of the more challenging concepts - diffusion. It seems auditory representation increases sensitivity to the micro-level interactions in a way less accessible in visual representations.

Integrating Agent-Based Modeling & Case Study to Learn About Population Dynamics: A Design Framework Aditi Wagh, Northwestern University

Michael J. Novak, Park View School and Northwestern University Firat Soylu, University of Alabama Uri Wilensky, Northwestern University *ABSTRACT:*

There is increasing emphasis in K-12 science education on integrating content learning with engagement in authentic scientific practices. Agent-based models provide computational representations of real world phenomena and can serve as sandboxes to conduct investigations and make sense of resulting patterns. On the other hand, researchers have also argued for students to engage in inquiry in the "messiness" of real world data. Both these ways of doing science serve as modalities for epistemologically authentic inquiry sites. In this paper, we present a design framework for a Population Dynamics unit that leverages the strengths of both these modalities. The goal of the unit is to facilitate learning about trends and mechanisms underlying the dynamics of population change in high school classrooms. The framework involves a series of increasingly complex NetLogo models, and parallel forms of data from a real world case study of the Isle Royale ecosystem. The design integrates the two modalities in the form of a symbiotic progression in which students grapple with increasingly complex ideas through the models and case study that inform, and build on each other. The framework also includes design features that support students through bridging connections across the two modalities in this progression.

Intersection of Creativity and the Design Process in SEG Design-Based Research

David B. Vallett, University of Nevada Las Vegas Richard L. Lamb, Washington State University Len Annetta, George Mason University

Marina Shapiro, George Mason University

ABSTRACT:

This study examined the potential interplay between participation in the design process for Serious Educational Games and learner creativity, both as scores on creativity instruments affect participation in the design process and participation impacted changes in scores on the Torrance Test of Creative Thinking. Linear regression methods indicated that learners who took a more active role in the design process as measured by investigators showed greater levels of creativity on their TTCT pretest, while participation in the design process itself did not have a significant impact on TTCT change scores. While not the only factor in play, this study establishes that creativity may be an important factor in engaging students in the design process.

Failing Better – Reflecting on an Activity in Which Students Analyze Common Mistakes

Elon Langbeheim, Arizona State University Menashe Puterkovsky, Jerusalem Institute of Technology Esther Bagno, Weizmann Institute of Science Edit Yerushalmi, Weizmann Institute of Science

ABSTRACT:

This study reflects on a computer based activity that confronts students with the misconceived reasoning of a fictitious student, in order to help them avoid this type of thinking. Although most students indeed evade the misconceived reasoning in a subsequent post-activity isomorphic question, they do not necessarily develop the necessary criteria for correctly solving the question. Examining the audio protocols of such students, indicates that they perceive the feedback from the computer as non-sensible. We analyze the students' performance through two theoretical lens, using the findings for suggesting an improved design of the activity.

Strand 15: Policy

Building Capacity for STEM Reform: Policy, Partnerships, and Capital 10:15am - 11:45am, Gibson Presider: Sharon J. Lynch, the George Washington University

Activating Capacity for Urban Science Education Reform: The Role of Resource Chains and Constellations Kathryn N. Hayes, California State University, East Bay Christine Lee, California State University East Bay Rachelle DiStefano, Cal State University East Bay Jeff Seitz, California State University, East Bay Dawn O'Connor, California State University, East Bay *ABSTRACT:*

Because NGSS requires districts to support extensive instructional shifts, research on how urban districts build capacity for science education reform is critical. Research on the outcomes of district financial investments in capacity-building is mixed at best; recent scholarship suggests that often additional resources (known as a "capitals") are necessary to activate financial investments. This study documents the chains and constellations of capitals that activate or obstruct the financial and structural capitals necessary for urban science education reform. A case study, this paper draws on interview, observation, and document data from one high-poverty district taking part in a major capacity building science reform effort. Results demonstrate that organizational structures--schedules, coring, and initiative alignment--played key roles in the ability of the focal district to

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support science education reform. In addition, social-organizational forms of capital (e.g., social capital, shared leadership, and shared vision) were necessary to activate or create these structural capitals.

Mismatch Between Important STEM Competencies and STEM Education

Hyewon Jang, Harvard University

ABSTRACT:

Gaps between STEM (Science, Technology, Engineering, and Mathematics) education and required skills have been identified in industries, academia, and government. STEM educators acknowledge the need to systemically reform STEM education in order to better prepare students for their future. We pursue growing interest in required skills in STEM disciplines and ask whether frameworks of 21st-century skills and engineering education illustrate a whole of important STEM competencies. In this study, we identify important 21st century STEM competencies and evaluate the relevance of present frameworks have been applied in education, using the standardized job-specific database operated and maintained by the U.S. Department of Labor. This article shows frameworks for 21st-century skills and engineering education do not illustrate a whole of important STEM competencies for STEM education programs to bridge gaps between education and important competencies.

Industrial Engagement in STEM-Initiatives: Three Case Studies

Maria AndrÈe, Stockholm University

Lena Hansson, Kristianstad University, Sweden

ABSTRACT:

Many different actors, including government, academy and industry, are engaged in school- and recruitment-STEM-initiatives. Despite a large number of initiatives put forward by different actors, with different agendas, there is little research on the initiatives, actors, aims and agendas involved. The aim of this paper is to develop in-depth knowledge about industrial engagement in STEM-initiatives and thereby shed light on what processes of commercialization that are at play in STEM-education. The study reports from three case studies of industrial STEM-initiatives in Sweden: The First Lego League, the school program of Innovation and Chemical Industries in Sweden (IKEM), and the school program of a Swedish private energy company called E.ON. The study draws on case-study methodology in combination with a theoretical framework of discursive psychology. The research questions are: What resources are drawn upon? What repertoires are mobilized when industrial actors motivate their engagement? The results show that the actors draw on repertoires focused on: increasing knowledge and/or interest in science, securing the future industrial workforce, and raising awareness of the importance of STEM. The results point to how the repertoires used by the industrial actors embed potential conflicts of interests concerning e.g. lack of repertoires relating to critical citizen perspectives.

Concurrent Session #5 1:15pm – 2:45pm

Presidential Sponsored Session

Engagement, Disengagement, and Alienation of Student in Science Education 1:15pm - 2:45pm, Baltimore Salon A
Presider: Mary M. Atwater, University of Georgia
Presenters:
Pauline Chinn, University of Hawaii at Manoa
Meshach B. Ogunniyi, University of the Western Cape
Xicotencatl Martinez Ruiz, Revista Innovacion Educativa
Liyu Fu, National Tsing Hua University
Henriette Tolstrup Holmegaard, University of Copenhagen

Strand 1: Science Learning, Understanding and Conceptual Change

Large Scale Assessment of Student Understanding 1:15pm - 2:45pm, Fells Point **Presider:** Mei-Hung Chiu, National Taiwan Normal University

Decision Tree as a Model for the Prediction of Student Performance on Diffusion Mei-Hung Chiu, National Taiwan Normal University Yuh-Ru Yu, National Taiwan Normal University Hongming L. Liaw, National Applied Research Laboratories, Taiwan ABSTRACT:

Given the difficulties learns often encounter when learning diffusion, it becomes imperative that educators find ways to overcome such difficulties. The current study proposes a new approach to solve this problem: to identify key diffusion concepts and questions that could be used to predict student performance on the subject. The decision tree methodology was adopted to construct a Decision Rule Set, from which common rules were identified for the top as well as bottom performing students. The pattern of rules observed provided us with a way to determine the optimal decision tree model for the prediction of student performance on diffusion.

Improving Science Learning Through Integrating the Arts

Brad Hughes, UCI

Robert Kalinowski, University of California, Irvine

Doron Zinger, University of California, Irvine

Alex Ray, University of California, Irvine

Doug Grove, Multi-Dimensional Education Inc.

Drew H. Bailey, University of California, Irvine

Christa Mulker Greenfader, University of California Irvine

ABSTRACT:

Science instruction is especially critical in elementary schools where students learn fundamental skills. Meeting the needs of the growing student populations of English Language Learners (ELLs) is especially important. Recent studies have investigated the impact of Professional Development (PD) focused on language-integration in teaching science to ELLs. The results of these studies reveal that PD efforts have largely failed to close the achievement gap between ELL and non-ELL students. This study investigates the effect of PD strategies utilizing Visual and Performing Arts (VAPA) integration to teach science, with special focus on addressing the needs of ELLs in urban, elementary school settings. We investigate student science learning through VAPA and Inquiry based methods as well as more traditional approaches. Pre- and post-tests of 1,181 3rd graders, 1,302 4th graders, and 1,260 5th graders were used to measure learning outcomes. Initial findings from year 1 of a 3-year study show show promise in engaging students in science and improving science achievement.

Inequitable Foundations and Adaptation: Educational Equality in Evolution

Jaimie Miller-Friedmann, University of Oxford

Sue Sunbury, Harvard University

Philip M. Sadler, Harvard Smithsonian Center for Astrophysics

ABSTRACT:

We assessed student understanding of middle school NSES standards for evolution with a nationally representative sample in diverse settings. We investigated whether students from a wide range of school type, SES, and regions in the United States are being taught and are learning evolution equally. We found no significant differences in population's understanding of evolution, indicating that there is educational equity for this unit. 0 false 18 pt 18 pt 0 0 false false false /* Style Definitions */ table.MsoNormalTable {mso-style-

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Psychometric Evaluation of the Nature of Solutions and Solubility—Diagnostic Instrument English Version Mandy McCormick Smith, Capital University

Lin Ding, The Ohio State University

Kathy Cabe Trundle, North Carolina State University

ABSTRACT:

The Nature of Solutions and Solubility—Diagnostic Instrument (NSS–DI) developed by Adadan and Savasci (2012) was designed to assess students' understanding of solution chemistry concepts. The original instrument was developed in Turkish to assess solution chemistry understanding among 16 and 17 year old students. From its original development and implementation the test has been modified to an English version of the instrument, the NSS-DI Eng. To evaluate the reliability and the discriminatory power of this assessment tool, statistical tests were used focusing on both item analysis (item difficulty index, discrimination index, point-biserial coefficient) and the entire test (Cronbach's alpha and Ferguson's delta). While the results indicate that the English version of the NSS-DI is a reliable assessment tool, there are also some indications that the instrument could be improved. The presentation will also present the common alternative conceptions of solution chemistry concepts among first year college chemistry students. Future hopes for the NSS-DI Eng are that upon further improvement, it will provide chemistry educators and researchers insights into common solution chemistry conceptions, alternative conceptions, and student understandings, and will lead to improved chemistry education.

Strand 2: Science Learning: Contexts, Characteristics and Interactions

Symposium - Pathways towards Engaging and Equitable Sense-Making for Elementary Teachers and their Students

1:15pm - 2:45pm, Maryland Salon E **Presider:** Christina V. Schwarz, Michigan State University **Presenters:** Christina V. Schwarz, Michigan State University Angela Calabrese Barton, Michigan State University Carrie T. Tzou, University of Washington Bothell Carolyn Colley, University of Washington, Seattle Beth Warren, TERC Ann S. Rosebery, TERC Elizabeth X. De Los Santos, Michigan State University Christa Haverly, Michigan State University Christina V. Schwarz, Michigan State University

ABSTRACT:

Sense-making lies at the heart of scientific ways of learning about the world – central to how learners develop and revise powerful science ideas and critical for equity because full participation, epistemic agency, and meaningful contribution to knowledge-building are hallmarks of equitable learning communities. Nonetheless, fostering engaging and equitable sense-making is challenging for teachers. Several research groups and programs have been systematically working on determining how to better help elementary teachers open-up spaces and foster engaging and equitable sense-making opportunities in classrooms. Research groups in this

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symposium drawn on their work with elementary teachers across the spectrum of experience to share their findings. In particular, the symposium will a) examine aims, goals and definitions of sense-making with an equity focus, b) share research findings in the form of cases highlighting what equitable and engaging sense-making looks like in classrooms at the elementary level, c) illustrate promising instructional practices, tools and approaches that may support engaging and equitable sense-making while considering challenges that teachers and students face, and (e) propose promising future directions for research in working towards engaging and equitable sense-making for all.

Strand 4: Science Teaching--Middle and High School, Grades 5-12): Characteristics and Strategies *Teaching and Learning Outcomes*

1:15pm - 2:45pm, Federal Hill **Presider:** Christine Lee, California State University East Bay

Using the Complexity Paradigm to Help Students Construct Meaningful Links Among Biology Concepts Fadi B. El Hage, Universite Saint Joseph Saouma B. Boujaoude, American University of Beirut ABSTRACT:

The objective of this study was to highlight the problem of fragmentation of knowledge in biology teaching and provide evidence in support of using the complexity paradigm in teacher professional development which aims to help students construct meaningful links among physiology concepts that are traditionally taught in a fragmented manner. The study utilized a mixed methods approach. Phase 1 included 300 Grades 7 and 10 students-with the same academic experience and similar social backgrounds-randomly selected from five schools. These students filled out a questionnaire including closed- and open-ended questions to investigate their ability to mobilize links among physiology concepts. Participants in phase 2, which involved investigating the effect of a professional development program on students' ability to construct linked knowledge, included 420 students and 16 teachers in 16 classes (Grades 7 and 10) who were divided into an experimental and a control group. Teachers of the experimental group participated in a professional development program. Results showed that student initially had fragmented knowledge (phase 1), developed linked knowledge after the intervention but not to the same extent in all physiology topics (Phase 2). Results showed that the complexity paradigm is useful in helping students mobilize "complex network links" in physiology.

Comparing Laboratory Instruction for Differently Tracked Groups of Students

Patrick J. Enderle, Georgia State University Anna M. Strimaitis, Florida State University Jonathon Grooms, George Washington University Victor D. Sampson, The University ofTexas at Austin Sherry A. Southerland, Florida State University *ABSTRACT:*

This study compares student outcomes on assessments of content understanding and investigation design as they experience two distinct laboratory instructional contexts. Data were analyzed to compare students within each school based upon the academic level of science course. Outcomes demonstrate that even "lower track" students can achieve significant learning through meaningful engagement in multiple science practices during laboratory instruction.

High Performers in Science: The Relation Between Instructional Characteristics and Performance, Self-Concept, and Interest Stefanie Schmidtner, Technische Universitt M, nchen

Anja Schiepe-Tiska, Technische Universitt M, nchen

Tina Seidel, Technische Universitt M, nchen Manfred Prenzel, Technische Universitt M, nchen *ABSTRACT:*

There is a high interest in promoting young talents in science. This requires science teaching to promote both, high performance in science as well as high motivational-affective characteristics like self-concept and interest. Although research has shown that the relation of instructional characteristics and outcomes varies for different student characteristics, results on differences between high and non-high performers and differences within the group of high-performers are limited. This paper investigates whether the relation of student-active instructional characteristics of science teaching (interactive teaching, inquiry-based teaching, and focus on application) and cognitive and non-cognitive outcomes (performance, self-concept, and interest) differs between high and non-high performers. In addition, the role of self-concept for the relation of teaching and interest of high performers is analysed. Data of PISA 2006 are used and analysed using multilevel analysis. Results reveal that student investigations negatively relate to science competence for high and non-high performers but positively relate to interest in science of non-high performers. Moreover, the crucial positive role of applications in science teaching for the interest of high performers is shown. Important insights into the relation of student-active teaching and cognitive as well as motivational-affective outcomes and into differences between high and non-high performing students are provided.

Fostering Problem Solving Skills: A Training on Pictorial Literacy

Julia Kobbe, University of Duisburg-Essen, Chemistry Education

Jenna Koenen, Humboldt-University Berlin

Stefan Rumann, University of Duisburg-Essen

ABSTRACT:

In modern science books, students are confronted with a broad variety of diagrams. In order to learn, students must adequately encode the presented information and process it in line with the particular requirements of a given task. Even though diagrams play an essential role for knowledge acquisition, scientific and analytical problem solving, students are rarely instructed in their handling systematically. Thus, we developed and evaluated two systematic short-term trainings, to foster pictorial literacy. Both trainings present the same information, one using diagrams with everyday life contents, the second training includes scientific contents. The trainings were evaluated in a quantitative pre-post-study-design with 9th grade middle school students (N=315). A control group attended a time-equivalent lab course. Data acquisition included items referring to pictorial literacy, analytical and scientific problem solving. Results show that both trainings in pictorial literacy lead to increased analytical problem solving skills whereas this is not the case for the control group. Since the problem solving items are mainly based on diagrams, this indicates that the ability to handle diagrams increases by attending our training in pictorial literacy. A more detailed analysis of both trainings will show possible transfer effects on the different applied domains.

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

Self-Efficacy and Motivations

1:15pm - 2:45pm, Watertable Salon B **Presider: To**njua B. Freeman, University of Central Florida

Relationships Among Taiwanese Undergraduates' Conceptions of, Approaches To, and Self-Efficacy Regarding Learning Earth Science Kuan Ming Shen, National Sun Vat sen University, Taiwan

Kuan-Ming Shen, National Sun Yat-sen University, Taiwan Min-Hsien Lee, National Sun Yat-sen University, Taiwan Chin-Chung Tsai, National Taiwan University of Science and Technology, Taiwan

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Jyh-Chong Liang, National Taiwan University of Science and Technology, Taiwan Yen-Yuan Chen, National Taiwan University, Taiwan Guo-Li Chiou, National Taiwan University of Science and Technology, Taiwan

ABSTRACT:

In the area of science education research, studies have attempted to investigate the conceptions of learning, approaches to learning, and self-efficacy mainly focused on the science in general or on the specific subject as biology, physics, and chemistry. However, there is still a dearth of empirical study focused on students' earth science learning. This study aimed to explore the relationships among Taiwanese undergraduates' conceptions of, approaches to, and self-efficacy regarding learning earth science. A total of 363 Taiwanese undergraduates participated in this study. Three instruments were developed to assess students' conceptions of, approaches to, and self-efficacy regarding learning earth science. Structural equation modeling (SEM) was utilized to identify the structural relationship. The results indicated that students with sophisticated learning conception as "understanding and seeing in new way" tended to use deep approaches to learning (i.e., deep motive and deep strategy) and may result in advanced self-efficacy of learning earth science. In addition, as most of participants were non-earth science majors, students with higher-level conception as "Applying" tended to draw on surface approaches. And, students viewed learning earth science as "memorizing" had effect on their self-efficacy of learning earth science.

A Comparison of Students' Motivation and Experiences in Face-To-Face and Virtual Laboratories in Introductory Biology

Amber J. Reece, University of Central Florida

ABSTRACT:

The objective of this study was to describe and compare the effects of students' experiences in face-to-face and virtual laboratories on their motivation to learn biology. Motivation was measured at the beginning and end of the semester using a questionnaire. At the end of the semester students also ranked their laboratory environment on several characteristics. Interview and observation data in the phenomenological research tradition described students' experiences in these lab environments. Statistical analyses suggest the virtual laboratory environment did not have a differential impact on students' motivation to learn biology. Comparison of the environments showed that students in the face-to-face labs reported greater instructional support, student interaction and collaboration, relevance of the lab activities, and authentic learning experiences than the students in the virtual labs. Qualitative results indicated the teaching assistants in the face-to-face labs were an influential factor in sustaining students' motivation. In comparison, the virtual laboratory students often had to redo their lab exercises multiple times because of unclear directions and system glitches, potential barriers to persistence of motivation. The face-to-face students also described the importance of collaborative experiences and hands-on activities while the virtual laboratory students appreciated the convenience of working at their own pace, location, and time.

Impacts of a Course-Based Undergraduate Research Experience on Novice Students' Attitudes and Motivation in Biology

Jeffrey T. Olimpo, The University of Texas at El Paso Ginger R. Fisher, University of Northern Colorado *ABSTRACT:*

Course-based Undergraduate Research Experiences (CUREs) have been identified as a viable mechanism for promoting students' development of scientific process skills in STEM domains. Recent bioeducation reports suggest furthermore that student participation in such opportunities increases their interest in conducting scientific research and confers a deeper appreciation for the discipline as a whole. Despite these documented benefits, such research has historically utilized non-voluntary student samples and has made use of self-reported

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data as the sole metric for evaluating student outcomes. To address these concerns, we adopted a quantitative approach designed to provide a more objective account of how CURE participation impacted novice students' attitudes and motivation in biology relative to a matched control group who had participated in the traditional, "cookbook" laboratory version of the course. Analysis of CLASS-Bio (attitudinal) and BMQ (motivation) survey data indicated a significant between-group, pre-/post-semester shift in students' overall responses on both measures (p < 0.001), with CURE participants adopting more expert-like views on several factors including self-efficacy, self-determination, and reasoning as compared to the match control group. These between-group effects were found to be especially pronounced among females and underrepresented minority students who had participated in the CURE.

A Comparison of College Students' Character Development and Socioscientific Argumentation Based on their Orientations: Individualism-Collectivism

Yeonjoo Ko, Ewha Womans University Yunhee Choi, Soongmoon Middle School Hyunju Lee, Ewha Womans University

ABSTRACT:

In this study, we aimed to investigate the differences in college students' character development and the patterns of socioscientific argumentation based on their orientations. Since students naturally brought in their own values, worldviews, and feelings when discussing on SSIs, we assumed that individualism and collectivism – one of the psychological constructs may affect students' worldviews and conversations. Thirty seven college students participated in this study. First, we assigned student groups by the results of INDCOL; individualism groups (IG), collectivism groups (CG), and mixed groups (MG). Second, we examined the differences in development of character and values among three types of groups. While observing SSI classes, we took detailed field notes and audio-taped all group discussion. Student argumentation was transcribed and analyzed with the framework of 'discourse clusters' and 'discourse schemes'. As a result, there were statistically significant differences in promotion of socioscientific accountability among groups. In addition, CG students concentrated on making a group consensus, while IG students tend to argue their opinions, and challenge or question the reliability of claim and evidence when discussing on SSIs. CG students felt responsibility and expressed their willingness to act for solving problems more than others in both argumentation and questionnaires results.

Strand 7: Pre-service Science Teacher Education

Preservice Teachers' Scientific Writing, Literacy, and Language 1:15pm - 2:45pm, Baltimore Salon B **Presider: To**nya D. Jeffery, Texas A&M University - Corpus Christi

Uncovering Preservice Science Teachers' Tacit Reading Strategies Kirsten K. Mawyer, University of Hawaii Heather J. Johnson, Vanderbilt University ABSTRACT:

A Framework for K-12 Education and the NGSS conceptualize science inquiry learning as engaging in scientific practices including obtaining, evaluating, and communicating information [OECI]. Preservice science teachers enter teacher education programs with extensive science content expertise, which includes well-developed personal strategies for reading a variety of science texts (Norris & Phillips, 2003). If reading is to play a more prominent role in secondary science, then we need to help preservice teachers make their tacit knowledge about how to read science texts explicit so they can transform their content expertise into content for teaching expertise (Ball, Thames, & Phelps, 2008). This study examines the question: What tacit strategies do preservice teachers use to understand science texts? Analysis revealed commonalities across the strategies of

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preservice teachers and highlighted that they used a combination of general and genre-specific strategies to read, analyze, and make sense of science texts. This critical information can be used to inform teacher educators as they design science methods and disciplinary literacy courses that scaffold development of the pedagogical content knowledge necessary to teach OECI as a scientific practice.

Pre-Service Educators' Digital Stories of Writing in Science

Nancy P. Morabito, St. John's University

ABSTRACT:

Recent movements in science education focus on providing opportunities for students to engage in the practices of science and engineering, including the communication of information. The Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas (National Research Council, 2012) states that, "Communicating in written or spoken form is [a] fundamental practice of science" (p. 74). This emphasis on the role of writing and communication in the K-12 classroom necessitates that teachers, themselves, be well-versed in these practices of science and engineering. Given the affordances of digital storytelling (DeGenarro, 2010; Genereux & Thompson, 2008; Ohler, 2013; Valkanova & Watts, 2007), this paper considers the manner in which pre-service educators explore and represent their understandings of writing in science and engineering through the medium of digital storytelling. This study focuses on two different digital storytelling facilitated students' consideration of writing in science, particularly with respect to the importance of different forms of representation and the role of writing for communication purposes. Two focal undergraduates, both aspiring secondary science teachers, also found the medium helpful for considering implications for their own future teaching.

A Study of Preservice Teachers' Use of Academic Language and Discourse in Science Teaching Sanghee Choi, University of North Georgia

ABSTRACT:

The purpose of the study was to examine the use of preservice teachers' science specific academic language in their science instruction and its development through field experiences in the elementary classroom. The qualitative research method was adopted. This was a year-long study with 30 preservice elementary teachers. Videotaped science lessons, lesson plans, student work samples, and interview data were collected and analyzed. The participant teachers facilitated academic conversation to mostly clarify and elaborate the concepts, paraphrase the student responses, and support student answers/ideas during instruction. The teachers instructed appropriate science concepts from the content in the science textbook. However, the concepts were not fully explained so that some students would be expected to encounter difficulties in science learning. In some lessons observed, the participant teachers only minimally used and explained mathematical words and symbols while numerical questions (problems) were being solved. This study suggested that teachers needed to develop more attention to the nature and general difficulty of the academic language of the science classroom. This study further revealed that the different levels and reasons for use of language during teaching seemed to derive from inadequate subject content knowledge and ineffective use of and lack of academic conversation skills.

Creating a Model of Acceptance: Using Culturally Relevant Science and Mathematics at Family Learning Events

Cherie McCollough, Texas A&M University-Corpus Christi, Life Sciences Olga Ramirez, University of Texas Rio Grande Valley Zulmaris Diaz, University of Texas Rio Grande Valley *ABSTRACT:*

Presenters have been conducting Family Science and Family Math Learning Events for 8 years as part of University preservice teacher training in Science and Mathematics content courses at their respective Hispanic

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Serving Institutions. Using Ladson-Billings concept of culturally relevant pedagogy, researchers/instructors infused culturally relevant teaching strategies in science and mathematics teacher education courses, requiring preservice teachers to engage families using these strategies at Family Science and Family Math Learning Events with audiences comprised of Latino majority populations. Researchers/instructors will present mixed-methods research (quantitative Parental Involvement questionnaire, written semi-structured written personal reflections, telephone interviews, course artifacts) regarding changed attitudes and perceptions of science and mathematics content by Latino families through the use of family learning events, as well as changed personal perceptions regarding Latino families by preservice science/mathematics teachers as a direct result of these experiences. Theoretical framework and research regarding culturally relevant teaching and implementation of Family Learning Events, curriculum, instructions and lesson/project examples will be provided to incorporate family learning as part of science and mathematics preservice teacher education curriculum. Multiple resources will be distributed and explained.

Strand 8: In-service Science Teacher Education

Issues About Earth Science in Teacher Education

1:15pm - 2:45pm, Homeland **Presider:** Greg Rushton, Stony Brook University

Authentic Ocean Data as a Pathway to Meeting the Next Generation Science Standards Meghan E. Marrero, Mercy College

Raya-Jean Zaczyk, NASA Endeavor STEM Teaching Certificate Program *ABSTRACT:*

With the Next Generation Science Standards' shift in emphasis to engaging students in science and engineering practices, science educators must find ways to provide teachers with strategies for doing so. There are myriad oceanic data sets available, from sea surface to sea floor, animal tracks to tsunami wave movements. K-12 students may access and analyze these authentic data and engage in several of the NGSS practices as they do so. This qualitative case study examined the perspectives of teachers engaged in an online graduate course focused on using oceanic data, as they related to their students' use of science and engineering practices. Using the techniques of grounded theory analysis of diverse data sources, including reflection papers, discussion posts, interviews, and student work, the authors found that teachers perceived that there was improved student engagement and ability to construct scientific explanations supported by evidence from the ocean data. This study's findings suggest that supporting teachers as their students work with authentic ocean data may be one strategy to strengthen students' development of science and engineering practices.

Examining Changes in Science Teachers' Conceptual Understanding About Earthquake Engineering Baki Cavlazoglu, Texas A&M University Carol L. Stuessy, Texas A&M University ABSTRACT:

Stakeholders in science education emphasize the integration of science and engineering in K-12 science classrooms. However, research has shown science teachers' conceptual understanding of engineering content knowledge is limited so that science teachers need opportunities to improve their engineering content knowledge. These opportunities are often found in engineering-oriented teacher professional development (EOTPD). Using a one-group, pre-test/post-test research design we examined changes in 12 science teachers' conceptual understanding of earthquake engineering as result of their participation in the Earthquake Engineering Education Project (EEEP) teacher workshop as an EOTPD that was designed with Meaningful Conceptual Learning (MCL) conceptual framework components. Results provided evidence that science teachers significantly enhanced their conceptual understanding of earthquake engineering to reate effective EOTPDs to increase science

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teachers their conceptual understanding of engineering content knowledge, the results in this study provided promising evidence that the EEEP teacher workshop was useful. Science teachers with better understanding of engineering content knowledge as a result of effective EOTPDs may have sufficient level of confidence to implement the engineering content into their science classrooms.

Geoscience Teachers' Visual Representations of Plate Tectonic Boundaries: Development and Validation of a Scoring Rubric

Dannah L. Schaffer, Minot State University Lloyd H. Barrow, University of Missouri *ABSTRACT:*

This study examined thirty-one Geoscience teachers, grades 6 – Community College, who participated in a 9day professional development workshop to study intraplate earthquakes, and how to incorporate the study of plate tectonics into their classrooms. Teachers were given an assessment, both as a pre-test and posttest, examining their content knowledge as well as their ability to model plate boundaries. The first goal of this study was to develop and validate a scoring rubric to examine Geoscience teachers' visual representations of plate tectonic boundaries. The second goal was to explore how these Geoscience educators modeled plate tectonic boundaries. Although there were significant gains in the Geoscience teachers' content knowledge and confidence levels about earthquakes and plate tectonics, the study found that the Geoscience educators were not proficient in their ability to model plate boundaries even at the end of the workshop. In addition, the study found that if the scoring rubric was more explicit in its expectations wanted in the drawings, then the result was an increase in both the reliability of scores and consistency from those grading the drawings.

Semi-Quantitative Characterization of Science Teachers' Use of Three-Dimensional Instruction

Deborah Herrington, Grand Valley State University

Senetta Bancroft, Grand Valley State University

ABSTRACT:

Professional development (PD) programs incorporating best practices such as long duration, research experiences, and pedagogy have been shown to promote inquiry-based instruction. Further, most of the effective PD programs aimed at reforming teacher instruction are framed by criteria related to inquiry-based instruction. However, the Next Generation Science Standards moves K-12 science instruction beyond inquiry by not just explicitly addressing disciplinary core content and science practices, but connecting these two dimensions to a third dimension of science instruction that reflects how scientists think: crosscutting concepts. It is unclear how PD programs already effective in promoting inquiry-based science instruction by teachers as they progress through an effective PD program, Target Inquiry (TI), and compare that to a group of comparison teachers. The qualitative Educators Evaluating the Quality of Instructional Products: Science (EQuIP) rubric was semi-quantitatively adapted for this purpose. We focus on the process of adapting the EQuIP (SA-EQuIP), how the SA-EQuIP characterized instruction, how these characterizations compared to Reformed Teaching Observation Protocol (RTOP) evaluations, and the progression of TI teachers' instruction relative to comparison teachers as characterized by the SA-EQuIP and RTOP.

Strand 10: Curriculum, Evaluation, and Assessment Curriculum and Assessment Practices in P-16 Education

1:15pm - 2:45pm, Watertable Salon C **Presider: An**n W. Wright, Canisius College

Assessing, Operationalizing, Profiling Evolution Acceptance in College Students William L. Romine, Wright State University

Emily M. Walter, University of California: Fresno Amber Todd, Wright State University *ABSTRACT:*

We validate the Measure of Acceptance of the Theory of Evolution (MATE) on undergraduate students using the Rasch model and utilize the MATE to explore qualitatively how students express their acceptance of evolution. Previous validation studies suggest the MATE is 1-dimensional, and it has been used as such in over 19 peer-reviewed studies since 2001. We found, however, that the MATE is best used 2-dimensionally. When used in this way, the MATE produces reliable (above 0.85) measures for acceptance of facts and supporting data around evolution and acceptance of the credibility of evolution and rejection of non-scientific ideas. Using k-means clustering, we found students express their acceptance of evolution within 5 distinct categories: (1) uniform high acceptance, (2) neutral acceptance, (3) uniform moderate acceptance, (4) acceptance of the facts, but rejection of the credibility, and (5) rejection of both the facts and the credibility. Further, we found that knowledge of macroevolution moderately explains students' acceptance. We use these findings to express the first set of operational definitions of evolution acceptance and propose that educators continue to explore additional ways to operationalize acceptance of evolution.

Improving Science Teachers' Use of Data for Instructional Decisions

Matthew Kloser, University of Notre Dame

Hilda Borko, Stanford University

Matthew Wilsey, University of Notre Dame's Center for STEM Education

Stephanie Rafanelli, Stanford University Graduate School of Education

ABSTRACT:

The increasing focus on data-driven decision-making has resulted in large amounts of student performance data for educators. However, it is not clear how teachers use this data to inform their practice and improve student learning. In this multi-year qualitative study, we combine three conceptual frameworks to determine whether, when, and how middle school science teachers analyze, interpret, and use student performance data to make instructional decisions. Additionally, we examine how conceptions of effective assessment practice and data use can be influenced through professional development (PD). Initial data show that while teachers are familiar with assessment types – especially formative and summative assessments, they do not view collection and data use as a diagnostic tool to address specific concerns beyond re-teaching. Through the first part of our ongoing PD, teachers' general understanding of science assessment practice has shifted from separate and disconnected activities to a more iterative and interconnected process. These data suggest that teachers' understanding of the connection between assessment and student learning needs improvement. Furthermore we see evidence that effective PD can change teachers' conceptual models of assessment practice and data use; a crucial step in linking the push for data use in classrooms and high-quality science instruction.

The Rubric for Scientific Writing: A Tool to Support Research, Assessment, and Instruction

Katherine L. Wright, Texas A&M University Tracey S. Hodges, The University of Southern Mississippi Jennifer K. LeBlanc, Texas A&M University

ABSTRACT:

Students who are given the opportunity to write in science take part in authentic activities for the field which include argumentation thus increasing their proficiency in science. The purpose of this study was to create and validate a rubric, known as the Rubric for Scientific Writing, which can be used to support writing instruction in science classes and evaluate scientific writing. This rubric assesses both students' general writing skills and their ability to write appropriately within the scientific genre. To provide external validity, this rubric is based upon the Common Core State Standards and Next Generation Science Standards for writing. Six certified teachers scored 75 student scientific writing samples and participated in a focus group to explore the use and

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application of this tool. Overall, our findings demonstrate that the Rubric for Scientific Writing produces valid and reliable scores of students' scientific writing. The Rubric for Science Writing has the potential to aid both science teachers who may currently lack the self-efficacy to teach and assess writing as well as researchers who need a stable measure of students' scientific writing.

Capture of Interest and Motivation in Written Competency Tests with Context-Based Tasks Mariella Roesler, University of Kassel Nicole Wellnitz, University of Kassel Jürgen Mayer, University of Kassel ABSTRACT:

The students' interest, as well as their motivation, have an effect on their test performance. The aim of this study (funded by the German Research Foundation (DFG); MA 1792/6-1) is to describe the amount of performance variation through both, cognitive and motivational determinants. Therefore, we analyze the influence of interest and motivation depending on contexts (health, environment, technology, natural resources) with biological contents and required competencies (content knowledge, decision making) on the test performance in written tests. For this purpose two test instruments (paper-pencil-tests) were used to measure the competencies of students (N = 1881; grade 10) as well as their interest and motivation: a competency test (N = 144) to measure students' competencies in biological content knowledge and decision making and a questionnaire (N = 28) about interest and motivation (embedded design). First results show that, although the items of the different contexts and those of biological content knowledge and decision making do not differ in their difficulty, the students' motivation and interest vary.

Strand 10: Curriculum, Evaluation, and Assessment

Symposium - Science Teachers as Science Education Researchers: Singapore School Teachers' Research Projects

1:15pm - 2:45pm, Watertable Salon A

Presider: Gavin W. Fulmer, National Institute of Education, Singapore)

Presenters:

Gavin W. Fulmer, National Institute of Education, Singapore)

James Long, Punggol Green Primary School

Siew Ling Quek, Pioneer Junior College

Flavian B. Fernandez, Woodgrove Secondary School

Hooi Ling Chua, NUS High School of Mathematics and Science

ABSTRACT:

In this symposium, we present four examples of teacher-as-researcher projects that showcase how teacher-asresearcher studies can go beyond a professional development role, to be fully informed by existing science education literature and can even contribute to the international literature. We see this as a major distinction, and could form a more explicit bridge between the sphere of practice and the sphere of research. Our examples come from the Master of Education in Curriculum and Teaching of the National Institute of Education (NIE), Singapore. While renowned for students' international performance and the vertical alignment of its education system, Singapore is relatively under-recognized for the role of teachers as researchers. Our four examples are: (1) First-year primary school science teachers and scientific inquiry; (2) The use of computer chats to help students understand physics concepts: Valid instructional approach or frivolous activity? (3) Conceptual understanding of thermal physics concepts; and (4) The effect of feedback order: Use of descriptive feedback for Chemistry in a secondary specialized school.

Strand 11: Cultural, Social, and Gender Issues Gender and Science 1:15pm - 2:45pm, Pride of Baltimore Presider: Zoe E. Buck Bracey, BSCS

A Feminist Physics Framework: Deconstructed Physics and Students' Multiple Subjectivities Diane C. Jammula, Teachers College, Columbia University **ABSTRACT:**

While interactive physics curricula have doubled students' learning gains, gender and race gaps persist. This study asks how students negotiate their subjectivities to affiliate with or alienate from their perceptions of physics. It first identifies dichotomies in conventional physics education including rational/emotional, theoretical/practical, elite/accessible. The words on the left define conventional physics and are associated with middle class white masculinity, while the words on the right are associated with femininity or other, and are often missing or delegitimized in physics education. Dichotomies were deconstructed by valuing terms on the right and including them in a popular interactive physics curriculum called Modeling Instruction. The curriculum was taught in an algebra-based interactive physics course at an urban public college. Participants were the 7 female and 16 male students of different race and ethnic backgrounds, and I was the course instructor. Field notes, students' journals, and classroom artifacts were analyzed using open coding and discourse analysis. Results show some students affiliated with perceptions of physics as personal, in the everyday, accessible, and collaborative, suggesting that broadening notions of physics may allow a wider range of students to connect with the discipline.

What We Talk When We Talk About Gender

Devasmita Chakraverty, University of Virginia Donna B. Jeffe, Washington University, St. Louis, Missouri. Heather D. Wathington, University of Virginia Robert H. Tai, University of Virginia Robert H. Tai, University of Virginia *ABSTRACT:*

Women in medicine and biomedical science research face more career-related barriers than men, and are more significantly affected as primary caregivers in their family. Women have to overcome many challenges to their retention, promotion, and advancement to leadership positions. The objective of this qualitative study is to understand gender-barriers that impede professional success. We wanted to investigate if men also face similar barriers. Our research question is: What barriers do participants describe when they talk about gender in medical schools and biomedical research programs? We examined 48 semi-structured interviews with students, faculty, postdoctoral fellows, residents, and scientists who specifically discussed gender-barriers. Of them, 38 participants (79%) from both the genders reported barriers to balancing family and work. Other gender-barriers (only reported by women) included gender-perceptions, discrimination, gendered-mentoring, and experiencing glass-ceiling effect. This study advances our understanding about the personal and institutional factors related to gender-barriers. Timely intervention will prevent women from feeling excluded or lacking resources to handle their professional and personal challenges. Our findings indicate the importance of developing better support systems (including peer-support) to avoid isolation and alienation.

Gendered Patterns of Future-Oriented Motivation to Learn Science Across 57 Countries Fatih C. Mercan, Bogazici University

ABSTRACT:

Gender inequalities in science education and employment are important problems. Understanding predictors of future-oriented motivation to learn science, may help understand the origins of the segregation of science

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Annual International Conference Abstracts education and careers between males and females. Previous research attempted to explain gendered patterns of future-oriented motivation by using self-concept as the major construct. However, a more comprehensive explanation may be possible, using control value theory (CVT) of academic emotions. The 2006 PISA data allows testing the predictions of CVT; the purpose of this study. The results show besides self-concept, personal value of science must be taken into consideration. Using CVT, beside the direct effects, indirect effects refracted through enjoyment of science and continuing motivation in learning science were detected. The relative importance of self-concept and personal value between males and females display a distribution, hence generalized statements are not grounded. Research on countries with similar and different distributions is recommended in order to understand the cultural and contextual influences on gender and future-oriented motivation.

Intentionality or Unrealized Potential? Examining High School Girls' Perceived Efficacy and Potential Science Course Paths

Jill V. Patterson, William Paterson University Issam H. Abi-El-Mona, Rowan University

ABSTRACT:

The mixed method study investigates how gender informs high school girls' efficacy-activated processes related to their perceptions of choosing potential science course paths. Participants were 80 public high school girls registered in an honors chemistry class. From a socio-cognitive theoretical framework with an embedded feminist lens, the study followed a sequential, explanatory design. Data was collected in two phases. The first phase relied on survey data to describe relationships between girls' self-efficacy in STEM areas and perceptions of potential science course paths. The second phase collected interview data from both focus groups and individual participants. Findings indicate a positive association with statistical significance between participants' cumulative perceived self-efficacy in STEM areas and potential pursuit of AP Chemistry and Physics courses. In addition, individual participant findings highlight various environmental and behavioral factors that contribute to girls' efficacy considerations. As these factors were most likely to limit girls' perceptions of Physics as a viable option, findings support the need for girls' earlier exposure to physics, improved career and course guidance, and gender-responsive instructional and assessment practices.

Strand 13: History, Philosophy, and Sociology of Science

Symposium - Nature of Science and the Next Generation Science Standards: Consideration, Critique and **Conversation**

1:15pm - 2:45pm, Kent Presider: Richard A. Duschl, Penn State University **Presenters**: Richard A. Duschl, Penn State University Jonathan Francis Osborne, School of Education, Stanford University William F. Mccomas, University of Arkansas Valarie L. Akerson, Indiana University David Stroupe, Michigan State University

ABSTRACT:

The symposium led by three science educators with intimate knowledge of NOS in the Next Generation Science Standards (NGSS) has three primary goals: 1) to examine in detail how and to what extent the three Dimension Framework (Science Content + Science and Engineering Practices + Crosscutting Themes) that inspired NGSS addresses NOS learning goals, 2) to examine alternatives for what constitutes 'explicit' instruction around NOS and 3) to encourage understanding and conversation about NOS as it appears in NGSS while considering research questions and classroom practices that may flow from this understanding. The discussants are tasked

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with raising new research questions and research programs for resolving NOS learning issues as they pertain to K-12 students and teachers and to the design of learning environments.

Strand 14: Environmental Education

Administrative Sponsored Symposium - How Should We Treat Animals in Science Education?

1:15pm - 2:45pm, Maryland Salon F **Presenters:** Stacey Britton, University of Mississippi Sophia (Sun Kyung) Jeong, University of Georgia Shahknoza Kayumova, University of Massachusetts Andrew Kinslow, University of Missouri Troy Sadler, University of Missouri Dana Zeidler, University of Central Florida Christopher Bentley, York University Steve Alsop, York University Teresa Shume, North Dakota State University Michael Reiss, UCL Institute of Education, London, UK Cassie Quigley, Clemson University Kimberly Haverkos, Thomas More College Rachel Gisewhite, University of Southern Mississippi Deborah Tippins, University of Georgia **ABSTRACT:**

This symposium will engage participants in thinking about ecojustice and environmental education in relation to the various roles of animals in science education. Animals have an interesting relationship in science education that has yet to be explored in a meaningful and significant way. This symposium will explore the vital role of animals in science education, specimens, protected species, and other associated issues with regards to the role of animals in science. The most visible issue of course is the ethical treatment of specimens used for scientific research and this category of animals is so important that it is an essential standard for science teacher preparation for the National Science Teacher Association. Most universities employ an ethical board of review for projects that involve animals in scientific research. However, these reviews are often limited to vertebrate animals rather than invertebrates and there are numerous other issues that come up with specimens. The closer that animals as specimens are related to humans (such as chimpanzees), the more scrutiny they receive to the point where some organizations such as PETA protest animals used in science. In particular, we are interested in theory and pedagogy associated with the socio-scientific framework, citizen science, school programs, and education policy orbiting the role of animals in science education.

Concurrent Session #6 All strand poster sessions. 3:15pm – 5:15pm

Poster Session A 3:15pm – 4:15pm, Maryland Ballroom A, B, C and D

Strand 1: Science Learning, Understanding and Conceptual Change *Poster Session A*

3:15pm – 4:15pm, Maryland Ballroom A, B, C, & D

A1. Characterizing Students' Epistemic Considerations: An Automated Computational Approach for Embedded Assessment Responses

Joshua Rosenberg, Michigan State University

Christina Krist, Northwestern University

ABSTRACT:

Meaningful engagement in scientific practices requires that students learn how to construct, evaluate, and revise models or explanations of phenomena using disciplinary criteria, and to understand how and why disciplinary criteria can be useful for building scientific knowledge. We present a novel and promising method for identifying and characterizing written responses for students' epistemic ideas, specifically related to the generality of their responses. We use an automated computational approach--a classifier--in order to examine how such an approach can be used for coding embedded assessment responses at scale. Evaluating this approach using cross-validation, we found that we were able to achieve moderate agreement (accuracy = .57, κ = .42; Spearman's = .59). Examining students' consideration of generality for their models and explanations for two phenomena, we found a high proportion of less-sophisticated responses, but also saw evidence that students were capable of identifying the boundary conditions for their models or explanations to be general or specific. Future directions involve applying this method at scale and to ask how students' epistemic ideas about generality and other epistemic considerations develop over time.

A3. Determining Curriculum Related Progress in Science Education among Gymnasium Students – A Longitudinal Study

Regina Soobard, University of Tartu Miia Rannikmae, University of Tartu

ABSTRACT:

The goal of this study was to investigate upper secondary students' curriculum related progress using authors' developed scenario-based test instrument. For this study, the first step was identifying key concepts and skills from the science curriculum, which is heavily expressed as scientific literacy, and then developing items based on Structure of Observed Learning Outcomes (SOLO) taxonomy four levels. Items were later modified based on 5 experts' reviewing comments and grade 10 students' pilot testing results. Data collection time was in November 2011 (grade 10) and May 2013 (same students in grade 12). Longitudinal data from 316 students from 44 representative Estonian schools showed that there was no expected shift in between grades. Although students did gain more knowledge over the three year period and the expectation was that students would enhance their operational skills for scientific literacy, this was not reflected in their reasoning skills and in their competence to solve problems. The suggestion made was that changes were needed in upper secondary science education to ensure students gave more appropriate responses related to problem solving and decision making items.

A5. Development of an Empirically-Based Learning Performances Framework for 3Rd-Grade Students' Model-Based Explanations About Plant Processes

Laura A. Zangori, University of Missouri-Columbia Cory T. Forbes, University of Nebraska-Lincoln

ABSTRACT:

To develop scientific literacy, elementary students should engage in knowledge-building of core concepts through scientific practices such as modeling (NRC, 2012). Yet modeling remains underemphasized in elementary science learning environments. Here we report on a design-based study to investigate the ways in which 3rd-grade students' generate model-based explanations about plant life cycles and plant structure/function. First, using design-based research, we developed and empirically tested a learning performances framework that integrates discipline-specific content with scientific practice to examine the ways

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in which 3rd-grade students' construct model-based explanations about the two plant processes. Next, we used the learning performance framework as a rubric to measure 3rd-grade students (n = 73) model-based explanations developed prior to and after a long-term curriculum enactment about plant growth and development. Findings from the learning performance highlight students' conceptual knowledge about plant processes and use this knowledge to reason in sophisticated ways. However, our findings from the pre/postmodels suggest that when students do not have opportunities to build conceptual knowledge, they depend on anthropomorphic analogies to reason about plant processes. Study findings imply that 3rd-grade students require more sophisticated opportunities in building knowledge about how and why plant processes occur.

A7. Emotions during Reading of a Refutational Science Text

Brian W. Miller, Towson University

ABSTRACT:

Learning from science texts is an important teaching method. Research has shown that compared to traditionally structured texts, students learn more from texts written in a refutational structure in which the text describes common preconceptions as well as the scientifically accepted conception. Emotions might play a role in this effectiveness since being contradicted can be an emotional experience. However, the most popular theory explaining the refutational effect does not include an emotional element. In this study, participants read a text with a traditional structure and a text with a refutational structure using the emote-aloud procedure in which participants are asked to describe how each sentence made them feel. The emote-alouds are coded for what types of emotions are expressed, and a qualitative analysis is used to link emotions to possible conceptual improvements as measured by the Force Concept Inventory. Preliminary data suggests that the refutational text might elicit cycles of engagement and confusion while the traditional texts elicit less emotional intensity including mild boredom. The results of this study might lead to a refinement of current theories explaining the refutational effect as well as leading to improved science texts.

A9. How Astronomers Investigate the Universe: Student Ideas About Astronomical Practices Before and After Instruction

Chrysta Ghent, Pennsylvania State University Julia Plummer, Pennsylvania State University Timothy Gleason, Pennsylvania State University Christopher Palma, The Pennsylvania State University Yann Shiou Ong, The Pennsylvania State University

ABSTRACT:

This study describes student ideas about the practices astronomers use to study the Universe and what scientists can learn from those practices. High school students (N=20) were interviewed before and after six weeks of astronomy instruction. The students were interviewed about how astronomers learn about the Moon, Pluto, the composition of stars beyond our Solar System, the orbital period of Europa, and what scientists can learn about a star from its spectrum. Students showed significant improvement in their ideas about how scientists measure the orbit of Europa, shifting from suggesting the use of mathematical calculations and analogies to other bodies to the more productive use of telescopes and cameras to take pictures over time. And while students did not show a significant improvement in their ideas about observation and space exploration for other categories, we observed some trends in improvement that suggests students were starting to apply what they learned about telescopes and observations to some of these phenomena. Questions relating to using spectroscopy to measure a star's composition suggest that while many students' recalled this practice when shown a spectrum, they had difficulty making this connection when they were asked how to find a star's composition directly.

A11. Investigating Students' Pre-Instructional Ideas and Misconceptions About the Big Bang Theory Sarah Aretz, CERN

Andreas Borowski, University of Potsdam Sascha Schmeling, CERN

ABSTRACT:

The beginning of the Universe, the Big Bang, being an important subdomain in cosmology marks the beginning of space and time. Therefore it has formed our modern scientific worldview. Transfering this to students is a frequent request made for science literacy. What are the ideas regarding the Big Bang Theory with which students enter the classroom? Do they vary by nationality? If teaching modules are to be based on students' existing knowledge, such questions are critical, as potential misconceptions may affect students' learning. But is it possible to apply the same module to students from different countries who may have diverse sociological and cultural backgrounds and different curricula? This study shows the results of an open-ended questionnaire recently implemented in Germany, with questions based on recent US studies. We reveal students' common pre-instructional ideas and misconceptions about the Big Bang Theory. In addition, we compare our results to literature on German, American and Swedish students and uncover the differences in their beliefs. The outcome can be used to build an effective teaching module, which helps students' to overcome their difficulties with cosmology. Furthermore, it can make a contribution to the transferability of results in education research between different countries.

Strand 2: Science Learning: Contexts, Characteristics and Interactions

Poster Session A 3:15pm – 4:15pm, Maryland Ballroom A, B, C, & D

A13. The Affective Domain in Science Education

Bette L. Grauer, Kansas State University

Lawrence C. Scharmann, University of Nebraska-Lincoln

ABSTRACT:

The purpose of this qualitative case study was to examine student affective responses in science classes as reported by secondary science teachers using Krathwohl's Affective Taxonomy as a research framework. The study explored how teachers worked with student affective responses and interactions present in the classroom when student affective responses emerged. Eight secondary science teachers participated in individual semi-structured interviews. Student affective behavior reported by participants was classified within the five levels of Krathwohl's Affective Taxonomy: receiving, responding, valuing, organization, and characterization. The types of behavior most frequently reported by participants were identified with the receiving and responding levels of the Affective Taxonomy. Organization behavior emerged during the study of perceived controversial science topics such as evolution. Teacher participants in the study used student affective behavior to provide feedback on their lesson activities and instructional practices. Classroom interactions identified as collaboration and conversation contributed to the development of responding behavior. We identified a process of affective progression in which teachers encouraged and developed student affective behavior changes from receiving to responding levels of the Affective Taxonomy.

A15. Elementary School Students' Reasoning Skills: A Meta-Analysis

Yurdagul Bogar, University of Tennessee

ABSTRACT:

The meta-analysis is one of the most effective ways of research synthesis. Different applications of metaanalysis has been encouraged in many disciplines including social and educational sciences. The aim of this meta-analysis study is to address elementary school students' reasoning skills. This meta-analysis examined 46

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published articles that met the researchers' criterion for elementary school students' reasoning skills. These studies on elementary school students' reasoning published between 1980 and 2015. In this study, we narratively reviewed five themes which were scientific reasoning, analogical reasoning, evidence-based reasoning, statistical reasoning and model-based reasoning. The results of this meta-analysis showed that most of the studies conducted between 1991 and 2014 on elementary school students' reasoning skills were related to scientific reasoning. Moreover, most of the studies reviewed in this appear that investigated elementary school students' analogical reasoning were conducted between 1987 and 2014. In addition, other studies that investigated elementary school students' reasoning skills were related to evidence-based reasoning, statistical reasoning, model-based reasoning, logical, mechanistic, abductive, retrodictive, verbal, and inferential reasoning. However, they were very limited in numbers.. Key words: Reasoning skills, elementary students, meta-analysis

A17. Evaluating Science Educators' Perception of Students' Intrinsic Relevance as Key Component to Enhance Science Learning

Tormi Kotkas, University of Tartu Miia Rannikmae, University of Tartu Jack B. Holbrook, University of Tartu

ABSTRACT:

Learning science is seen as a key to keep societies developing in the face of constant change. Unfortunately school students do not consider science classes relevant for them. Yet without students who consider science worthy of study, problems like lack of specialists in science related fields in some areas has already developed. This article focuses on one possible reason for this, namely lack of students' perception of relevance in science and its' difference from educators' perception of relevance. In order to find out what is considered relevant among educators, titles and initiating scenarios from 77 modules developed with the PROFILES project were analysed using qualitative text analysis. The result showed that although learning material creators had gone through a course of developing student relevant modules, only a quarter of the modules were built around relevant socio-scientific issues. Students' perception of relevance is not strongly recognised in such cases, as students are not shown relevant links between science and everyday life. Although most scenarios can be recognised as familiar, relevance of the contexts related to students' everyday life, remains a question.

A19. Creating Learning Environment for Argumentation: Analysis of Fifth Grade Students' Writing in Argument-Based Inquiry Approach

Sae Yeol Yoon, Delaware State University Brian M. Hand, University of Iowa

ABSTRACT:

Argumentation has been seen as a core practice in science. Yet, previous studies reported that students failed to produce sufficiently scientific arguments through their writing although the writing of arguments seemed to help students learn important scientific big ideas. This present study explored students' argumentative writing for learning of science in elementary contexts, and its different roles from explanatory writing. Particularly, this study compared two different learning environments, and examined six fifth grade students' writing samples from two different classroom to explore how student engagement in critique or evaluation process impacted their learning. Both classrooms required students to build science arguments as a consequence of using argumentation as their classroom inquiries, but the learning environment that was created varied significantly. Particularly, in two learning environment, we observed that student engagement in critique or evaluation was differently implemented in their learning of science. Particularly, their reasoning and use of language were differently emerged in writing. Findings emphasized the importance of learning environment where students could be immersed in argumentation, not simply for assessment purpose, but for core practice in learning of sciences, and also discussed the roles of argumentative and explanatory writing based upon Walton's notions of "unsettled" and "settled" knowledge.

A21. The Effect of Students' Gestures on their Reasoning Skills Regarding Linear and Exponential Growth Sahar K. Alameh, University of Illinois and Urbana Champaign Nicholas Linares, University of Illinois and Urbana Champaign Nitasha Mathayas, University of Illinois Urbana Champaign Robb Lindgren, University of Illinois Urbana-Champaign

ABSTRACT:

Getting middle school students to make sense of magnitude, small and large scale quantities, and linear and exponential growth is one of the most difficult challenges faced by science teachers. Equally important, there is strong support from multiple disciplines for the notion that gestures facilitate processes of thinking and learning (Roth, 2001), and building evidence that gestures promote STEM learning (e.g., Alibali & Nathan, 2012). This paper examines the effect of gestures on middle school students' reasoning skills on mathematical growth. Researchers developed interview protocols that include several topics related to growth including the solar system, bacterial growth, and Richter scale. Students' verbal and gestural responses during the interviews were transcribed, coded, categorized and analyzed. Analysis revealed trends regarding students' use of symbolic gestures (e.g. using fingers to indicate numbers) as opposed to concrete gestures (e.g. using the hand as a curve to gesture exponential growth). Results showed that symbolic gestures hinder students' reasoning skills and discourages them to reconsider their reasoning. Students who used concrete gestures spent more time reflecting on their thinking, and revisiting their decisions. Finally, we conclude that concrete gestures support correct reasoning and help students in making clear the distinction between linear and exponential growth.

A23. Development of a Meaningful Chemistry Laboratory Guide Using Real-World Contexts

Liliam A. Palomeque-Forero, Universidad Nacional de Colombia

Luis A. Angarita-BaldeÛn, Universidad Nacional de Colombia

ABSTRACT:

This study was conducted in Bogotá-Colombia (in a District called South San Cristóbal) over the course of the school year in a 10th grade chemistry classroom. Both the school and the neighborhood have serious social problems that could be resolved, at least partially, with education and strategies aimed at improving citizen competencies. A laboratory guide was designed and written using a model of active learning (group and individual predictions, subsequent checks, conclusions and extrapolations). Students' preconceived ideas and previous knowledge were also taken into account. The guide uses elements of students' everyday life such as water from a nearby river, building materials, and commonly consumed food and drinks; with these elements seven labs for teaching and learning solutions concepts were proposed. Progress was evaluated through field diaries and comparing the grades obtained by the working group to those usually obtained by other students from the same school. The most important results revealed that students learned how to use scientific discourse to explain and discover connections between science and their own worlds. In addition, students showed more interest, which then not only encouraged a deeper understanding of chemistry concepts but generated an unexpected desire to return to school every day.

Strand 3: Science Teaching--Primary School, Grades preK-6): Characteristics and Strategies *Poster Session A*

3:15pm – 4:15pm, Maryland Ballroom A, B, C, & D

A25. Children's Ideas About Fossils Lisa A. Borgerding, Kent State University Sara P. Raven, Kent State University ABSTRACT:

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The fossil record is an important line of evidence for evolutionary biology. Yet, the question of how evolutionary biology should be addressed in younger grades is not fully answered. The purpose of this study was to investigate preschool students' emerging ideas about differences between living and nonliving things, whether fossils represent living or nonliving things, whether fossils represent natural or human-made things, how fossils are made, and how fossils are similar or dissimilar to present-day living organisms. The sample consisted of 15 children aged 3 through 6 enrolled in a week-long camp entitled "Dig into Fossils." Data collection included students' pretests, collected student work and daily assessments, whole-group discussions, and post-instruction individual interviews. The findings indicated that preschool children most often correctly distinguished living/nonliving with respect to animals. Many had a clear understanding that fossils were very old, and their ability to identify objects as fossils and struggled with the concept of absolute age. Thus, preschool children can develop preliminary understandings of some aspects of fossils, especially when they are able to manipulate actual objects.

A27. Examining the Development of Elementary Teachers' Science Teacher Identities Sarah J. Carrier, North Carolina State University Ashley N. Whitehead, North Carolina State University

Sarah C. Luginbuhl, North Carolina State University Margareta M. Thomson, North Carolina State University *ABSTRACT:*

The purpose of this qualitative study was to investigate the contributions of pre-service teachers' memories of science and science education along with their experiences in a STEM focused teacher preparation program to their developing identities as elementary school teachers of science. Data collected over three years include a series of interviews and observations of science teaching during elementary teacher preparation and into the first year of teaching. Grounded within a theoretical framework of identity we examine experiences that contribute to case studies' developing identities as teachers of science. Data analysis revealed key themes: memories of science and science instruction, views of effective science teaching, science methods coursework, field experiences, identity trajectories, and reform-based science teaching. Findings are summarized in main assertions and discussed along with implications for teacher preparation and research.

A29. Exploring a Science Teacher's Views and Instruction on Reading Science Text Jing-Ru Wang, National Pingtung Teachers College **ABSTRACT:**

The ability to read texts carefully, critically, and with an enquiring mind is a key indicator of scientific literacy. Yet over the last few decades, a survey of teachers' knowledge on teaching science, indicates that little is known about how a teacher teaching reading comprehension of science text. This study explored the professional change for a science teacher in the instruction of reading comprehension on science text. The participants included a science teacher and her fifth-grade and sixth-grade students of an elementary school in southern Taiwan. The science texts and reading lessons were embedded in the lessen unit Watching Stars designed by the case teacher. The data were collected through the ways of classroom observation, interviews with the case teacher and her students. The teacher's journals, teaching plans and mind maps about teaching science reading were also collected. The teacher's pedagogical content knowledge about reading science influenced her teaching practices through self-reflection and self-awareness in actions. The factors causing teacher's professional change included the students' assignment; debrief discussions among school teachers and university professor, and teacher's self-reflection and awareness.

A31. Pre-Service Teachers' Enactment of Topic Specific PCK Related to Chemical Equilibrium

Marissa S. Rollnick, Wits University

Elizabeth Mavhunga, University of Witwatersrand

ABSTRACT:

Between science content and methodology lies the teacher's pedagogical content knowledge (PCK) which refers to their ability to transform content knowledge for teaching. This study investigated the enactment of two preservice teachers' topic specific professional knowledge (TSPK) on chemical equilibrium. The study uses a theoretical framework for TSPK, which consists of five components, Learners' Prior Knowledge, Curricular Saliency, What makes topic easy or difficult to understand, Representations and Conceptual Teaching Strategies. The pre-service teachers were part of an intervention involving direct instruction on the five components of PCK in chemical equilibrium. At the end of the intervention each pre-service teacher produced a major assignment demonstrating their ability to capture and portray their PCK. Subsequently each teacher taught four lessons on chemical equilibrium during their practice teaching. The lessons were videorecorded and transcribed and each teacher was interviewed before and after each lesson. The level of the participants' TSPK was categorised using a rubric and the transcripts analysed for TSPK content using the five components above. Emerging results show multiple examples of interaction between components and strong evidence of awareness of student prior knowledge. However the conceptual teaching strategies component remained a challenge for both participants.

A33. Identifying an Engineering Knowledge Base for Science Teachers: A Delphi Study Baki Cavlazoglu, Texas A&M University Carol L. Stuessy, Texas A&M University ABSTRACT:

Stakeholders in science, technology, engineering, and mathematics (STEM) education have called integrating engineering content knowledge into STEM-content classrooms. To answer the call, stakeholders in science education announced a new framework, Next Generation Science Standards, focuses on integration of science and engineering. However, research ha shown many science teachers need to broaden their knowledge in engineering content areas for successful integration. In this regard, researchers have suggested that new integrated STEM curricula should contain a list of key concepts for understanding the specific engineering content area. Therefore, there is a need for generating key concepts in critical engineering areas enabling science teachers to implement engineering into science classrooms. Using a modified Delphi research design, we identified and verified key concepts in earthquake engineering necessary for high school learners to acquire a basic understanding of earthquake engineering. As a result, we created a key concepts list and strand map with 35 earthquake engineering key concepts to understand and teach earthquake engineering content in their classrooms.

A35. Middle School Science and Mathematics Teachers' Understanding of the Nature of Science: A Two-Year Study

Sissy S. Wong, University of Houston Irasema Ortega, University of Alaska-Anchorage Eunjin Bang, Iowa State University *ABSTRACT:*

This research study examined the nature of science (NOS) knowledge of middle school science and mathematics teachers (N=19) as they engaged in a two-year online master's program that focused on integration

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of both content areas. This study utilized two NOS instruments to collect data on the initial NOS conceptions the teachers held prior to starting the program, one year after starting the graduate program, and after two years at the conclusion of the program. This study examined changes in NOS understanding of the group as a whole, between the science and math teachers, and whether years of classroom service are related to level of NOS understanding. Findings show that the teachers' views of NOS significantly after one year of explicit and reflective NOS instruction. Findings also show there was no statistical change during the second year of the program with participants' maintaining the level of NOS development reached at the end of year one. By understanding the NOS understanding of practicing middle school science and math teachers, researchers and teacher educators may gain insight into how to foster, develop, and sustain NOS understanding in preservice and practicing teachers.

A37. Opportunities for Science and Engineering Practices in Middle School Content: Comparing Curricula and **Standards**

Daniel Z. Meyer, Illinois College Bradley Perrin, Monmouth-Roseville High School Leah Shumaker, Illinois College Holly Crocher, Illinois College

ABSTRACT:

Emphasizing the process, in addition to the content, of science has been a perennial aim of science education reform and research. Until now, however, the two have been kept separate, with little attention to how the details of each connect - or impede - each other. The Next Generation Science Standards deviates from this by explicitly denoting a specific integration of process and content. In this exploratory study, we examine the issue of process and content integration by comparing that of that of several popular middle grades science curricula, both to each other and to the NGSS We found both commonalities and significant variations in the integration of each. This confirms some previous understandings, such as the challenge of engaging students in question forming. But it also raises some questions, such as would a broader emphasis on applied sciences be more relevant to life sciences than engineering?

A39. Science Teachers Instructional Practices on the Way to Argumentation

Yasemin Ozdem-Yilmaz, Gaziosmanpasa University

Jale Cakiroglu, Middle East Technical University

Hamide Ertepinar, Istanbul Aydin University

ABSTRACT:

This study is an investigation of instructional strategies that the science teachers use when they integrate argumentation in science lessons. There were 7 science teachers, who were also graduate students and were enrolled in a graduate course which enabled them to develop theoretical and pedagogical understanding about argumentation during the study. The study took place when the teachers planned and implemented argumentation-based science lessons in schools. The data for the study were generated from the transcripts of the videos of teachers' practices, which were studied in terms of the interactions and which interactions of the teacher resulted with argumentation or its justification. Interpretive content analysis were applied for the analysis of each transcript of the participants' classroom practices in multiple cycles. As a result, there were three typology of teachers' instructional strategies specific to argumentation revealed in this study; argumentation specific instructional strategies (ASIS), meta level knowledge of instructional strategies specific to argumentation (ML-ASIS), and meta-strategic knowledge of instructional strategies specific to argumentation (MSK-A). In this paper, these instructional strategies were explicated and the implications for argumentation in science education and teacher pedagogy were discussed.
Strand 5: College Science Teaching and Learning, Grades 13-20) **Poster Session A**

3:15pm – 4:15pm, Maryland Ballroom A, B, C, & D

A41. A Snapshot of Science Teacher Perceptions of State, National and International Assessments Rhea L. G. Miles, East Carolina University

Anthony Thompson, East Carolina University

ABSTRACT:

Findings revealed teacher perceptions of how the science education of their students compared to highperforming students in other states and nations. This study also provided information about teacher perceptions of preparation to teach an in-depth scientific curriculum comparable to curricula in high-performing states and nations.

A43. Assessing College Students' Misconceptions of Photosynthesis and Respiration in an Introductory Plant Science Course

Cecilia Espinoza-Morales, Purdue University Neil A. Knobloch, Purdue University Kathryn E. Orvis, Purdue University

ABSTRACT:

College students have limited comprehension about photosynthesis and respiration. This study investigated college students' knowledge about the concepts of photosynthesis and respiration upon completion of an introductory plant science course. The purpose of the study was to identify various conceptions of photosynthesis and respiration and develop a reliable and valid assessment tool to detect high and low performing students' difficulties regarding those concepts. There were three findings. First, low performing students did not know oxygen and carbohydrates are products of photosynthesis. Second, low performing students did not know photosynthetically active leaves fix carbon dioxide into carbohydrates. Third, low and high performing students knew respiration involves the transformation of carbohydrates from photosynthesis into ATP, however, they failed to identify respiration as a chemical process. Further inquiry should look at students' benefits of teaching the processes of photosynthesis and respiration as interdependent scientific processes.

A45. Assessing the Use of Small-Group, Active Engagement Exercises and Peer Evaluation in Introductory **Biology** Courses

Marcia Shofner, University of Maryland Gili Marbach-Ad, University of Maryland

ABSTRACT:

This study measures the effectiveness of using small-group, active engagement and peer evaluation exercises in a large enrollment introductory biology course - BSCI106 (Principles of Biology II: Ecology, Evolution, and Diversity). BSCI106 is a 4-credit course, required for all biology majors, offered in a traditional lecture and laboratory format each semester: three hours of lecture and three hours of lab per week. In Spring 2015, a course redesign was initiated to move from teacher-centered to student-centered learning. The course was taught in two sections. One section (n=95) was based mainly on traditional lecture style (Traditional), the other section (n=115) employed several group exercises. In particular, we piloted one group activity followed by peer evaluation (Experimental). Students in the experimental section received significantly better grades than students in the traditional section, suggesting that student learning outcomes may be impacted by class activities. Across all sections, minority students received significantly lower final grades, holding other variables constant, such as gender and section. The group activity and peer evaluation exercise offered in the experimental section were positively perceived by most of the students. This study can contribute to the teaching and learning community and NARST members by highlighting general and specific recommendations. A47. Combining Lexical Analysis and Students Interviews to Gauge Students Understanding of Genetic Information Flow

Alexandria L. Mazur, Michigan State University Rosa A. Moscarella, Michigan State University Mark Urban-Lurain, Michigan State University John Merrill, Michigan State University

ABSTRACT:

Students around the globe struggle with genetics, which is fundamental for biology literacy. This has motivated increasing research on students' misconceptions and classroom reforms that require precise assessments tools. Lexical analysis has proved to be a powerful method to reveal students thinking in several STEM disciplines, especially within large undergraduate classes. In addition, the finding of this analysis can be used to efficiently design interview protocols. In this study we analyzed 2,087 students' responses to a question related to the flow of genetic information. These results supported previous finding about students' misconceptions regarding the effect of stop codon in the transcription of DNA. The lexical analysis results were used to guide student interviews to gain a better understanding of the nature of student misconceptions. The lexical analysis also informed the interview protocol, helping us create questions relevant to student misconceptions. The combinations of lexical analysis and interviews provided an exceptionally rich picture of students thinking which can then be used to inform classroom reform.

A49. Comparative Analysis of Recognition of Scientists, Engineers, Teachers & Students About Problem Specification Elements

Yohan Hwang, Kyungpook National University Yune Bae Park, Kyungpook National Univ

Eunjeong Yun, Affilation is Kyungpook National University

ABSTRACT:

Integrating science and engineering has been attempted for a long time, which showed at STEM education and practices in NGSS. Also, inquiry design has been emphasized in problem solving in science education. Problem Specification (PSp) is developed to improve inquiry design ability through analyzing research procedure of scientists and engineers. PSp has various elements to be used in the process of planning for solving problem. In this study, we investigated directions of educating 50 elements of PSp through comparing recognition of each related group. For this, we conducted the 5-point Likert scale survey and asked descriptive questions about PSp to 72 scientists, 68 engineers, 119 teachers, 81 graduate students, 93 undergraduate research students, and 1021 high school students who have research experiences. We analyzed differences among each group by t-test and one way ANOVA using PSAW 22.0. As a result, Engineers emphasized 10 elements ('simulation(t=5.291, p=.000)' et al.) more than scientists, and scientists recognized more important in most of elements than other groups. If proper strategies complemented by each group's thinking are developed, PSp will be a good material for training novice researchers.

A51. A Comparison of Learning Environments in Preservice Elementary Teachers' Science Self-Efficacy Christine M. Knaggs, Lourdes University

Toni A. Sondergeld, Drexel University

ABSTRACT:

Online and blended/hybrid courses are an increasingly important component of college education. Many studies have been conducted looking at outcomes of such courses, but none have focused on self-efficacy of preservice students in a survey science course. Our study compares preservice teachers completing the course in a traditional face-to-face format and blended/hybrid in terms of science teaching self-efficacy. Regardless of delivery mode, students had a similar statistically significant increase in self-efficacy. Qualitatively, students

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reported similar perceptions (regardless of delivery format) of the field of science and their ability to teach science in the future before and after the course. Results suggest that the blended/hybrid course was as effective as the traditional section.

A53. Developing Understanding of Pre-Service Teacher Exposure to Climate Literacy Content in Higher Education Science Courses

Gili Marbach-Ad, University of Maryland

ABSTRACT:

With the recent incorporation of climate change content into the Next Generation Science Standards (NGSS), focus is being placed on preparing pre-service and in-service to teach these topics to K-12 students. However, climate change is a complex subject with important social dimensions. Our project is addressing the need to infuse climate change literacy into K-16 education, in order to prepare the next generation of citizens. In the spring of 2013, we selected 295 faculty members, from four higher education institutions (University 1 (U1) – 117; U2 – 92; U3 – 58; U4 – 28), who taught basic science courses to pre-service science teachers. Of the 295 invited faculty members, 119 took the survey (response rate of 40%). Results show that many courses do address some areas of climate literacy, but the amount and depth varies significantly by field, course purpose and by instructor. Faculty members are motivated to incorporate this material due to the immediacy and large-scale impacts that influence their students' lives. Most faculty members do not address how scientists learn through observations, modeling, and theory, which is an important focus of the NGSS. Some faculty indicated lack of time or space in the curriculum to add climate literacy to their courses.

A55. Effect of Science Teaching on Undergraduate Students' Science Self-Efficacy

Nicholas Stroud, Massachusetts College of Liberal Arts Leslie Rule, Massachusetts College of Liberal Arts Jean Bacon, North Adams Public Schools Christopher Himes, Massachusetts College of Liberal Arts Molly Polk, Williams College Lindley Wells, Williams College Jennifer Swoap, Williams College ABSTRACT:

This study presents preliminary results from a study on the impact of science teaching on the science selfefficacy of participating undergraduates. We find evidence for moderate increases in undergraduates' science self-efficacy. Gains appear to be most significant for students from the participating public liberal arts college, and for all students in their ability to explain science concepts. Implications for retention in science majors and science course-taking are discussed.

A57. Energy Conservation in Biological Contexts: Intersection Between Scientific and Everyday Language Usage

Vivien M. Chabalengula, University of Virginia

Frackson Mumba, university of Virginia

ABSTRACT:

This study diagnosed students' understanding of energy conservation using the pencil and paper test, reflecting test items phrased in the biological and everyday life situations. Ninety first year biology students enrolled at a large South African University participated. The three research questions that guided this study were: (1) How do students define or describe the energy conservation principle? (2)To what extent are students able to apply the energy conservation principle to everyday life situations involving biological phenomena? (3) What are students' explanations of what happens to energy during metabolic processes in biological/living organisms? The results showed that nearly all students (98%) provided a correct textbook definition of energy conservation. To the contrary, majority of the students still reverted back to their erroneous everyday understandings of

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energy being used up, created or lost during activity, when they had to apply this principle in closed-ended biological and everyday context statements. This implies that even though these students can correctly state the energy conservation principle, they do not understand it fully so as to apply it to biological situations. The implications for the teaching and learning of energy conservation are discussed. KEY WORDS: energy conservation, scientific language, everyday language.

Strand 6: Science Learning in Informal Contexts

Poster Session A

3:15pm – 4:15pm, Maryland Ballroom A, B, C, & D

A59. An Exploration of the Educational Museum as a Learning Space for In-Service Science Teachers Jinwoo Jeong, Korea National University of Education Sophia (Sun Kyung) Jeong, University of Georgia Eunjeong Kim, University of Georgia Young Ae Kim, University of Georgia ABSTRACT:

In 2013, the Korean government has implemented the latest policy that teachers need to develop an accurate and in-depth knowledge about Korean history in order to complete an employment examination when applying for teaching positions. In this study, eighteen in-service science teachers visited the largest, state-of-the art Educational Museum established at a major teacher preparation university in Korea. The purpose of this study is to explore the feasibility of the Educational Museum as a learning space for in-service science teachers about Korea's unique history of education. The researchers postulate that the functionalities afforded by the Educational Museum can serve as a meaningful learning space to learn about Korea's history of education. This qualitative study analyzes the in-service teachers' written responses and reflections about their field-trip experience at the museum. The findings of this study contribute to increasing the familiarity of museums for science teachers as a resource for teaching and learning as well as integrating social science into their science teaching.

A61. Conceptualizing STEM Outreach in Rural Library Spaces

Allison Antink-Meyer, Illinois State University

Ryan Brown, Illinois State University

ABSTRACT:

Public libraries have increasingly begun to incorporate STEM programming due to public interest and funding opportunities in recent years (Roberson, 2015). In an era in which STEM education is viewed as vital to a prosperous economic future, the role of STEM education within rural public libraries, which can also be viewed as having a role in community economic development (Hancks, 2012), is gaining importance. This study examined how Midwestern rural librarians who facilitate STEM programming conceptualize the community library space as one of STEM learning.

A63. Extension Faculty Lack Systematic Training in Outreach

Kathryn A. Stofer, University of Florida

Teresa Wolfe, Oregon State University

ABSTRACT:

Supporting scientists in effective public engagement is critical. Yet a gap remains between what researchers know about effective outreach and what scientists actually do when they conduct outreach. However, future researchers are prepared primarily, if not exclusively, for research work during their graduate and post-graduate studies. The purpose of this study was to gather narratives from extension faculty identified as doing exemplary outreach, to determine their sources of outreach preparation, as well as resources for and barriers to outreach at

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a land-grant university, and motivations for and definitions of effective outreach. Semi-structured interviews were captured and analyzed using constant comparative method to identify expected and emergent codes. Consistent with previous research, this study found that even at a university with a mission for public outreach through University extension, faculty with extension responsibilities had little formal support for developing their outreach skills and programs and little support for outreach during their graduate studies. The mentoring in outreach they did receive as faculty was driven primarily by the mentee. Many faculty learned outreach primarily by trial and error and observation. Faculty and future faculty need more awareness of existing outreach resources and more formal support for outreach development at the university.

A65. Finding Scale: The Role of Research in Revising Program Design and Supporting Local Innovation Meghan P. Groome, New York Academy of Sciences

Johanna Duncan -Poitier, the State University of New York

Philip Ortiz, the State University of New York

Gaylen Moore, Gaylen Moore Program Evaluation Services

Gwendolyn Elphick, the State University of New York

Kristian Breton, the New York Academy of Sciences

Stephanie Wortel, the New York Academy of Sciences

ABSTRACT:

The Mentoring Program in STEM places volunteer scientists-in-training in afterschool programs to serve as mentors and instructors for a semester to high poverty urban and rural students creating a mutually beneficial partnership where mentors improve their teaching skills and students have access to inquiry-based STEM learning. This paper examines the first two years of a federal grant in which six university campuses across the state worked with a national scientific non-profit to scale up the program and presents findings in the areas of mentor recruitment and development, partnership management, curriculum and teaching and training. The research concludes that a central framework designed with flexibility to respond to and reflect regional and local priorities and needs is key to creating a scalable model and system that improves student and mentor outcomes at each cycle of the program implementation. Evaluation feedback integrated into a cohort model of central and program staff are key structures for improvement to address two key interventions to improve science education: improve teaching in higher education and increase access to high quality STEM teaching. This model creates a mechanism to bridge research and practice

A67. Place or Practice? Negotiating the Boundary of Formal/Informal Science Learning in the Classroom Jennifer Adams, Booklyn College- CUNY

ABSTRACT:

This paper is based on a qualitative study of relationship between new teacher identity and classroom practice in regard to informal science teacher learning experiences; preservice courses around integrating informal science resources in the classroom. A group of teachers engaged in dialogues and shared teaching artifacts in relation to classroom science teaching and learning and informal science learning during the course of an academic year. The central questions that guide this research are 1) how do teachers define informal science education and 2) how do they enact their definitions in their teaching practice? First the definitions of formal, informal, nonformal learning are revisited, then using a framework of identity, agency, and learning to teach teachers' experiences were restoried (Creswell, 2007) into narratives that described how they defined and adapted informal science learning in their classrooms and used their notions of ISE to create equitable learning experiences for their students.

A69. Using Case Studies to Develop Deep Understandings of Adolescent Youths' STEM Interest and Participation Pathways Nancy Staus, Oregon State University Lynn D. Dierking, Oregon State University Deborah L. Bailey, Oregon State University Jennifer N. Wyld, Oregon State University William R. Penuel, University of Colorado Julie Cafarella, University of Colorado Boulder John H. Falk, Oregon State University *ABSTRACT:*

Declining attitudes or interest in science, technology, engineering, and mathematics (STEM) during adolescence has been an area of considerable research in science education. This longitudinal investigation of STEM interest pathways in adolescents utilized both survey and case study data to better understand how and why youth become interested in STEM topics and activities, or lose interest over a 3-year period of time. Analysis of survey data indicated that youth could be grouped into three STEM interest profiles: STEM Interested, Math Disinterested, and STEM Disinterested. To better understand why and how some youth remained interested in STEM over time, while others lost interest, we chose one case study youth from each profile to analyze more deeply. Results suggest that parental support and encouragement, and participation in out-of-school interest-related activities were critical to the development of STEM interests, but were not necessarily sufficient to ensure the persistence of interest over time. In particular, lack of peer support and selfefficacy in STEM were implicated in the decline of STEM interest in these three youth. Findings underscore the importance of out-of-school factors in the development and persistence of STEM interests, and can inform the development of connected, coordinated formal- informal educational intervention strategies.

A71. Using CHAT to Understand How Elements at STEM Outreach Stations Stimulate Student Engagement

David Yale, Univesity of California Santa Barbara

Jasmine Kyle McBeath, University of California, Santa Barbara

Walter Aminger, UCSB

ABSTRACT:

Increasingly, science and technology museums, university outreach efforts, after school programs and other outof-school STEM learning venues are turning towards interactive exhibits to provide opportunities for children to experience a more first-hand perspective of science and hopefully stimulate their interest. This study used Cultural Historical Activity Theory and the National Research Council's framework on informal science learning strands to explore what types of interactions engage and stimulate children's STEM interest in a science outreach program. We analyzed archival video footage from a school-community program and use mixed methods to determine individual student and host profiles and student engagement rates. While all the stations offered a chance for students to take part in the scientific practices of people who use technology and science in their professions and everyday lives, there were different approaches to encouraging scientific reasoning. We found that student engagement varied widely between individuals and between different station contexts, identifying a relationship between the host verbal styles and student engagement. Understanding how learners are engaging with the community partners and outreach materials could greatly benefit researchers, educators, and practitioners to maximize the intended outcomes of science outreach events.

Strand 7: Pre-service Science Teacher Education

Poster Session A

3:15pm – 4:15pm, Maryland Ballroom A, B, C, & D

A73. "I Don'T Want You to Feel Guilty, I Want You to do Something About It": Designing for Pre-Service Teacher Learning About Race, Science, and Teaching Manali J. Sheth, Iowa State University Melissa Braaten, University of Wisconsin ABSTRACT:

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This qualitative design-based study highlights the design of a science teacher education module based on sociocultural perspectives on teacher learning and race to support the teacher identity development of science teacher candidates towards becoming equitable science teachers. The module centers on facilitated science teaching methods conversations around popular science books that highlight issues of race, power, and privilege. We have currently completed three iterations of design and implementation and will be conducting the 4th iteration in Fall 2015. Design principles that guided the cycles of design, implementation, and revision of the module include 1. Learning is situated and context-specific. 2. More sophisticated conceptions about science, race, and power need to be bridged to the work of teaching. 3. Unlearning the racist ideologies and discourses embedded in social institutions such as science and schools requires making ideas visible, critical reflection, checking assumptions, and reinterpreting taken for granted ideas and practices.. 4. Learning is a socially mediated activity. Findings support revision and further specification of learning and design principles.

A75. Investigating Open-Mindedness Among Early Childhood Education Majors

Nazan Bautista, Miami University Thomas Misco, Miami University Stephen Quaye, Miami University

ABSTRACT:

This study investigates the open-mindedness of the preservice Early Childhood Education (ECE) teachers during their teacher preparation. We intend to identify and create the profiles of preservice teachers who lack open-minded thinking dispositions as they enter the early childhood education program, monitor if and how they develop open-mindedness dispositions, and investigate the factors that positively or negatively impact the development of their open-mindedness. The preliminary findings of this study revealed that two major factors must be considered to move teacher candidates' less sophisticated worldviews to more open-minded worldviews. First is how "porous" a teacher candidates' religious and political worldviews determines how likely it is to move each toward open-minded worldviews. The second factor is about the purposefulness of the instruction teacher candidates received in their formal preparation programs. This study points out the need for all education courses to purposefully challenge preservice ECE teachers' worldviews as they enter and go through their formal teacher preparation programs. In our presentation, we will specifically focus on how this can be achieved in science content and science methods courses. Strategies for meaningful classroom discussions and in- and out-of-class critical reflection opportunities will further be discussed

A77. Investigating Science Teacher Candidates' Assessment Practices Using EdTPA

David Kimori, University of Minnesota Barbara Billington, University of Minnesota Gillian Roehrig, University of Minnesota

ABSTRACT:

Research on assessment at the classroom level usually takes an assessment-centered, teacher-centered, or student-centered approach. Assessment-centered research focuses on the technical quality and fairness of traditional multiple-choice tests and alternative assessment strategies (Klassen, 2006). The emerging paradigm in assessment argues for teachers to assess student thinking, as opposed to factual recall, thus calling for alternative-performance, project, and portfolio-based assessments that would align with constructivist and sociocultural views of learning (Resnick & Resnick, 1992; Shepard, 2000). In this study three science teacher candidates' field experience in assessing students is documented. Data analysis was based upon open prompt surveys, 15 EdTPA artifacts collected from the three teacher candidates and individual interviews. Findings indicate that science teacher candidates make deliberate effort in giving students feedback that can guide students for further learning but they struggle with strategies that can encourage students use the feedback given to them. We argue that broadening how we analyze assessment and the feedback we give to students in science classes should not only indicate the right or wrong responses but act as a guide for future learning and motivate the students on their strengths.

Strand 8: In-service Science Teacher Education Poster Session A 3:15pm – 4:15pm, Maryland Ballroom A, B, C, & D

A137. Implementing the NGSS: Results of a Statewide Professional Development Project David B. Vallett, University of Nevada Las Vegas Hasan Deniz, University of Nevada Kristoffer Carroll, Southern Nevada Regional Professional Development Program Bret Sibley, Southern Nevada Regional Professional Development Program Elif Adibelli, University of Nevada Las Vegas

ABSTRACT:

This study describes a yearlong professional development on the NGSS, conducted jointly by a large school district, a local university, and a state teacher development agency. The PD, including teachers from across the state and all grade levels, consisted of three phases. Phase one focused on content knowledge, pedagogy, and lesson development including crosscutting concepts. The second phase focused on teacher implementation of developed lessons, along with peer-review and self-reflection on that implementation. The third phase focused on integration of engineering concepts. Results of STEBI-B and ATLAST instruments indicated a small decrease in self-efficacy, but a marked and sustained increase in content knowledge, while examination of student artifacts demonstrated deeper understanding of concepts taught during participant developed lessons.

A139. Professional Learning Impact: Outcomes of PD Grounded in Reformed Science Teaching Practices and Educative Curricula

Max L. Longhurst, Utah State University Todd Campbell, University of Connecticut Paul Wolf, Utah State University

ABSTRACT:

The link between what a teacher does and what a student learns is the purpose for all formal and informal teacher development efforts. Increasing emphasis on instructional reform drive a need for realizing the potential of professional learning. This work focused on providing professional learning for eighth grade science teachers using new literacies and technology within a frame of reformed teaching practice. This investigation grounded professional development in educative curricula focusing teacher learning experiences on cyber-enabled cognitive tools integrated with reformed science teaching principles. Data from this investigation suggests that teachers who participate in professional development focused on an educative form of learning that integrates new literacies and technology with scientific literacies will demonstrate increased student achievement. The information collected supports the notion that a teacher who participates in ongoing professional development (2-years) will have student achievement scores that exceed similar teachers who only participated on a shorter timeline (1-year). In light of The K-12 Framework for Science Education document (2012) and the Next Generation Science Standards (2013) it is critical that we continue efforts to understand the factors that contribute to the implementation of new pedagogical practices from professional development opportunities.

A141. Promoting Equity in Science Teaching through Transformative Professional Development in Rural Alabama

Melody L Russell, Auburn University M Goldston, University of Alabama Mohammed Qazi, Tuskegee University Shaik Jeelani, Tuskegee University Christopher Parrish, Auburn University Crystal Kaczor, University of Alabama-Tuscaloosa Ruby Ellis, Auburn University

Laura Crowe, Auburn University David Laurencio, Auburn University *ABSTRACT:*

There is a critical need for improving the teaching and learning of science for grades 6th – 8th in schools in the rural Alabama Black Belt Region. For the past several years, science performance data on standardized tests (e.g. SAT-10) at these grade levels have been dismal and consistently among the worst in the state. This project includes the development and implementation of inquiry –based nanoscience modules designed to promote science achievement and interest through enhanced and systemic teacher professional development. This research qualitatively examines teacher perspectives on the role of professional development in implementation of new curriculum nanoscience modules. The research questions are as follows: a) How does professional development impact in-service science teachers' perspectives on the implementation of new nanoscience modules; b) In what ways does teacher professional development impact teachers' self-efficacy and motivation to implement new nanoscience modules. Teacher and administrator participants emphasized the importance of: a) administrative support; b) resource support; c) collaborative structures between schools and professional development organizers; and d) engagement of teachers in workshops that model and emphasize inquiry based strategies to motivate teachers and promote self-efficacy in nanoscience content.

A143. Technology Teachers' Use in Inclusive Chemistry Classrooms and Factors that influence the Selection of such Technology

Laura Ochs, University of Virginia Frackson Mumba, University of Virginia Vivien M. Chabalengula, University of Virginia *ABSTRACT:*

In science education, research studies on technology decisions have mainly focused on teachers' technology decisions for regular science classrooms. As such, there is a dearth of research on science teachers' technology decisions for inclusive science classrooms. Yet, inclusive science classes have become the norm in schools, fulfilling the instructional needs of students with mild disabilities. We explored the technologies high school chemistry teachers' use in inclusive chemistry classes. We also sought to find out the factors that influence their selection and use of such technologies. A sample of 26 chemistry teachers participated in this study. Data were

selection and use of such technologies. A sample of 26 chemistry teachers participated in this study. Data were collected using a questionnaire. Results show that most of the technologies they used in inclusive classrooms were instructional technologies that were only appropriate for regular students. The factors that influenced their technology selection are: user friendliness, increase accuracy and precision of readings in the labs, applicability, cost, availability, prep time, convenience, school support, and ease of use. Although chemistry teachers' technology selection criteria were within the framework that integrates instructional technology for regular classes, such practices are unlikely to promote effective science teaching and learning in inclusive classes. Results have implications on teacher education and learning.

A145. Varying Conceptualizations of STEM Education and the Implications for Professional Development Tamara Holmlund Nelson, Washington State University Vancouver Kristin Lesseig, Washington State University Vancouver

David Slavit, Washington State University Vancouver

ABSTRACT:

There is little common agreement as to what STEM education means in terms of curriculum and student outcomes. This lack of clarity impacts what is provided to teachers through professional development (PD) and how teachers' understandings are translated into student learning opportunities. In this study, we examined the conceptualizations of STEM education by three different groups of educators: middle school teachers involved in a two-year PD project, teachers and a principal at a STEM-focused secondary school, and STEM education PD providers. Concept maps and interviews were used to capture the meanings teachers and others had constructed for "STEM education." Maps were analyzed for nine themes commonly ascribed to STEM

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education. These themes were also elements of the PD encountered or provided by participants. Additional categories related to challenges or problems with STEM education and factors relevant to teaching emerged from the analysis. Results show that "access and opportunity for all students" and "technology" were included on only 20% of the maps, despite being critical elements of STEM education. "Integration" was common to 90% of the maps, although people had differing conceptions of what that means. Implications for professional development are examined in light of these and other findings.

Strand 9: Reflective Practice

Poster Session A 3:15pm – 4:15pm, Maryland Ballroom A, B, C, & D

A79. A Scaffolded Approach to Planning Investigations in an Urban Science Classroom: An Action Research Study

Anna K. Monteiro, Newark Public School Rosiane Lesperance, Newark Public Schools

ABSTRACT:

Students who have not been exposed to NGSS during primary school years are at a disadvantage when trying to achieve success with the NGSS, in particular, the scientific and engineering practices. This creates a gap for students who have not learned science under NGSS, a gap that is further widened for urban science students. This action research study aimed to determine whether the implementation of a scaffolding approach would promote students building of scientific skills necessary to meet the expectations outlined by The Framework. More specifically, it focuses on the essential science and engineering practice of planning an investigation. This action research study involved 74 tenth and eleventh grade science students from an urban district in New Jersey. Students were given a diagnostic test based on a five point rubric which served as both the pretest in the beginning and the post test at the end of the school year to determine any change in the skill of planning an investigation. Analysis of the results found that there was a statistically significant increase in the post test scores of the students compared to the pretest scores, suggesting that a scaffolding approach to building science skills could be effective.

A81. How do Science Graduate Students Benefit From Conducting Educational Research? Janet F. Stomberg, Illinois State University Alicia T. O'Hare, Illinois State University

Rebekka Darner Gougis, Illinois State University

ABSTRACT:

Scientists who teach in informal settings or at the post-secondary level are increasingly called upon to apply best practices that have been demonstrated to be effective through educational research. However, in order for scientists to apply such research findings, they must perceive the research as valuable and reliable. Scientists who do not see value in qualitative research are not likely to apply its findings. The goal of this study is to engage two science graduate students in qualitative analysis of educational data and track the progression of their ideas about the value of educational research. This poster presents the summarized reflections of these graduate students over the course of an academic year, highlighting their ideas about the nature of educational research, the value of educational research, and the likelihood of applying educational research to future practice as science faculty or informal science educators. These reflections suggest that engaging future scientists in qualitative analysis of educational data may enhance their future science instruction, such as by fostering an approach to science education that emphasizes understanding and conceptual development over grades and correct answers.

A83. Implementing a Peer Mentoring Program in Preservice Science Teacher Education

Lisa Neesemann, Teachers College Columbia University Jessica Riccio, Teachers College, Columbia University **ABSTRACT:**

To combat retention issues and effectively prepare preservice teachers, I have created a mentoring program for use during teacher education preparation. Focusing on a peer mentoring model in which both members of the dyad are of equal positionality leads to authentic feedback, open communication, and a meaningful teacher preparation experience.

Strand 10: Curriculum, Evaluation, and Assessment **Poster Session A**

3:15pm – 4:15pm, Maryland Ballroom A, B, C, & D

A85. Assessing Changes in Relations Among Self-Evaluated Values, Cognition, and Engagement in Leisure Science Free-Choice Learning

Brady M. Jack, National Sun-yat Sen University Hsiao-Ching She, National Chiao Tung University Huann-shyang Lin, National Sun Yat-Sen University

ABSTRACT:

Utilizing structural equation modeling on the Taiwan PISA 2006 Main Survey (MS) and the Taiwan PISA 2015 Field Trial (FT) survey datasets, this study investigates how self-evaluated values (i.e., personal and general) and cognitive factors (i.e., self-efficacy and self-concept) of students from identical language and culture traditions but separated by 9 years of classroom-presented science instruction experience impact leisure science engagement in free-choice learning activities. We also verify the statistical fitness of a newly created five-factor model called the SEVCE (Self-Evaluated Values, Cognition, and Engagement) model. SEVCE revealed good model fit to the datasets, showing a significant increase in pathway parameter strength for students' personal value of science and a significant decrease in pathway parameter strength of students' science self-efficacy between the two PISA survey cycles. Possible reasons for these phenomena and why the results of this study are important to measurement specialists in science education are also forwarded.

A87. Developing a Learning Progression and Assessment to Track Three-Dimensional Learning During an NGSS-Aligned High School Physical Science Curriculum

Leonora Kaldaras, Michigan State University Shawn Stevens, University of Michigan Steven Mcgee, Northwestern University Joseph S. Krajcik, Michigan State University

ABSTRACT:

The Framework and NGSS describe science proficiency as a combination of a body of knowledge and a practice-driven endeavor (NRC 2012, NRC 2013). This view is reflected in defining three dimensions of science (disciplinary core ideas (DCI), scientific practices (SP) and crosscutting concepts (CCC)) that form the basis of learning experiences in NGSS classroom-three-dimensional learning (3D learning). 3D learning approach is anchored in theories of situated cognition stating that learning content is inseparable from doing activities focused on that content (Schweingruber et. al., 2007) and developmental approach stating that learning complex ideas takes time and appropriate scaffolding (Smith et. al., 2006). Achieving and measuring 3-D learning in the classroom is key to successful implementation of NGSS. It is also a challenge because it requires careful alignment of science content, instruction and assessment. Learning progressions (LP) provide a promising way of tackling this problem. In this work we discuss preliminary results of developing a LP for NGSS-aligned curriculum that will subsequently incorporate all three dimensions on NGSS. We use evidence-centered design

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(ECD) process (DeBarger, Mislevy 2006) to develop assessments that show evidence of 3D learning in the context of NGSS-aligned Physical Science high school curriculum materials called "Interactions".

A89. Does Knowledge and Situational Interest Support Personal Interest: A Health Education Study

Michele Miller, Wright State University William L. Romine, Wright State University Amber Todd, Wright State University Bill Folk, University of Missouri

ABSTRACT:

High quality K-12 STEM education and assessment complement and support each other, and is a national priority along with improving science literacy and expanding the number of youths capable of entering science and healthcare careers. One new program is responding to these needs by developing and distributing science enrichment materials to middle schools in the Midwest. In concert, we are developing and validating multilevel assessments of student learning and interest in science and healthcare careers to assess and strengthen understanding of how personal and situational interest change during STEM instruction. We demonstrate that the Assessment of Interest in Medical Sciences (AIMS) displays high reliability for personal and situational interest and a related Science and Health Literacy Assessment has moderate reliability. We also demonstrate that gains in situational interest do significantly support gains in personal interest. These assessments are continuing to be refined, together with the program's enrichment materials, through reiterative cycles of implementation in partnership with the schools, teachers and students. Here we describe the most recent developmental studies of these assessments.

A91. How Students Develop an In-Depth Understanding of Neurobiology Concepts in a Three-Dimensional Virtual Learning Environment

Sophia (Sun Kyung) Jeong, University of Georgia Georgia Hodges, University of Georgia Tugba E Toprak, Gazi University *ABSTRACT:*

The researchers of this study developed a three-dimensional virtual learning environment with the goal of facilitating students' learning of neurobiology. The purpose of this study is to investigate how students learn neurobiology concepts in a three-dimensional virtual learning environment and how their understanding is reflected in their writing. The researchers postulate that the learning environment allows students to develop an in-depth and integrated understanding of scientific concepts. This study employs a quasi-experimental design and analyzes student responses to the test items on the pre and posttests as well as the embedded questions in the learning environment. The findings of the study contribute to the assessment of science education and understanding of how students learn difficult scientific concepts as well as develop in-depth and integrated understanding.

A93. Relationship Between Students' Collaborative Learning Attitudes and their Satisfaction with an Online Collaborative Case-Based Course

Niva Wengrowicz, Technion William Swart, East Carolina University Kenneth MacLeod, East Carolina University Ravi Paul, East Carolina University Dov Dori, Technion Yehudit Judy Dori, MIT *ABSTRACT:*

Case-based learning is a common and useful collaborative teaching method in STEM education. However, using such methods in online courses can create obstacles to students' active engagement with learning and

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adversely impact their satisfaction with the course. These obstacles can be defined and measured using the theory of Transactional Distance (TD) in general and the Coll-TD instrument in particular. Inclination to recommend a course to peers is a measure of student satisfaction from the course. The goals of this research were to (1) determine whether there are significant differences in TD between students who indicated they would recommend this course to a peer - and those who did not, and (2) identify satisfaction TD predictors and understand how the different predictors work together. The results obtained from administering the Coll-TD instrument to 193 students, followed by qualitative analysis, indicated that student's attitude toward collaborative learning is an important predictor of students' satisfaction in online case-based courses. These findings emphasize for course designers the importance of including online teamwork training in appropriate and relevant courses in order to foster a positive attitude toward collaborative learning. Our results contribute to advancing the pedagogy related to online case-based STEM courses.

A95. The Nature of 'Nature' in Science Education

Ajay Sharma, University of Georgia

ABSTRACT:

This paper undertakes a conceptual analysis of the social and discursive production of 'nature' in school science in the United States, and makes an appeal for its reconceptualization in light of current scientific understanding of life in the current Anthropocene era. Supporting my argument with illustrative examples drawn from my research as well as of others, I make the case that the nature as constructed in science education is distinguished by three main features: (a) Separation of the social from the natural; (b) Propagation of the 'balance of nature' view; and (c) Framing of nature in a market-based rationality. These features reflected an outdated understanding of nature and hence point to an urgent need to reconceptualize nature in science education.

A97. Connecting the Imperatives of STEM, NGSS, Deep Learning and Assessment: A Conceptual Paper Eunjeong Kim, The University of Georgia J. Steve Oliver, The University ofGeorgia David F. Jackson, The University ofGeorgia

ABSTRACT:

In this conceptual paper, we consider curricular integration as described by NGSS and by the more general STEM models. Our knowledge and expectations are informed by historical awareness of the failure of previous efforts to gain widespread or long term implementation of the teaching of science as an interdisciplinary study that forms around multiple foci as STEM must do. Current discussions of the actual or desired relationship among Science, Technology, Engineering, and Mathematics (STEM) in science classrooms emphasizes multidimensional, reciprocal, and symmetric relationships among the four domains. We put forward a model of STEM that suggests equitable emphasis among the four domains and also conceptualizes how each can serve as subject matter content, as instructional workspace, and/or as enabler. Historical awareness also suggests that one reason for the failure of previous efforts is linked to the challenge of assessing student learning associated with integrated and/or interdisciplinary study. To move forward successful implementation, we propose the adoption of an encompassing model of deep learning and a complementary model of assessment that can validly assess the multidimensional and interconnected nature of NGSS or STEM such as one based in the SOLO taxonomy.

A99. Exploring How a Collaborative Board Game Can Be Used as a Scientific Model within the Classroom Hillary Z. Lauren, University of Illinois at Urbana-Champaign Barbara Hug, University of Illinois at Urbana-Champaign ABSTRACT:

The current reform underway in K-12 science and engineering education, based on A Framework for K-12 Science Education, identifies three dimensions that are integral to science education, including scientific practices. One core scientific practice identified in the Framework and the NGSS is the practice of developing

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and using models. Models are the distilled, conceptualized systems that form the framework of simulations, which can be present in various types of interactive media, including games. In the science education research community, the affordances and possible gains in learning that well-designed educational games can offer learners has warranted further research. This study, as part of a larger project examining the alignment of the game to three-dimensional learning, seeks to explore the possibilities of using games within the classroom as scientific models. We evaluated a collaborative board game modeled on current scientific literature on the genetic and environmental influences of honey bee behavior, and examined how students evaluated the game as a model within authentic education settings of high school classrooms. The findings from this study have implications for the continued research of game-based learning and participatory simulations in the classroom as possible avenues for meeting the science learning goals of the NGSS. We view this exploratory research study as a starting point for further investigations of using games and participatory simulations to incorporate three-dimensional learning envisioned in the NGSS into classrooms.

Strand 11: Cultural, Social, and Gender Issues

Poster Session A

3:15pm – 4:15pm, Maryland Ballroom A, B, C, & D

A101. Influence of Nollywood Film in Mother Tongue on Students' Learning Outcomes on Contemporary Environmental Concepts

Michael A. Ahove, Lagos State University Peter A. Okebukola, Lagos State University Isaac S Bankole, Lagos State University Foluso O Okebukola, Lagos State University Grace O. Oshun, Lagos State University

ABSTRACT:

Influence of mother tongue as a medium to enhance learning is major concern for educators and researchers. This study seeks to experiment the use of Nollywood film presented in mother tongue in a multicultural cooperative learning class using constructivism to positively influence learners' outcomes. The question this paper seeks to answer is; will Nollywood film presented in mother tongue significantly influence students' attitude, achievement, gender, willingness to act, and personal threat towards global warming and ozone layer depletion? Mixed approaches of quantitative and qualitative methodologies were adopted in this study. Results show that mother tongue has no significant influence on students' attitude, achievement, willingness to pay a price and personal threat of global warming and ozone layer depletion irrespective of ethnic background or group. Experimental group showed no significant gender difference in attitude, achievement and willingness but significant gender difference existed in personal threat. Control group showed significant gender difference in attitude but not in achievement, willingness and personal threat. Irrespective of ethnic background male performed better than female students in attitude, achievement, willingness and personal threat.

A103. A Place for Race in Elementary Science Classrooms

Stefanie L Marshall, Michigan State University

Amal Ibourk, Michigan State University

ABSTRACT:

Race and science education are often spoken of as though they are mutually exclusive, when in fact race is everpresent in science classroom discussions. The NRC Framework is to be used by teachers, and researchers as a tool to enhance science instruction. In this paper, we raise that the scope of the NRC Framework support around diversity and equity hold limited value to teachers. In this study, we use a Critical Race lens to examine how one fifth grade elementary teacher engages with science content/ assessment and race in an elementary science classroom. This study reveals that teachers may be willing to take up race, but that they may not have the

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capacity to do so effectively even when it is relevant to the science content presented. Taking up race in some classes converges with reform efforts, which in many respects challenges professional security, and therefore fosters conformity, confining diversity to symbolic representations each academic year.

A105. Competing Conceptions of Knowing in Practice: Indigenous Teachers Teaching Western Science Paulina Grino, University of Arizona

ABSTRACT:

This qualitative research project looks at the science teaching practice of indigenous teachers among elementary schools located in southern Mexico. The disconnections that exist between Western science and Indigenous ways of understanding the world have been used to explain the underrepresentation of indigenous people in science. As a response, building a bridge between cultures would allow students to participate in science. This project analyzed how indigenous teachers bring science to elementary schools that serve indigenous populations. Preliminary findings of this initial stage of this project showed that the social and cultural context of schools plays an important role in teaching. Also, within this context, science teaching is embedded within cultural practices, which allows teachers to bring into the classroom community knowledge and practices along with science content. Finally, as the state is developing a new and local educational system, this is providing meaningful opportunities for teachers to work within communities of teachers to develop science lessons.

A107. Exploring the Cross-Disciplinary Collaborations Between Engineers and Educators at Engineering Research Centers

Osman Aksit, NC State University Katherine Chesnutt, North Carolina State University M. Gail Jones, North Carolina State University Shelley Glimcher, North Carolina State University

ABSTRACT:

To address the growing need for a domestic engineering workforce, Engineering Research Centers (ERCs) which are funded by National Science Foundation (NSF) conduct K-12 level educational outreach to increase students' interest in STEM related careers. The success of these educational initiatives depends on the meaningful collaborations established between educators and the engineers who work together in ERCs. However, collaborations and partnerships between different disciplines are not without their difficulties, and the presence of ERCs does not guarantee successful collaboration between individuals. This qualitative study investigated educators' and engineers' personal epistemological beliefs, educational practices and views about collaboration. Six case study participants who work in ERCs from both engineering and education backgrounds, were interviewed to better understand the experiences ERC educational initiatives. Findings indicated that across participants' backgrounds there was agreement about the potential to affect positive change in education and engineering. However, differing epistemologies hindered clear communication and thus optimal collaboration between the two groups.

Strand 12: Educational Technology

Poster Session A 3:15pm – 4:15pm, Maryland Ballroom A, B, C, & D

A109. Students' and Teachers' Perceptions of Presence and Preferences for 3-Dimensional, Haptic-Enabled, Virtual Reality Science Instruction
Rebecca Hite, North Carolina State University
M. Gail Jones, North Carolina State University
Gina Childers, North Carolina State University
Katherine Chesnutt, North Carolina State University

Elysa N. Corin, North Carolina State University Mariana Pereyra, North Carolina State University **ABSTRACT:**

This exploratory case study evaluated students' and teachers' perceptions of virtual presence after learning science topics on a 3-dimensional, haptic-enabled, virtual reality system. Twenty students and teachers completed four, one hour sessions with the instructional technology exploring biology and physical science content. Participants were surveyed to evaluate their perception of presence via four constructs: control, sensory, distraction, and realism. Results indicated the survey had high reliability for all constructs and groups. Differences between students' and teachers' responses found students perceived their virtual experience more realistic than labs at school. Participants engaged in an interview to rank their preferences for various instructional options based upon interest and increased understanding of presented science content. Students reported greater preferences for virtual learning environments than teachers in both categories as a viable and engaging instructional method.

A111. The Development of a Computerized Interactive Teaching Assistant

Cyrus Vandrevala, Purdue University Lynn A. Bryan, Purdue University Andrew Hirsch, Purdue University Hisao Nakanishi, Purdue University Laura Pyrak-Nolte, Purdue University **ABSTRACT:**

We are developing a Computerized Interactive Teaching Assistant (CITA) for the next generation of our inhouse online homework system. Through this program we aim to extend the ideas behind existing interactive examples, raising them to a higher level of interaction between the students and the online learning tool, by applying the current findings of multimedia learning and physics education research. Unlike most computerized homework systems that only provide students with a "correct" or "incorrect" response to their answers, the CITA program will guide students through fundamental concepts and appropriate problem solving techniques in physics. It will provide students with dynamic feedback to their specific responses, thus allowing them to learn from their mistakes as they analyze each problem. We report some of the findings of the first phase of the project. After the first round of development and testing we find evidence that the CITA program does improve student's conceptual understanding of physics concepts.

A113. Tracing the Development of a Haptically-Enhanced Science Simulation for Matter and Intermolecular Forces

James Minogue, North Carolina State University David Borland, RENCI, Renaissance Computing Institute) UNCCH Marc Russo, North Carolina State University Shengyen Chen, North Carolina State University Trevor Davis, North Carolina State University

ABSTRACT:

This poster session documents the research-design-develop-test cycle of a haptically-enabled matter and intermolecular forces simulation for upper elementary students. It highlights Year 2 work from a 3-year exploratory project leveraging force-feedback haptic technology to reach beyond what is typically done in today's classrooms. Most opportunities to learn during elementary school science take place at the visible concrete (macro)scale, side-stepping the abstract invisible (micro)scale mechanisms that help explain the science behind what is observed. As our suggests, this leaves students' stuck practicing phenomena-based reasoning with limited opportunities to engage in relation-based reasoning and modelling. We use hapticallyenhanced simulations to provide conceptual encounters with the invisible aspects of the science phenomena. Our work is guided by some of the previous work in two key areas: haptics in science education and students'

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understandings about basic chemistry (namely matter, phase change, and molecular forces). The session embraces the NARST 2016 theme of Equity and Justice: Many Different Voices, Cultures, and Languages in Science Education Research for Quality Science Learning and Teaching as our work provides traditionally underrepresented student groups (Hispanic and black) access to innovative science education technology.

A115. A Computational Modeling of Student Cognitive Processes While Solving Critical Thinking Problems in Science

Richard L. Lamb, Washington State University David B. Vallett, University of Nevada Las Vegas Tariq Akmal, Washington State University Maureen Schmitter-Edgecomb, Washington State University Reanne Cunningham, Washington State University *ABSTRACT:*

Critical thinking within science problems such as those related to the Piagetian volume conservation task is a complex endeavor. Tasks such as the conservation task require the interaction of multiple cognitive systems. Much of the research in science education on cognition in general, and critical thinking specifically at the level of the student, views student learning as a simple linear serial input-output system. This view of learning, coupled with the use of linear research approaches such as pretest/posttest observations without testable underlying mechanisms of action and attempts to reconcile across frameworks, fragments science education and isolates researchers. The purpose of this computational ablation study was to establish the role of critical thinking as a necessary component of a system of cognition necessary for completion of the conservation task. This ablation study consisted of three phases: phase one is creating the ablations within the computational model, phase two is the examination of responses from elementary students on the same task, and phase three is the comparison of the ablation computational model to the elementary students. The confidence intervals between the ablation network and the elementary students do not overlap, indicating they are not statistically significantly different.

A117. A Model of Remote Learning Environments: Factors Influencing Remote Microscopy Investigations Gina Childers, North Carolina State University

M. Gail Jones, North Carolina State University

ABSTRACT:

Remote access technologies offer unique learning experiences that allow students to become virtual researchers. The purpose of this study was to explore factors of a successful remote learning environment model by documenting high school students' (n = 72) perceptions of science motivation, science identity, and virtual presence during a remote microscopy investigation. An exploratory factor analysis identified three constructs that contribute to a successful remote investigation: Science Learning Drive (students' perception of their competence and performance in science and intrinsic motivation to do science), Environmental Presence (students' perception of control of the remote technology, sensory and distraction factors in the learning environment, and relatedness to scientists), and Inner Realism Presence (students' perceptions of the realness of the remote program and being recognized as a science-oriented individual). By investigating the factors that support science learning through virtual tools (e.g. remote technologies), teachers will be able to support students during virtual learning sessions.

A119. Collecting and Interpreting Highly Variable Real-World Data Using a Mobile Technology-Enabled Ecosystem Science Field Trip Cailean B. Cooke, WestEd Amy M. Kamarainen, Harvard Graduate School of Education Denise M. Bressler, Independent Consultant Shari Jackson Metcalf, Harvard University

Tina Grotzer, Harvard University Christopher Dede, Harvard Graduate School of Education

ABSTRACT:

Using data as evidence during scientific reasoning involves processes of synthesis, aggregation, representation and interpretation; this is more challenging in the face of variable data sets. Given the challenges of working with and interpreting data, learners in science classrooms too often are given simplified data sets with reduced variability, and are provided too few opportunities to apply conceptual understanding to interpreting highly variable real-world data. This may cause students to form misconceptions about what real datasets resemble and to reject scientific explanations based on, from their perception, "messy" data. We describe a curriculum that integrates the affordances of mobile broadband devices and probeware to support students' first-hand data collection and exploration of data variability in their local environment during a field trip to a pond near school. Based on the results of a pre-post survey assessing student abilities to describe data, understand variability, and support claims with evidence. We found that this intervention enhanced their ability to understand variability and better support claims with evidence. These tools and resources enabled students to develop and demonstrate fairly sophisticated descriptions of highly variable environmental data and helped them to integrate data interpretation and explanation with personally meaningful experiences in their local environment.

Strand 13: History, Philosophy, and Sociology of Science

Poster Session A

3:15pm – 4:15pm, Maryland Ballroom A, B, C, & D

A121. Contextualization: How It Works on NOS Views and NOS Teaching of Pre-Service Science Teachers? Jale Cakiroglu, Middle East Technical University

Kader Bilican, Kirikkale University

Valarie L. Akerson, Indiana University

ABSTRACT:

Even though nature of science (NOS) has been claimed as an important learning outcome for science education, research studies have consistently shown that both students and teachers have naïve ideas of nature of scientific knowledge and teachers cannot effectively teach NOS. Although there has been some effort to develop pre-service science teachers PCK for teaching NOS, there is less emphasize on contribution of contextualization on development of PCK for NOS. The purpose of the current study is to investigate pre service elementary science teachers' views on NOS in different contexts such as history of science(HOS) and inquiry based teaching (IBT) and find evidence for which context is more effective to improving NOS conceptions. Participants were 18 students in total, 9 students enrolled in each of two sections of elementary science teaching method course. Findings of the study revealed all participants in both sections improved their ideas on NOS toward either "approaching to informed" or informed" views as a result of participating in courses. Generally, all participants developed their instructional planning for teaching NOS.

A123. Toward Quantifying Responses to the Views of Nature of Science Questionnaire: Empirically Investigating Qualitative Coding

Jeanne Brunner, University of Illinois at Urbana-Champaign Ryan Summers, University of Illinois - Urbana/Champaign John Y. Myers, University of Illinois at Urbana-Champaign Fouad Abd-El-Khalick, University of Illinois at Urbana-Champaign *ABSTRACT:*

In an attempt to understand nature of science (NOS) conceptions held by students in greater detail, researchers have been attracted to open-ended questionnaires, with the Views of Nature of Science Questionnaire Form C

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(VNOS-C) being the most widely used instrument of this type. The shift away from predominantly forcedchoice instruments allows for deeper investigation of respondents' NOS views, but utilizing qualitative measures also makes it difficult to perform statistical analyses regarding individuals' views of NOS and their relation to other variables. To rectify this issue, researchers have taken to assigning a quantitative score based on a qualitative code for each NOS aspect. In the case of the VNOS-C, with its 10 open-ended questions, this practice is problematic because there is not a 1:1 correspondence between target NOS aspects and questions. As such, in this study, we seek to gain a thorough understanding of how the qualitative codes are generated in response to questions on the VNOS-C in a sample of undergraduate students. Additionally, we examine the frequency that NOS aspects are addressed across VNOS-C questions. Based on this understanding, we identify challenges in quantifying responses and suggest the implications the qualitative codes have for generating a quantitative coding scheme.

Strand 14: Environmental Education

Poster Session A

3:15pm - 4:15pm, Maryland Ballroom A, B, C, & D

A125. A Systems Mapping Approach to Community-Based Science Learning by Rural Learners

Eleanor D. Abrams, University of New Hampshire Sameer Honwad, University of New Hampshire Erica Jablonski, University of New Hampshire Michael J. Middleton, University of Massachusetts--Boston Claes thelemarck, University of New Hampshire Ruth Varner, University of New Hampshire Robert Eckert, University of New Hampshire

ABSTRACT:

Developing an understanding about environmental sustainability is challenging because it requires learners to use systems thinking to understand sustainable practices. We developed a program for ages 10-14 that employs a highly contextualized, science practices, learning model that engages rural adolescents to explore local sustainability practices and share their results with other communities. The program uses a systems thinking approach as a learning heuristic to help students critically reflect on a sustainable practice before and after an inquiry-based investigation. We qualitatively examined 55 before"and after systems maps created by students in grades 4-6 from 11 classrooms. Maps were analyzed using a scoring rubric based upon system thinking principles. These systems maps show what students know about a sustainable practice, how that practice works as a process, and identifies the local experts involved as it is enacted in their community. The presentation will show how the system maps worked as a way for students to understand the unique assets within each rural community, and the potential pathways through which science knowledge may be transmitted in different communities. These benefits will be demonstrated in student work that displays how both local and non-local resources are valued and used in rural communities.

A127. Development of CCE-RS – a Formative Model for Educational Partnership

Michelle Molina, SmartStart Evaluation and Research

Erica Watson-Currie, SmartStart Evaluation and Research

Lauren Birney, Pace University

ABSTRACT:

The Curriculum + Community Enterprise for Restoration Science (CCE-RS) brings together educators from multiple settings to provide engaging STEM-C curriculum through restoration science to urban middle school students. By developing partnerships across multiple urban educational settings, project leaders hope to help ameliorate disenfranchisement as they implement captivating curriculum to students who are typically

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underrepresented in STEM-C fields. This paper focuses on describing the model through the perspectives of project leaders thereby facilitating future replications. Based on this early phase, researchers were able to derive communication guidelines to promote the development of future educational partnerships; namely, the importance of clearly defined goals and streamlined decision-making.

A129. Education for Sustainability in Egypt: Participants' Perspectives

Heba El-deghaidy, American University in Cairo

ABSTRACT:

The purpose of this study is to present the experience students at the Graduate School of Education went through while enrolled in an elective course as part of their MA programme. The course was on Sustainability and STEAM education. It aimed at developing students' deeper understanding of education for sustainable development (ESD) as a societal need for Egypt while taking the role of 'agents of change'. It also set out to identify the factors that facilitate and hinder infusing sustainability in education in Egypt from their views. With a societal emphasis in mind and a local versus global interdisciplinary perspective, the 'STEA2M education model' was developed and acted as the core driving theoretical framework to the course and the study. With the ten students enrolled in the course, they were provided the opportunity to engage into the various dimensions of ESD while being exposed to constructivist principles in their learning activities throughout the 15-week sessions of the course. The activities resulted into data analysed using quantitative and qualitative tools following a mixed methods approach. Findings depicted the transformative process, which students went through, what they identified as challenges and opportunities for infusing ESD and their progressive perspectives of ESD.

A131. Learning at a Personal Level: A Middle School Agricultural Science Teacher's Enactment of Action Gardening

Heather Rudolph, University of Northern Colorado

ABSTRACT:

The purpose of this ethnographic case study was to examine garden based science learning in an eighth grade class. This paper focuses specifically on the teacher's experience as she worked to relate agricultural science concepts to students' lives. Place conscious education (PCE) was used as a theoretical framework because it calls for a sense of agency in learning, emphasizing the importance of relevant knowledge as well as active and democratic community participation, all of which are tenets of the theory of action gardening. Data collection methods included interviews, participant observations, fieldnotes, and reflective journaling. Data was organized and interpreted through summative and in-progress memos, visual organization, and in-depth analysis. Three main themes are discussed in this work: community support of garden based learning (GBL) contributed to the perception of school as a valued place of learning; curriculum was structured around relevancy and physical activity; and GBL promoted problem solving and student autonomy. Findings have implications for further research, including longitudinal studies of this teacher and others enacting the theory of action gardening in middle school contexts.

A133. Phraseology, Science Learning and Secondary Marine Science Students' Global Warming and Climate Change Engagement

Benjamin Herman, University of Missouri

Mark Newton, University of South Florida

ABSTRACT:

This investigation determined the extent 550 secondary marine science students' perceptions about the validity of climate change/global warming (CC/GW) science and willingness to mitigate CC/GW were influenced by the: 1) phrase "climate change" or "global warming"; 2) number of science courses completed; and 3) extent CC/GW was a focus in their science coursework. Categorical regressions (CATREG) showed the use of the phrase "climate change" or "global warming" insignificantly influenced the participants' perceptions about the

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validity of CC/GW science and willingness to mitigate CC/GW. However, the amount of completed science coursework and how much that coursework focused on CC/GW was positively associated with participants' perceptions about CC/GW science's validity and willingness to mitigate CC/GW (e.g., recycling and conserving energy). Furthermore, the extent the participants had learned specific CC/GW topics (e.g., how CC/GW science develops evidence, CC/GW impacts on sea level and biodiversity) was positively associated with their confidence in CC/GW scientists' claims and their willingness to mitigate CC/GW through actions requiring varying levels of personal involvement. Implication include the need for implementing science curriculum that extensively addresses the nature of CC/GW science and CC/GW topics relevant to students in order to help achieve longstanding goals of motivating responsible socioscientific decision-making.

Strand 15: Policy

Poster Session A

3:15pm – 4:15pm, Maryland Ballroom A, B, C, & D

A135. Defining and Measuring Leadership Content Knowledge (LCK) for Science Practices

Rebecca Katsh-Singer, Boston College Katherine L. Mcneill, Boston College Rebecca Lowenhaupt, Boston College Kyle Fagan, Boston College

ABSTRACT:

Strong instructional leadership is crucial for the successful implementation of the Next Generation Science Standards (NGSS). One key aspect of this leadership is principals' supervision of teachers, which can support teachers to shift their beliefs and instruction to accomplish NGSS' challenging goals. Unfortunately, the majority of k-8 principals do not have a background in science and have limited understandings of effective science instruction. This is an important consideration given the biggest difference between NGSS and most current science standards: the eight science practices. Therefore, in this poster we present our initial efforts to conceptualize, develop, and pilot an instrument to measure principals' specialized leadership knowledge, Leadership Content Knowledge (LCK), for science practices, to better identify and support their needs around science. To measure LCK for science practices we created an instrument with 4 vignettes of classroom instruction of varying proficiencies focused on science practices. Using multiple choice and open-ended questions about the vignettes, our items target principals' abilities to notice and provide appropriate feedback about the teaching. Our poster will share our results from the piloting of this instrument with 50 principals, and also address the further redesign of the assessment.

Poster Session B 4:15pm – 5:15pm, Maryland Ballroom A, B, C and D

Strand 1: Science Learning, Understanding and Conceptual Change **Poster Session B**

4:15pm – 5:15pm, Maryland Ballroom A, B, C, & D

B2. MEL Diagrams: An Instructional Strategy That Promotes Scientific Thinking and Practice in Earth Science **Students** Shondricka Burrell, Temple University Doug Lombardi, Temple University Janelle M. Bailey, Temple University

ABSTRACT:

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Model-Evidence Link (MEL) diagrams are instructional scaffolds that may facilitate evaluation of alternative hypotheses, comparison of plausible explanations, and argumentation. Recent reform efforts have identified each of these skills as scientific practices important in K-12 science education. We developed MEL diagrams and used them during instruction at two high school Earth science classrooms over the course of the 2013-2014 academic year. Our research goal was to examine whether this intervention leads to increased critical evaluation and subsequent knowledge gains, and specifically to investigate differences between two school districts. One site was in a well-resourced school in New Jersey and the other in an under-resourced school in Nevada. A second research question focused on the MEL as a low-cost intervention that could provide meaningful skill development and learning experiences for science students. Preliminary analyses revealed increased knowledge about the Moon's formation after participants completed the MEL diagram, and also, greater critical evaluation scores in the under-resourced district in Nevada. The implications for these results are that MEL diagrams can be used as: (1) an instructional strategy for essential skill development in science students; and (2) an affordable tool that promotes scientific reasoning and practice.

B4. Rasch Validation and Measurement of Students' Understanding of the Nature of Models: A New Computer-Based Questionnaire

Silvia Wen-Yu Lee, National Changhua University of Education *ABSTRACT:*

The aim of this study is to validate a computer-based questionnaire for measuring students' understanding of the nature of model. The questionnaire consists of 31 items, including 10 items with representations of models and 21 statements. The 10 representations can be further divided into five modalities: text-based, 2D static, 3D static, 2D animated, and 3D animated. The questionnaire was given to 1136 students, including 548 middle school students and 588 high school students. The 21 statements were designed based on five themes including "what model present," "forms of models," "functions of models," "relationship to real objects," and "construction of models. The results show that students were least likely to agree with text-based model and 2-dimensional static models; while students were mostly likely to agree with 3-dimensional static models. Among other aspects of models, students seemed to have difficulty to endorse that a model predicts but accept that models facilitate scientific reasoning. As for "construction of models," students were least likely to agree with the models are as simplified. The results are discussed in relation to previous studies in the literature.

B6. Scientific Reasoning in Contextualised and De-Contextualised Cases

Bashirah Ibrahim, The Ohio State University Lin Ding, The Ohio State University Katherine N. Mollohan, The Ohio State University andria Stammen, The Ohio State University *ABSTRACT:*

We explore the differences and similarities of how students coordinate self-generated theory and evidence when reasoning through contextualised (domain general) and de-contextualised (domain specific) cases. We are also interested in the kinds of explanations formulated, "satisfactory", "accurate" and "poor", when coordination occurs as they provide insights into the students' level of reasoning. Five open-ended reasoning questions, borrowed from published instruments, were completed by 27 science major students. Two questions deal with domain-general scenarios and three questions are concerned with the topic of energy in the physics domain. Results show that theory-evidence coordination predominantly occurs for the de-contextualised tasks as opposed to the content-specific ones. In both cases, when theory-evidence coordination occurs, evidence is overwhelmingly used in a confirmatory manner to support the theory. That said, the students tend to provide "poor" reasoning in situations that require formal knowledge. The study suggests that scientific reasoning can be applied as a useful assessment tool in the enterprise of science. B8. Spatial and Creative Development for STEM Education Jaclyn K. Murray, University of Georgia Barbara A. Crawford, University of Georgia ABSTRACT:

Spatial knowledge and creativity are two essential themes within STEM education. The National Science Board, the Educate to Innovate initiative, and other appeals have underscored the importance of spatial development in K16 education. The National Science Foundation emphasizes scientific and technological innovation whereby innovation refers to the knowledge, skills, creativity, and foresight to advance discovery and the construction of new knowledge, processes, and products. Early and frequent exposure to visualization and open-ended assignments may contribute to an understanding of a variety of STEM spatial representations and the practice of science, technology, engineering, and mathematics. Exposure to spatial and creative skills provides equity among students. This poster explores the intersection of spatial knowledge and creativity in K16 education, and will draw upon educational psychology, cognition, creativity, and education literature to form an argument in support of integrated spatial creativity.

B10. Supporting English Language Learners' Learning with Dynamic Visualizations: Generating Versus Reading Explanations

Kristin D. Bedell, University of North Carolina, Chapel Hill Kihyun (Kelly) Ryoo, University of North Carolina, Chapel Hill Amanda Swearingen, University of North Carolina, Chapel Hill ABSTRACT:

ABSTRACT:

This study examines how seventh-grade English Language Learners (ELLs) (n=18) interpreted matter and energy transformations during photosynthesis as depicted in a dynamic visualization when provided with different types of guidance. The students were selected from a larger study in which 190 ELLs and their 210 non-ELL partners from two different middle schools were randomly assigned to either a reading condition, in which they were asked to read scientifically normative explanations synchronized with an animation, or a generating condition, in which they were asked to generate their own explanations without feedback at three points during the course of the same animation. Video data was collected on each of the participants (9 per condition) and was analyzed using a coding scheme based on the Knowledge Integration framework. Percentages were calculated to determine the frequency of each code to uncover patterns in ELLs' discourse moves within each condition. Differences in patterns of adding, distinguishing, and sorting ideas were found to be associated with each condition and related to error rates. Despite an initially higher error rate, ELLs in the generating condition appeared to develop a more coherent understanding overall of energy and matter transformations during photosynthesis.

B12. Utilizing Cognitive Model Construction Strategies to Support Students' Participation in Kinesthetic Simulations

Grant Williams, St. Thomas University Ryan Oulton, St. Thomas University Laura Taylor, St. Thomas University *ABSTRACT:*

Students are frequently exposed to simulations (particularly the computer-based type) of science concepts relatively passively and without direct instruction from the teacher with the hopes that simply observing and interacting with the simulations will result in learning of the target concept. This study adds a socio-physical aspect to the use of simulations as a teaching medium by having K-12 students take on active roles of key elements of natural systems in order to cooperatively act out or kinesthetically simulate particular scientific phenomena. We refer to these kinesthetic simulations as Kinulations and our team has developed a collection of 22 of these movement-based, human-sized modelling activities for a variety of grade levels and science

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concepts. While having students participate in these kinds of active simulations is not a new instructional strategy, our interest lies in exploring the ways teachers can support students' engagement in the modeling of and reasoning about abstract scientific concepts during these simulations, as opposed to simply following teachers' directions. Our research has identified 15 specific discussion-based strategies referred to as Cognitive Model Construction strategies that can be employed during these kinesthetic simulations to foster students' construction and refinement of explanatory scientific models.

B14. Examining Middle School Learners' Scientific Explanations about Sea Level Rise

J. R. McGinnis, University of Maryland

Wayne Breslyn, Montgomery County Public Schools

Emily Hestness, University of Maryland

ABSTRACT:

This qualitative study examines middle school students' scientific explanations about sea level rise. We used written assessments, classroom observations, and interviews to examine how seventh grade students (N = 28) at a single public middle school coordinated claim, evidence, and reasoning when constructing their explanations. Our data indicate that students' use of evidence and reasoning depended on the context of the scientific explanation. In particular, the structure of students' scientific explanations depended on whether or not scientific data was provided to the students. In the absence of scientific data, students relied more heavily on reasoning to construct their scientific explanations. Our study also identifies various alternative conceptions that students hold about sea level rise, including the idea that increased precipitation and decreased evaporation are a major cause of sea level rise.

Strand 2: Science Learning: Contexts, Characteristics and Interactions

Poster Session B

4:15pm – 5:15pm, Maryland Ballroom A, B, C, & D

B16. Self-Positioning Within Laboratory Groups Resulting from Community College Faculty and Early Undergraduate Students Engaging in Authentic Scientific Research: Relationships to Participant Future Plans Stephen R. Burgin, University of Arkansas

Daniel L. Dickerson, East Carolina University

ABSTRACT:

In this study, we report on the impact of a research apprenticeship experience for undergraduate students, community college students, and community college faculty on their notions of belonging within a laboratory group (positioning) and the relationships between that positioning and their future plans. Interviews were conducted with a group of participants engaged in studying the transmission of a specific disease within a population of shrimp in the Gulf of Mexico. Despite limited epistemic involvement, participants felt a belonging within the laboratory group and that their contributions were significant. However, their relationship to one another within the laboratory's hierarchical structure was not clearly understood. Additionally, participants were able to find connections to their future plans.

B18. Healthy Bodies, Healthy Minds, Healthy Learners: Growing Equity Environments to Foster Science Learning

Bhaskar Upadhyay, University of Minnesota Nancy Albrecht, University of Minnesota *ABSTRACT:*

The purpose of this study is to understand how immigrant and refugee students' engagement in science through gardening could provide a better science learning environment. This study framed gardening as a space that provided mental and emotional support to overcome trauma and frustration of science learning and schooling

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difficulties. In our qualitative study we collected data in two elementary science classrooms over a year. From the analysis of data we found that gardening is a space for poor and traumatized students where science learning is more productive and practical. Furthermore students who were less engaged in science seemed to have more positive outlook to science when they were given the responsibility to care for and learn more about the plants.

B20. Strategies for Promoting Student Participation in Science Practices: A Teacher's Organization of Science Classroom Talk

Deb Morrison, TREE Educational Services

ABSTRACT:

This study examined how one science teacher organized classroom talk around the scientific practice of reasoning with evidence to support students in building conceptual understanding of natural selection. This work is framed in sociolinguistics and classroom talk to socially situate student-teacher interactions in a community of learners. The author used qualitative data analysis to locate patterns of talk during whole class and small group discussions to understand how one high school science teacher, Lisa, organized classroom talk to make the scientific practice of reasoning with evidence to connect the everyday to scientific concepts a common classroom practice. Primary sources of data were classroom video of Lisa's enactment of classroom-based assessments, which were collaboratively designed in a professional learning community over a two-year period. Transcripts were coded for science content and classroom talk moves. There were three main ways in which Lisa promoted a community of learners around the practices of science: setting explicit norms for participation, asking clarifying and pressing questions, and linking everyday to scientific language. This study provides an example of how teachers can engage in classroom talk to create a community of learners focused on both scientific practices and conceptual development of complex science ideas.

B22. Engaging in Groupwork in Science: Students' Views of the Causes of and Barriers to Equity Alexis Patterson, University of California, Davis

ABSTRACT:

Science educators have called for a shift in science instruction that will make science for all rather than just for a few. This shift, described in science education literature, requires teachers to use more dialogic instruction amongst diverse groups of students. Studies proposing this approach, ask students to have conversations in small groups. This study builds on Cohen's principle that students in small groups learn most when they work and talk together—that is, the more each student talks and engages in a task the more each student learns. Equitable interactions, then, becomes integral to effective groupwork. This study sought to understand the knowledge and skills science teachers need to support students in groups by exploring students' observed and self-perceived interactions during groupwork in science. This exploratory study took place in a high school that serves underrepresented students in Silicon Valley. The analysis, based on 18 interviews with students, focused on students' perceptions of groupwork and their theories about what causes barriers to cooperative groups and who is responsible for addressing those challenges. Students mentioned exclusionary and off task behavior as key inhibitors to groupwork but also discuss the role of the teacher and the impact of race on group interactions.

B24. Leveraging Social Network Learning Platforms and Teacher Practice in Online Spaces to Engage Students in Science

Vanessa B. Lujan, University of California, Berkeley Lynn U. Tran, University of California, Berkeley *ABSTRACT:*

Science identity is how students see themselves in relation to science and is contextualized by different social settings. This identity is related to attitudes and perceptions towards science, such as self-confidence and usefulness they ascribe to science. Engagement in science learning in school can be facilitated when students have a science identity to draw from. Teachers can foster student science identity development through classroom discourse, and making connections between science and who students are (e.g., personal experiences,

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local community knowledge). This study explores how Facebook-like social network learning platforms can support student science identity through discourse online. Leveraging such technology for science learning can be advantageous because they align with commonplace interactions young people have in everyday 21st century life.

Strand 3: Science Teaching--Primary School, Grades preK-6): Characteristics and Strategies *Poster Session B*

4:15pm – 5:15pm, Maryland Ballroom A, B, C, & D

B26. Pedagogical Differentiation: A Case Study of Classroom Orchestration
Katherine Chesnutt, North Carolina State University
Alonzo B. Alexander, North Carolina State University
Eric N. Wiebe, North Carolina State University
Courtney Behrle, North Carolina State University
ABSTRACT:

To account for variability in elementary science teacher preparation, many teachers and school districts adopt curricular materials designed by outside publishers. However, decisions on the classroom orchestration of these materials are largely left up to the teacher, leaving room for variability in the formation of learning ecologies. This case study investigated how one teacher chose to implement such materials, in this case a digital science platform, in three different classes. A constant comparative method outside of grounded theory (Fram, 2013) was used to analyze classroom observation data. Interview data were triangulated and synthesized with classroom observation data and field notes to elaborate on the instructional strategies in each class as well as teacher PCK. Findings revealed that the formation of learning ecologies relied on the feedback cycle that exists between all phases of the orchestration process: curriculum creation, arranging, and conducting. While the teacher's goal was to create learning ecologies for all students, differences in the arranging and conducting afforded some classes more opportunities than others to develop science process skills. We suggest that as teachers modify orchestration while using pre-made resources, they should be cognizant of not only generating equal learning opportunities for science content but also scientific practices.

B28. Examining Early Childhood Teachers' Instruction of Scientific Explanations for Fostering Children's Explanations in Science

Heidi L. Masters, University of Wisconsin - La Crosse Meredith A. Park Rogers, Indiana University Christina Cooper, Corban University Susan Hawkins, Indiana University *ABSTRACT:*

This study employed an embedded mixed methods multi-case study design (Creswell, 2014) with three early childhood (grades K-2) teachers to examine a) how they implemented scientific explanation instruction within a teacher developed unit on properties of matter, and b) what affordances their instruction of scientific explanations had on fostering their students' abilities to generate explanations in science. Both quantitative and qualitative measures were analyzed in accordance to this study's conceptual framework of ten instructional practices teachers should consider assimilating or accommodating into their knowledge base for teaching scientific explanations (McNeill & Krajcik, 2008; Zembal-Saul, McNeill & Hershberger, 2013). Using rubrics developed specifically for this study, results indicate the three teachers' employed seven or eight of the instructional practices to varying levels of effectiveness. Many of these teachers' students also showed improvement in their ability to formulate a scientific explanation, particularly their ability to provide multiple pieces of evidence. Implications for professional developers, teacher educators, and elementary teachers

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regarding how to prepare teachers for and support students' construction of scientific explanations will be discussed.

B30. Examining Elementary Teachers' Existing Epistemological Beliefs in Science and Engineering Megan R. Lancaster, University of North Carolina at Greensboro *ABSTRACT:*

The recently developed National Generation Science Standards (NGSS) have changed the way that we approach science education and have paved the way for innovative interdisciplinary instruction. As the focus continues to shift toward integrating engineering within the science curriculum, a deeper look into how this integration will take place is valuable. Teachers are tasked to merge new ideas with discipline-specific pedagogies providing a unique yet exciting challenge. In order to tap into how this integration will take place in the classroom, we find it relevant to first examine how teachers conceptualize science versus engineering as two disciplines. We believe that by examining teachers' personal epistemologies in these two disciplines, we will create a framework from which to build for professional development and pre-service teacher education reform. The goal of this study was to examine elementary teachers' existing context-specific epistemological beliefs before exposure and experience with an engineering: Teaching, learning and the nature of the discipline. Several themes emerged from our data providing excellent insight in how elementary teachers' epistemological beliefs in these two disciplines may influence engineering integration in the classroom.

Strand 4: Science Teaching--Middle and High School, Grades 5-12): Characteristics and Strategies *Poster Session B*

4:15pm - 5:15pm, Maryland Ballroom A, B, C, & D

B32. The Implementation of Interdisciplinary Science Inquiry of Biology Teachers Compared to Physical Science Teachers

Sarah A. Chudyk, State University of New York at Buffalo, SUNY Xiufeng Liu, State University of New York at Buffalo, SUNY Michelle R. Eades-Baird, State University of New York at Buffalo, SUNY Noemi Waight, State University of New York at Buffalo, SUNY Shao-Hui Chi, State University of New York at Buffalo, SUNY *ABSTRACT:*

The Next Generation Science Standards provides a new framework that solidifies the importance of teaching interdisciplinary STEM courses. Specifically, the National Research Council has argued for the need to make biology education more interdisciplinary. Since biology teachers seem to have the most difficulty teaching interdisciplinary STEM, a comparative case study was conducted to understand which factors influence interdisciplinary teaching, and, if there are differences between biology and physical science teachers. Using the framework of interdisciplinary science inquiry (ISI), seven high school science teachers were compared to understand how professional development and subject pedagogical content knowledge informed their implementation of ISI. Findings of the study revealed a range of levels of implementation, with no notable differences between science teachers from different content backgrounds. Rather, there were common factors, such as time limitations due to the curriculum, and a teacher's understanding of, and value placed on ISI, which affected their implementation. Based on the results of this study, it seems that further efforts need to be made to help teachers develop a better understanding of what ISI is. In addition, teachers need to develop their subject content knowledge in all of the sciences, better enabling them to make interdisciplinary connections.

B34. The Learning Curve: High School Science Teachers Helping Students Make Sense of Data

Lauren H. Swanson, Whittier College *ABSTRACT:*

The present study investigated how six high school science teachers implemented lessons prompting students to reason with data. Lessons were planned by the teachers as a result of their participation in a long-term professional development program and thus included activities teachers had not previously implemented. In particular, teachers' use of questions both on written materials and to facilitate small group and whole class discussions about data were explored. Analysis of curricular materials revealed that written prompts focused on procedural concerns and articulating conclusions as opposed to facilitating student understanding of the analytical process. Video of the implementation of these lessons documented teachers questioning students about their data analyses; these conversations worked to illuminate how science knowledge is constructed thereby deepening student conceptual understanding. While important, many of these conversations occurred in formats such as whole class discussions in which few students participated as active members. Student work demonstrated students' successes and challenges documenting their analytical process in writing. In particular students struggled to write explain how their conclusions arose from their investigations. Implications from this study extend to both curriculum design and teacher professional development.

B36. High School Student Attitudes about Science and Career After Interactions with GK-12 Biology Graduate Students

Kim Cleary Sadler, Middle Tennessee State University Rachel Lytle, Brentwood High School Anthony Farone, MTSU Ginger Rowell, MTSU Mary Farone, MTSU

ABSTRACT:

The purpose of this study was to determine the effect of biology graduate student interactions on high school student attitudes toward science and career choice. Through the National Science Foundation GK-12 program at Middle Tennessee State University, Graduate Fellows (GFs) partnered with a science teacher (PT) ten hours a week during the school year to serve as a scientist-in-residence, engage students in inquiry-based laboratory experiences, and mentor research projects. A multi-method design compared PT classes with and without a GF using the Student Attitude Inventory- II (SAI-II), interviews, and student artifacts. Although small positive differences were present in GF classes, repeated measures MANOVA found no significant differences between SAI-II categories. Both groups decreased in STEM career interest; however, student interviews with GF classes conveyed increased understanding of the scientific process and a desire to continue practicing science. Although GF classes actively participated in documented STEM experiences, this study supports the challenges in changing student attitude about science and increased pursuance of STEM careers.

B38. Exploring How One Teacher's Perception of Science Pedagogy Aligns to the Enactment of Scientific Practices

Kelly Mills, University of Maryland, College Park Diane Jass Ketelhut, University of Maryland, College Park *ABSTRACT:*

One of the goals of novel technologies is to impact the way teachers think about and enact scientific inquiry in their classrooms. This case study explored one aspect of this—how a teachers' perception of their science pedagogy compared to the enactment of scientific practices through three years of participation in a program designed to support teachers implement immersive virtual environments in their classrooms. Participation in the project modeled and exposed scientific inquiry for the teacher, and may have prompted him to believe that inquiry practices were an important part of his teaching. However, these beliefs were not transferred into practice. Classroom observations, surveys and interviews revealed that the enactment of scientific practices in this teacher's classroom was in direct opposition to how the project staff trained teachers to conduct scientific

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practices in professional development sessions through the three years of the technology-based project, and his own beliefs about his teaching practices.

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

Poster Session B

4:15pm – 5:15pm, Maryland Ballroom A, B, C, & D

B40. Examining Biology and Chemistry Students' Values for and Experiences with Various Skills and Teaching Methods.

Gili Marbach-Ad, University of Maryland Carly H. Rietschel, University of Maryland Katerina Thompson, University of Maryland

ABSTRACT:

The present study examined undergraduate biology and chemistry students' values for and experiences with various skills and teaching methods. Towards the end of their senior year, students in our college complete an online exit survey that includes eight items assessing the extent to which they value a series of skills. We examined data collected from 2011 to 2015 (1117 biology students and 213 chemistry students). We used data reduction techniques to explore the constructs underlying the items, and we found that items loaded onto two theoretically meaningful constructs, 1) transfer-based skills (e.g., knowledge application) and 2) retention-based skills (e.g., memorization). Regression analyses indicate that student characteristics (i.e., gender, underrepresented minority status, major, and GPA) are associated with at least one of these constructs. When examining teaching methods, we found that there were differences between biology and chemistry students in their reported experiences. This study provides a measurement tool of the extent to which students value transfer-based and retention-based skills, and information on the student characteristics related to valuing these skills. We discuss teaching implications for fostering appreciation and value for acquiring transfer-based skills.

B42. Flipping the Large Lecture Physical Science Content Course for Preservice Teachers: Assessing the Success

Stacy McCormack, Indiana University Meredith A. Park Rogers, Indiana University

ABSTRACT:

This action research study focuses on a redesign of a large lecture style physical science content course for preservice elementary teachers. Action research was chosen as this approach supports practitioners seeking to improve their practice, to find a solution to a practical problem (Creswell, 2012) or to "explore questions but not necessarily to provide definitive answers" (Leonard, 2006, p. 399). Using a flipped technique with inquiry focused pedagogical strategies we sought to examine if this strategy would improve conceptual understanding for students. Formative assessment questions using personal clicker devices and summative course assessments serve as data sources for this study. Results indicate that the instructional intervention was successful as student means improved 82.9% of the time, but statistical significance was not found in 51.2% of the analyzed questions. This may be indicative of poorly designed assessments, or could be due to instructional decisions made based on results from the formative assessments. Comparisons indicate higher summative assessment results except the final exam. These results certainly point out areas of improvement for the course which is valued in an action research study. Implications regarding improvements on course assessments and the flipping technique for supporting inquiry-based learning will be discussed.

B44. General Chemistry Students' Understanding and Application of Acid-Base Ideas across Contexts: Acid-Base Neutralization and Conductiometry

James M. Nyachwaya, North Dakota State University

Shayla Evans, East Carolina State University *ABSTRACT:*

This study looked at the extent to which second semester general chemistry students applied their knowledge of acid-base neutralization in a different context. The students covered acid-base neutralization in general chemistry (I). As part of the course, they carried out a lab experiment on neutralization involving a strong acid and a strong base, and determined the end-point using an indicator. In this research study through a series of 'leading questions', students (in groups of 3-5) were expected to apply their prior knowledge of acid-base neutralization to conductiometry, where the acid-base reaction would be monitored using electrical conductivity. Results indicate that students struggled with very basic ideas regarding acid-base chemistry, such as identifying the right species involved in a neutralization reaction. Students also struggled with providing symbolic and sub-microscopic representations of the acid-base reaction most students could not accurately predict how electrical conductivity would change as the neutralization reaction progressed. None of the groups provided an accurate sketch depicting the trend of electrical conductivity. None of the groups correctly applied acid-base ideas to the context of conductiometry, indicating that students were not able to transfer knowledge to this new context.

B46. Instant Feedback and Automated Grading System in Collaborative Exams: More Learning in Weaker Teams

Hyewon Jang, Harvard University

ABSTRACT:

To promote students' learning in collaborative exams, we design instant feedback system with the policy that let teams answer for a possible total of three trials when teams failed to answer correctly. Instant feedback system with automated grading was implemented in online responses system called Learning Catalytics developed by our group. We describe details of design and function of the system and report the effectiveness of instant feedback in collaborative problem solving with three aspects; 1) Learning gains from instant feedback system regardless of level of students' abilities, 2) More learning in weaker teams, and 3) Improved problem-solving even in team rounds with all incorrect answerers. Combining the increased learning gains with the ease of adoption of automatic grading and feedback systems would encourage instructors to adopt collaborative assessments in their courses.

B48. Measuring Professional Knowledge of Laboratory Assistants in Germany: Test Instrument Development and Validation in Biochemistry/Cell-Biology

Devasmita Chakraverty, University of Virginia

Stephan Gantner, Leibniz Institute for Science and Mathematics Education

J^{rg} Groflschedl, Leibniz Institute for Science and Mathematics Education

Ute Harms, Leibniz Institute for Science and Mathematics Education, IPN)

ABSTRACT:

The quality of Vocational Education and Training (VET) programs can be assessed by measuring students' professional knowledge. However, there are no validated instruments for measuring VET professional knowledge in biology/medicine. To address this, we developed and validated a paper-and-pencil test (PROKLAS), to assess professional knowledge about laboratory tasks in biochemistry/cell-biology. Validity of the subscales was tested using correlational approach, which showed that the two disciplines (biochemistry/cell-biology) are empirically separable. VET-year, VET-grade, and general biological knowledge predicted PROKLAS subscale scores, as expected; self-efficacy and laboratory learning opportunities were positively related to PROKLAS achievement, making it a useful tool to assess professional knowledge. This test instrument is valuable in terms of its usability, and in furthering knowledge in VET.

B50. Teachers of Science: A Comparison of the Beliefs and Practices of Secondary Pre-service Science Teachers and Science Graduate Teaching Assistants

Patricia Simmons, North Carolina State University Raleigh David Haase, North Carolina State University Whitney Richardson, North Carolina State University

ABSTRACT:

This investigation is designed to examine and compare science teaching and learning beliefs and knowledge and teaching performances in two cohorts--secondary science pre-service teachers with double majors in science and education and beginning graduate teaching assistants in physics. The purpose of this research is to better understand secondary science teachers' learning of content and pedagogy over time (as a result of key interventions during a year-long student teaching experiences) and physics graduate teaching assistants' learning of pedagogy during a similar experience teaching freshman physics laboratory classes. A majority of the physics students saw questioning and experimenting as major principles of science, understood science when they confident and were able to make connections, and described science as a more fluid and dynamic enterprise (using terms associated with language from the Enlightenment time of science). Most stated that they learned science through thinking about ideas and then being able to explain science through written or visual representations or talking with others. A majority of pre-service teachers described science as the study of the natural and physical world, and the scientific method as the foundation of science.

B52. Undergraduate Science Majors', Interdisciplinary-) Metamodeling Knowledge Regarding the Integration of Physical Models in Understanding Biological Systems

Shannon H. Sung, Spelman College

Derrick Hylton, Spelman College

ABSTRACT:

Models and modeling practices are crucial in scientific reasoning and inquiry and are often used as simplified representations for describing or visualizing micro- and macro-level phenomena (Cheng & Brown, 2015). However, students usually encountered problems during the modeling process that is believed to require more sophisticated reasoning. This study intends to investigate students' perceptions toward interdisciplinary metamodeling knowledge (i.e., their interdisciplinary knowledge about modeling). We introduced three interdisciplinary models to reinforce students' understanding of biological system through hands-on activities. The participants (N = 66) were majority biology majors taking the second general physics course in their junior year of college. The students' responses for the end-of-class survey administered was analyzed to inform future model-based instructions. Students self-reported that they were very clear about the purpose of using physical models (8.18 out of 10) while less certain (6.87 out of 10) about how to apply modeling practice in other disciplines. Educational implications are discussed.

B54. Undergraduate Students' Scientifically-Informed Decision-Making About Water-Based Socioscientific Issues

Jaime L. Sabel, University of Nebraska-Lincoln Tina Vo, University of Nebraska-Lincoln Ashley R. Alred, University of Nebraska-Lincoln Jenny M. Dauer, University of Nebraska-Lincoln Cory T. Forbes, University of Nebraska-Lincoln *ABSTRACT:*

Knowledge of disciplinary concepts and epistemic dimensions of science are foundations of scientific literacy, but require that students learn to apply the knowledge in particular contexts. These skills are necessary to address a range of socioscientific issues (SSIs) to which a scientifically literate populous will need to respond. To engage effectively with contemporary water-related issues, students need to develop understanding of the properties of water and also about the nature of scientific processes and practices. However, students have difficulty in understanding both core hydrologic concepts and epistemic dimensions of science. More work is needed to determine how undergraduate students who will be tomorrow's global citizens structure their

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decision-making about SSIs. In this study, we have investigated undergraduate students' SSI decision making with a focus on the resources they leverage to make and support their decisions about water-based SSIs. We show that students more effectively state a decision than they provide support for their decision and they incorporate information from outside resources when they state an opinion, but do not tend to incorporate the same information when asked to vote on an issue. Findings provide insight into the development of scientific literacy and engagement with decision-making about SSIs among undergraduate students.

B56. Using Primary Literature to Promote Science Literacy of Undergraduate Students in Cell Biology

Hadiya A. Woodham, University of Maryland Gili Marbach-Ad, University of Maryland Katerina Thompson, University of Maryland

ABSTRACT:

In an effort to provide undergraduate students in the biological sciences with laboratory-based experiences that more closely resemble the scientific research process, we implemented a scientific literacy in cell biology-based (SLCB) curriculum. The SLCB curriculum incorporated both hands-on, collaborative practical experiences that culminated in a final research project and the analysis of relevant primary literature. It was implemented in five stages over the semester during which students were also introduced to the theory and practice of common cell biology techniques. We report on the effectiveness of the course, as measured by pre- and post-survey data probing students' content knowledge and level of familiarity, confidence, and experience with different skills pertaining to analyzing (reading, interpreting, and discussing) relevant primary literature. In Spring 2015, 287 (72%) of the 396 students who were enrolled in the laboratory completed both the pre- and post-survey. The average overall score on the content questions of the post-survey was significantly higher (p<0.0001) than the average overall score on the pre-survey. Students reported that they gained greater familiarity, experience, and confidence in the skills that were measured. This research may aid in reforming higher education science laboratory courses to promote the writing, reading, data processing, and presentation skills.

B58. Validation of the Science Motivation Questionnaire II using Classical Test Theory and Rasch-andrich Model

Hye Sun You, The University ofTexas at Austin Kyungun Kim, The University ofTexas at Austin Karynne A. Black, The University ofTexas MD anderson Cancer Center Kyung Woo Min, The University ofTexas at Austin *ABSTRACT:*

Motivation in science learning is believed to be an essential element for students to pursue of college-level studies in science and a lifelong interest in science. The purpose of this study is to analyze the psychometrics properties of the Science Motivation Scale II (SMQ II) developed by Glynn et al. (2011), using classical test theory (CTT) and the Rasch-Andrich rating scale model. The data were collected from 415 college students from a public university in Texas. The original instrument consisted of 25 items allocated in five sub-factors: Intrinsic motivation, career motivation, self-determination, self-efficacy, and grade motivation. The results of confirmatory factor analysis (CFA) showed that the data fit for the CFA five-factor conceptual model of student motivation was adequate to good (TLI .89, CFI .90, RMSEA .081, SRMR .073), with standardized item-to-factor loadings ranging from .543 to .912. The internal consistency was excellent in both CTT and Rasch analyses. The results of the Rasch analysis show that model-data fit and PCA on residual do not support the unidimensional structure of the SMQ II. Overall, the results of CTT support that the SMQ II is a valid and reliable tool, yet the Rasch analyses demonstrate room for improvement of the instrument.

Strand 6: Science Learning in Informal Contexts *Poster Session B* 4:15pm – 5:15pm, Maryland Ballroom A, B, C, & D

B58. Taking Science Home; Being an Informal Science Educator at Housing Authority Afterschool Program Mark T. Enfield, Elon University Sara B Rosenthal, Elon University *ABSTRACT:*

This paper reports on a reflexive ethnographic study of an after school science program occurring in a public housing authority. The researchers, a team of a professor and undergraduate education student, created and then analyzed their reflections on creating the program. Findings reveal that children did benefit from the program, but more that the researchers' collaboration was vital. Furthermore, the findings reveal more about the complexity of attempting to enact equity in science learning for all children. First, we show that the reflexive process can be important for understanding the challenges of being a teacher working committed to equity and justice in science, and particularly informal science. In addition, by making spaces for students to position themselves in science, the program was able to adjust and ultimately support students development of science practices and science identities.

B60. Learning to Model as a Citizen Scientist: Adapting Experience to Scientific Practice

Whitney E. Novak, Indiana University

Joey Huang, Indiana University

Cindy E. Hmelo-Silver, Center for Research on Learning and Technology

Rebecca Jordan, Rutgers University

Steven A. Gray, University of Massachusetts Boston

Alycia Crall, Virginia Polytechnic Institute and State University

Greg Newman, Colorado State University

ABSTRACT:

This is a study that investigates the process of a Citizen Science group using modeling to develop an adaptive management plan curtailing the growth of an invasive species, Japanese Stilt Grass. We used interaction analysis to find evidence related to collaborative knowledge development, group modeling norms, and how our facilitation both enabled productive collaboration and can be improved to further participant stake in modeling as a scientific practice.

B62. Science, Humor, and Dialogue in an Online Gaming Space Logan M. Leslie, University of West Georgia

ABSTRACT:

This study contributes to our knowledge of how people's understanding of science is shaped by their online activity related to computer games and gaming communities. As noted in a 2009 National Research Council (NRC) report, "news and entertainment media merge with natural history museums and science centers, after-school programs, and computer games and gaming communities to reshape the world and people's exposure to science" (2009, pp. 28). This study focuses on an online forum dedicated to Portal 2, a game which involves both content oriented knowledge due to its physics puzzles as well as Nature of Science concepts with its choices of descriptions of scientists and their laboratories. Using the work of Deleuze, Guattari, and DeLanda on assemblages, the study looks at forum posts and the responding comments as they relate to scientific knowledge and the Nature of Science. Analysis of discussions of artwork and videos created by Portal 2 players suggests a number of takeaways for educators interested in the intersection of games and science, particularly the importance of looking at the interactions that actually occur rather than making assumptions about the expected interactions, as discussions often veer in intriguing but unanticipated directions.

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B64. Student Perceptions of STEM and Attitudes Toward	STEM Workshops at a Youth Organization
Stephen T. Adams, California State University Long Bead	ch
Paul Burns, California State University Long Beach	
Elaine V. Bernal, California State University Long Beach	
Lisa M. Martin-Hansen, California State University Long Beach	
ABSTRACT:	
This research study is part of a project with complementa	ry goals related to both developing teachers and

serving students at a youth organization. As part of a university course for training teachers to use technology in STEM subjects, teachers developed and implemented STEM workshops, with particular emphasis on engineering tasks, for student participants at a youth organization. Teachers used curriculum kits from the Engineering is Elementary series of the Museum of Science, Boston (www.eie.org) as a starting point, and also incorporated iPads as a resource. In previous work, we focused on the teachers participating in the program. The focus of the present mixed methods study is investigating youth perceptions toward STEM and their attitudes toward the STEM workshops. 36 youth aged 8-13 took 10-question surveys before and after the workshops and participated in focus groups at the end of the workshops. Students agreed with three items more strongly after the workshops than they did before the workshops, including, "I like thinking of new and better ways of doing things." Analyses of the focus groups is underway as a complementary data source. This work contributes to both teacher development and to science learning for diverse learners in a non-formal setting.

B66. An Exploration of Racial and Ethnic Minority Participation in Science-based Hobbies

Rebecca Hite, North Carolina State University M. Gail Jones, North Carolina State University Thomas andre, Iowa State University Gina Childers, North Carolina State University Elysa N. Corin, North Carolina State University *ABSTRACT:*

Despite targeted interventions, racial and ethnic minorities continue to be underrepresented in science fields. Previous research has explored underrepresentation issues within formal science learning spaces, however, exploration of minority participation in science-based hobbies is at present undeveloped. A nationwide quantitative survey was given and qualitative interviews were conducted to explore the demographic structure and experiences of science hobbyists. One hundred and sixty-eight ethnic and minority hobbyists responded to the survey and seven participated in an in-depth interview. Results indicate disparities in minority access to science experiences, contributing to the lack of minority science hobbyists. Majority white hobbyists outnumbered minority hobbyists 16 to 1, although both populations were demographically comparable. However, hobby engagement between racial and ethnic hobbyists differed significantly from majority respondents when asked about barriers or challenges regarding hobby participation. Challenges include differential participation due to inadequate access with prohibitive costs, and postponed hobby development. Findings suggest science hobbies may be an avenue through which minorities may find robust science opportunities to develop science interest, skills and identity. This information may prove useful in guiding next steps regarding policy and research in the under-representation minorities in science hobbies and science careers.

B68. Citizen Scientists' and Science Hobbyists' Science Capital: Factors Influencing Development and Engagement for Lifelong Learning
M. Gail Jones, North Carolina State University
Gina Childers, North Carolina State University
Thomas andre, Iowa State University
Elysa N. Corin, North Carolina State University

Rebecca Hite, North Carolina State University *ABSTRACT:*

This study investigated factors that influenced the development and participation in science hobbies and citizen science projects to understand how science interests develop over the lifespan. A nation-wide survey was conducted as part of a series of studies with 2119 non-Citizen Scientists and 745 Citizen Scientists. Citizen Scientists reported different motivations, interests, and experiences than the non-Citizen Scientists. Citizen Scientists reported improved science process skills and a better understanding of the nature of science as a result of participating in their hobby. Citizen Scientists were more likely than non-Citizen Scientists to report enhanced skills in collecting data, observing, analyzing data, as well as understanding the probabilistic nature of science, measurement error, the limitations of science and the tentative nature of science. The role of these lifelong learners as science capital in their families, local and national communities is discussed.

B70. Impact of a Science Methods Course Combined with a Summer Camp on Pre-Service Teachers' Self-Efficacy

Eulsun Seung, Indiana State University Soonhye Park, North Carolina State University *ABSTRACT:*

The purpose of this research is to examine how a combined camp and methods course influences elementary preservice teachers' self-efficacy in teaching science and K-7 students' attitudes towards science. The science camp was offered to K-7 school students as part of our intensive 4-week, 3-credit science teaching methods course during summer. This course requires elementary preservice teachers to teach a 10-day summer science camp as part of the course requirements. The survey and interview data show that elementary preservice teachers' self-efficacy improved significantly throughout the course. The main experiences that contribute to the increased self-efficacy are: 1) developing and teaching inquiry based 5E lessons and fun hands-on activities, 2) camp participants' positive reactions to lessons and activities, 3) the opportunity for connecting theory and practice, and 4) peer reflection and mentoring. The findings of this study also imply the effectiveness of informal STEM experiences for K-7 students. Various camp experiences are useful for children because these increase positive attitudes towards science and science careers while providing unique opportunities to engage with science in an inquiry-based manner. The findings of this study provide insight for teacher educators who are interested in developing an informal context -based science methods course.

Strand 7: Pre-service Science Teacher Education Poster Session B

4:15pm – 5:15pm, Maryland Ballroom A, B, C, & D

B72. Learning to Teach Science by Integrating the Three Dimensions in NGSS Dongmei Zhang, The University ofGeorgia Barbara A. Crawford, The University ofGeorgia

ABSTRACT:

The new K-12 Science Education Framework (NRC, 2012) and Next Generation Science Standards [NGSS] (Achieve, 2013) recommend teachers to teach science by integrating three dimensions –Practices , Crosscutting concepts, and Disciplinary Core Ideas. Therefore, helping prospective teachers prepare for the new "integrating three dimensions" (ITD) teaching approach is an imperative task for science teacher educators. In this multiple-case study (Yin, 2014), we investigated how four prospective middle-school teachers' beliefs about ITD developed in a methods course, as well as their intentions and practices related to ITD in their practicums. The data included pre-questionnaire, three reflections, post-questionnaire, semi-structured interviews, and researchers' journals. The inductive method (Erickson, 1986) and cross-case analysis technique (Yin, 2014) were used to analyze the data. This study had several conclusions. First, prospective teachers' beliefs

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development was influenced not only by their knowledge about ITD, but also by their openness to new teaching approaches and other beliefs in their belief system. Second, prospective teachers held both positive and negative beliefs about ITD approach. Third, prospective teachers' beliefs about ITD were tentative and needed to be further cultivated. Finally, prospective teachers' belief enactment was constrained by contextual factors. The implications of these conclusions are also discussed.

B74. Recruiting and Retaining STEM Majors for Teacher Certification

Marilyn M. Stephens, University of Alabama Dennis Sunal, University of Alabama Cynthia Szymanski Sunal, The University of Alabama James W. Harrell, University of Alabama Jeremy Zelkowski, University of Alabama Jim Gleason, University of Alabama Sharon Vincent, Shelton State Community College *ABSTRACT:*

In a mixed-methods four-year study, freshmen and sophomore students from community colleges and universities, majoring in chemistry, math, or physics were recruited to participate in 2014 and 2015 National Science Foundation paid summer Noyce internships that consisted of early teaching and research. Analysis of the first two years of quantitative data revealed that the students had strong attitudes toward science and moderate to high self-efficacy towards teaching and STEM careers. Qualitative analysis of intern interviews revealed many students had not considered teaching as a career choice, but after the internship were considering becoming a teacher or at least had not ruled it out. 57% of 2014 interns have entered a teacher education program through a NSF Noyce Scholarship.

B76. Understanding of Biotechnology Processes Among Pre-Service Science Teachers Jonathan Chitiyo, Southern Illinois University Carbondale Vivien M. Chabalengula, University of Virginia Frackson Mumba, university of Virginia *ABSTRACT:*

This study examined pre-service teachers' understanding of biotechnology and its related processes. A sample comprised eighty-eight elementary education pre-service teachers at a large university in the Midwest of the USA. Sixty and twenty-eight of the participants were enrolled in introductory and advanced science methods courses, respectively. Most participants had taken two integrated science courses at the college level. Data were collected using a questionnaire which had open-ended items and which required participants to write the definitions and examples of the following terms: biotechnology, genetic engineering, cloning and genetically modified foods. The results indicate that pre-service teachers had limited understanding of biotechnology and its related processes. The majority of the pre-service teachers provided poor definitions, explanations and examples of biotechnology, genetic engineering and genetically modified foods. Surprisingly, however, a moderate number of pre-service teachers correctly defined cloning and provided correct examples of cloning. Implications for science teacher education and science curriculum design are discussed. 0 0 1 183 1046 UVa 8 2 1227 14.0 Normal 0 false false EN-US JA X-NONE /* Style Definitions */ table.MsoNormalTable {msostyle-name: "Table Normal"; mso-tstyle-rowband-size:0; mso-tstyle-colband-size:0; mso-style-noshow:yes; mso-style-priority:99; mso-style-parent:""; mso-padding-alt:0in 5.4pt 0in 5.4pt; mso-para-margin:0in; msopara-margin-bottom:.0001pt; mso-pagination:widow-orphan; font-size:11.0pt; font-family:Calibri;} Key words: biotechnology, science, teacher, understanding

B78. Validation of the Science Wrap-Up Observation Protocol [SWOP] Kirby Whittington, Florida State University Shannon Gooden, Florida State University
Mary Beth Bowen Anna M. Strimaitis, Florida State University Sherry A. Southerland, Florida State University *ABSTRACT:*

Current evaluation tools used in teacher preparation programs are often used only in the final semester when the teacher candidate is in their internship. This is not surprising as these instruments broadly measure teaching and the classroom environment. If Teacher education programs are to preparing future teachers with the tools they will need to foster student engagement and learning within science they need methods through which to evaluate and provide feedback for their students.. This paper describes the validation of the Science Wrap-Up Observation Protocol [SWOP], designed for teacher education programs as a tool to provide constructive feedback to pre-service teachers as they learn how to facilitate wrap-up discussions. We looked at several measures of validity and have found SWOP to be a reliable measure for distinguishing between productive and non-productive wrap-up discussions. By focusing on one essential aspect of teaching - the productive facilitation of student-centered discussion for the purpose of helping students make shared conceptual sense of their learning – the SWOP can provide specific feedback on how a teacher candidate can improve on this aspect of their teaching, creating a manageable goal for later assessment.

Strand 8: In-service Science Teacher Education

Poster Session B

4:15pm – 5:15pm, Maryland Ballroom A, B, C, & D

B134. Conflict, Connection and Retention for STEM Teachers in High Need Schools

Amy Perfetti, Saint Joseph's University Stacy Olitsky, Saint Joseph's University

ABSTRACT:

The retention of qualified STEM teachers in high-need urban schools is essential for greater equity in science education. In this study, we draw on identity theory in order to investigate the development of identities among secondary STEM teachers in high-need schools, with the goal of generating insights that can support retention. We examine teacher logs, interviews and surveys of five STEM teachers over one year, exploring the teachers' relationships with students and colleagues, alignment between belief and practices, expectations and outcomes, and self-views and perceptions by others, and identity conflicts. Results show that the teachers who were very likely to stay reported stronger relationships with students, colleagues and administrators, fewer inconsistencies between expectations and outcomes in their teaching, stronger connections to the surrounding community, and more opportunities for overlap between their identities in and out of the classroom. The results suggest that potential supports that could assist identity salience and retention could include mentoring in ways that enhance self-efficacy, networks of teachers that facilitate connections to other high-need schools, a greater emphasis on teachers bringing numerous aspects of their identities into their teaching, and fostering community connections to enhance commitment.

B136. Designing an Instrument to Measure Science Teachers' Appraisals and Emotional Responses when Facilitating Inquiry-based Instruction
Daniel M. Alston, Clemson University
Jeff C. Marshall, Clemson University
Deborah Switzer, Clemson University
ABSTRACT:
Since the mid 1900's authors of science reform documents have advocated for teachers to engage in inquiri

Since the mid 1900's, authors of science reform documents have advocated for teachers to engage in inquirybased instruction. However, most science teachers are not enacting teaching practices that align with what constitutes as proficient inquiry-based instruction. Currently The Framework for K-12 Science Education and

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the Next Generation Science Standards, ask teachers and students to engage in even more rigorous teaching and learning. Inquiry-based instruction is once again a useful strategy for accomplishing these expectations. Many science teachers are unfamiliar with how to facilitate this type of teaching and learning. This can result in teachers experiencing negative emotional episodes as they struggle to facilitate inquiry-based instruction. Unchecked, these emotional episodes have the potential to adversely alter teacher behavior which might subsequently undermine the goals stated in reform documents. Therefore, it is critical that teachers' emotions and how they manage their emotions be further researched. This study seeks to design an instrument that can assess how science teachers appraise and emotionally respond to challenging situations that can occur when facilitating inquiry-based lessons. In order to accomplish this goal, a three phase instrument design and refinement process will occur. Implications regarding the use of this instrument in professional development will be discussed.

B138. Exploring Alternate Route Science Teacher Development of Pedagogical Content Knowledge Kim Feltre, Rowan University

Issam H. Abi-El-Mona, Rowan University

ABSTRACT:

The qualitative case study attempts to develop an understanding of the possible elements that contribute to alternate route science teacher learning experiences that facilitate the development of their pedagogical content knowledge (PCK). Research questions studied (1) In what way(s) do alternate route science teachers' learning experiences translate into instructional practices? (2) What elements contribute to alternate route science teachers' learning experiences that in effect, facilitate the development of their pedagogical content knowledge? Participants included three first year high school teachers from two alternate route program institutions. Data collection and analyses focused on semi-structured interviews, classroom observations, and teacher-generated artifacts of participant rich experiences in pedagogical content knowledge as a result of their having attended alternate route programs. Preliminary findings reveal patterns among all participant responses regarding learning experiences offered by their alternate route programs. Triangulation of preliminary findings of data sources indicated two emerging themes; relevance and reflection. Conclusions from the study inform understandings of how teacher participant learning experiences from alternate route programs could facilitate teacher pedagogical content knowledge development in novice teachers.

B140. From Professional Development to Teacher Practice: Project-based investigations of Local Watersheds Justin M LeVaughn, University of Kentucky

Rebecca McNall Krall, University of Kentucky Bharath Kumar, University of Kentucky Jennifer A. Wilhelm, University of Kentucky Carol Hanley, University of Kentucky

ABSTRACT:

Project-based learning (PBL) environments can promote application of scientific knowledge and skills in solving real world problems in authentic contexts. This professional development project aimed to support middle school teachers in the southeastern US in developing authentic PBL investigations on water quality in the watershed. A five-day summer teacher institute was developed to model PBL investigation of the region's watershed. Instruction focused on watersheds, water quality and techniques used to measure water quality, and instruction on PBL unit design. Seven teachers participated in this research study. The mixed methods research design included pre/post assessments to measure changes in teachers' knowledge of watersheds, water quality and water quality testing techniques, and components inherent to PBL units. In addition, unit outlines, field notes, and interviews were used to triangulate teachers' ability to develop and implement PBL units, and identify issues that limitations they experienced. Descriptive statistics were employed to analyze quantitative data, and the constant comparative method was used to analyze qualitative data. Preliminary findings revealed

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growth in teachers' knowledge of watersheds, water quality issues, and knowledge of geological features affecting water quality in one of the region's major watersheds. Teacher-designed units also will be discussed.

B142. High School, Community College, And University Faculty Perspectives on the Efficacy of Multi-Level **Professional Development**

Caren A. Gough, Stony Brook University Ross H. Nehm, SUNY Stony Brook

ABSTRACT:

This proposal explores the impact of a large-scale PD program focused on the "New Biology." In particular, it examines the efficacy of using multi-group PD (groups of High School, Community College, and University teachers), to learn and teach genomics and bioinformatics concepts. We discuss how the changing target of PD might require reconsideration of "best practices." In particular, we explore whether "collective participation" is a "best practice" for bioinformatics and genomics education. In order to shed light on these topics, we explored three research questions using survey research: (1) Did a large sample (> 100) of HS, CC, and UF teachers view their mixed-group PD experience to be an effective means of learning about bioinformatics and genomics? (2) What strengths and weaknesses of multi-level PD did participants identify? Were these strengths and weaknesses different among teacher groups? (3) What implications do the findings have for other PD efforts (e.g., NGSS)? Our qualitative and quantitative findings were in alignment and highlighted specific advantages and disadvantages of working together in a multi-level PD experience; the vast majority of participants preferred multi-level PD. We discuss the implications of these findings for future PD efforts in science education.

Strand 9: Reflective Practice

Poster Session B 4:15pm – 5:15pm, Maryland Ballroom A, B, C, & D

B80. Looking Inside Classrooms: Formative Assessment Approaches in Science Classroom

Hye-Eun Chu, Macquarie University Kok Siang Tan, National Institute of Education Singapore Rachel Ong, National Institute of Education Singapore Eugene Lim, National Institute of Education, NTU Singapore **ABSTRACT:**

This study investigates formative assessment practices in Secondary 3 science classrooms where students learn thermal physics concepts taught by six teachers (with varying ages, teaching experience and frequency/duration of participation in professional development workshops). Six teachers' self-recorded videos were analysed using a video analysis coding scheme which consisted of three main areas: 1) teaching resources, 2) teacherelicited questions and students' responses, and, 3) types of tasks supportive of formative assessment and feedback. Findings show that the teachers used open/guided questions but most students' responses were short. Only when teachers asked questions with various resources - demonstration, simulation and drawings, did students provide elaborated responses. Five teachers provided direct feedback on students' responses instead of encouraging students to construct their own explanations. One teacher was unable to maintain dynamic interactions because he asked a series of 3-4 questions continuously each time. He also failed to identify absentees and missed students' appropriate responses that could have been used for conceptual development. No peer assessment and students' self-assessment were observed and teachers' feedback appeared as a summary of teaching. Further analysis will be conducted to quantify the video analyses using Videograph software. This will be helpful for developing and revising teacher training programs.

B82. Understanding Enthusiasm in Teaching: A Self-Study of Teaching Science at the Undergraduate Level Brent Gilles, Indiana University Gayle A. Buck, Indiana University

ABSTRACT:

Although research has shown that teacher enthusiasm has a powerful impact on learning (Kunter et al., 2013), it is not widely understood (Schutz & Pekrun, 2007). Studies exist that show the importance of teacher enthusiasm in K-12 science classrooms and of student enthusiasm for science, but little from the perspective of science teacher preparation. The purpose of this study was to address this gap by examining how we demonstrate enthusiasm in our science classrooms and how our preservice teachers (PSTs) respond to this attribute. The findings revealed that during direct instruction, PSTs viewed us to be enthusiastic. During inquiry-based instruction, however, our enthusiasm was perceived to be lower. Also, when we did not view the PSTs as being enthusiastic, we tried to change that situation by stressing our own displays of enthusiasm. This false enthusiasm did not increase their motivation. In addition, during inquiry-based instruction, the PSTs were motivated to learn despite the fact that they found us less enthusiastic. We concluded that our initial understandings were naïve in that they 1) were too narrowly focused on outward displays, 2) assumed a cyclical process, and 3) assumed teacher enthusiasm to be equally critical during lecture-based and inquiry-based instruction.

Strand 10: Curriculum, Evaluation, and Assessment *Poster Session B*

4:15pm - 5:15pm, Maryland Ballroom A, B, C, & D

B84. How Does Written Feedback in Formative Assessment Enhance Students' Inquiry Skills Hilda Scheuermann, IPN Kiel Mathias Ropohl, IPN Kiel *ABSTRACT:*

According to educational standards, students are supposed to learn inquiry skills (KMK, 2005; Achieve, 2013). However, students have difficulties in planning investigations within controlling variables (Hammann, Phan, Ehmer & Grimm, 2006). One promising way to support students' learning process is said to be formative assessment and feedback (Black & Wiliam, 1998; Hattie & Timperley, 2007). However, contradictory effects of both formative assessment and feedback were found relating to its implementation, the subject and the task (Kingston & Nash, 2011; Ruiz-Primo & Furtak, 2007). In this respect, the first research question was developed: which type of feedback within formative assessment can enhance students' skill of planning an investigation? To analyse this question three different types of feedback were contrasted in an intervention study with pre, post, and follow up tests. The intervention was conducted in grade eight at lower secondary schools (N = 304). The students individually planned three investigations and received written feedback relating to their plans. First results show that students improve most if they receive information on the learning goal, learning level and opportunities on how to improve. Both this and a second study are presented on the poster.

B86. Manipulating 3D-Printed and Paper Models Enhances Student Understanding of Viral Replication Lisa Couper, WestEd Jodi Davenport, WestEd Matt Silberglitt, WestEd Jacklyn Powers, WestEd ABSTRACT:

As technological advances change the field of biology, students must develop understandings of the molecular level to gain a full understanding of key concepts in molecular genetics such as protein formation and gene

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expression. However, students struggle with these concepts as they are not directly observable and visual representations tend to be abstract and complex. In this paper we explore the utility of an activity involving an interactive physical model and novel visual representations for helping students understand key processes in viral replication. 3D-printed models embedded with magnets that represent chemical attractions provide new ways to help students understand how structures are formed from smaller to larger units via self-assembly (Host et. Al, 2013; Olson & Gardner, in press). Here we report findings from classroom trials of novel lessons that use a 3D-printed virus model in conjunction with paper virus cards, and provide evidence that interacting with these two models helps students develop a stronger understanding of viral replication and self-assembly

B88. Rigorous Investigation of Relevant Issues: A Socio-scientific Issues Approach to support Three-Dimensional Science Learning

Andrew T. Kinslow, University of Missouri - Columbia Troy D. Sadler, University of Missouri - Columbia Patricia J. Friedrichsen, University of Missouri - Columbia Kerri Graham, Rock Bridge High School, Columbia Missouri *ABSTRACT:*

The Next Generation Science Standards have generated great interest across the international science education community in three-dimensional science learning (3DSL). The move toward science teaching that promotes 3DSL is ambitious and significant gaps in research and practice exist. We present an empirically based instructional model for Socio-scientific Issue (SSI) instruction as an example of the rich context necessary for 3DSL. We also showcase results of a design and implementation study in which we develop an SSI based unit aligned with the instructional model. This unit focused on how global climate change is affecting tallgrass prairies of the US Midwest. Students investigated the social dimensions of climate change, core science ideas and practices, as well as evaluating sources of information, communications, and technology (ICT). We highlight insights that have emerged from our team in the context of this three-dimensional exploration of socio-scientific issue based instruction. Findings indicate the SSI model is consistent with our focus on 3DSL and provided emphasis on the core ideas of science content knowledge and engagement in scientific practices. Data also suggests that more purposeful attention to social connections and more extensive experiences with ICT components are needed.

B90. Students' Development of NOS Understanding: Integrating a Historical Case Study with the Revising of Models

Chandana Jasti, University of Illinois at Urbana-Champaign Robert C. Wallon, University of Illinois at Urbana-Champaign Barbara Hug, University of Illinois at Urbana-Champaign *ABSTRACT:*

An understanding of the nature of science (NOS) is critical to scientific literacy. The importance of teaching NOS is reiterated in current science education reform efforts. The Next Generation Science Standards recommend two ways of teaching NOS concepts: 1) providing students with opportunities to engage in and reflect on scientific practices and 2) incorporating instruction on historical case studies that illustrate NOS concepts (NGSS Lead States, 2013). For this study, we designed an activity that integrates a historical case study with the practice of revising models and examined the impact on students' thoughts about the nature of science. Data from four classrooms were collected and analyzed. Our findings showed shifts in students' understanding of the NOS theme: Scientific knowledge is open to revision in light of new evidence. We discuss implications of this study for future research and the development of guidelines for curriculum development and instruction for effective teaching of nature of science.

B92. The Importance of Random Assortment and Blinding in Qualitative Data Analysis

Andrea M.-K. Bierema, Michigan State University Rosa Moscarella, Michigan State University Mark Urban-Lurain, Michigan State University John Merrill, Michigan State University Kevin C. Haudek, Michigan State University *ABSTRACT:*

No matter the research question, qualitative data analysis contains some degree of error, and any research group that performs qualitative research should be concerned about reducing bias. Our research group investigates computerized analysis of undergraduate students' constructed responses in STEM. In order to increase the reliability of computer models, human-coded responses are necessary. Because it would reduce time, we tested if having the computer codes present (i.e., no blinding) and having the responses in the order of computer codes (i.e., no random assortment) would create bias in human coding. We tested four scenarios, and found that bias was greatest when computer codes were present and responses were in the order of the computer codes. Bias was lowest when computer codes were not present and responses were randomly sorted. The two other scenarios, in which either blinding or random assortment were used, contained bias that fell between the previously described scenarios. Therefore, using one of the two methods reduced bias but reduction was not as low as when both methods were employed. In conclusion, since science educators may alter their practice based on research results, we need to make sure that results are reliable so that alterations lead to improvement.

B94. Validation of an Instrument Measuring Student Complex Causal Assumptions

Michael S. Tutwiler, Harvard Graduate School of Education

Meredith Thompson, Harvard University

Tina Grotzer, Harvard University

Shari Jackson Metcalf, Harvard University

Amy M. Kamarainen, Harvard Graduate School of Education

Christopher Dede, Harvard Graduate School of Education

ABSTRACT:

In this study, we present the initial validation evidence of a survey designed to assess student complex causal assumptions. We found that student responses could be explained by a two level measurement model, with responses to the complex causal domains of action at a distance, change over time, and non-obvious causes loading on a higher order factor, but not the construct of agent-based causality. We present preliminary findings in this proposal, and will include the results of further testing of a revised instrument in the final poster.

B96. Engineering Instruction in Inclusive STEM High Schools: A Cross-case Analysis Erin E. Peters-Burton, George Mason University Todd Johnson, George Mason University *ABSTRACT:*

In an attempt to broaden participation in STEM, a new type of high school is emerging, high schools which have few or no academic admission criteria and actively involve students of all levels of ability, known as Inclusive STEM High Schools (ISHSs). The purpose of this paper is to report results of an NSF-funded systematic cross-case analysis exploring the extent of engineering learning opportunities in five exemplar inclusive STEM high schools. The results are framed by the Engineering in K-12 Education report which recommends eight different topics that should be taught to appropriately represent the field of engineering in schools: design, systems thinking, optimization, modeling, identifying constraints, analysis, communication, and engineering habits of mind. The cross case analysis was conducted by aggregating the information gathered through surveys, interviews, focus groups, classroom observations and document analysis, noting similarities and differences across schools and mechanisms for the course foci. The most prominent topics from the recommended list found at the schools were design, engineering habits of mind, and communication, while the

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least prominent were modeling, analysis, and identifying constraints. Implications include making engineering concepts and skills accessible to K-12 educators, who may not be trained in the field of engineering.

B98. Validation of the Science Motivation Questionnaire II with 9th Grade Science Students Donna M. Shapiro, SUNY Stony Brook

ABSTRACT:

The SMQ II (Science Motivation Questionnaire II) is an instrument designed to measure student motivation to learn science. Nearly all studies of the SMQ II have been examined using Classical Test Theory methods, and no studies to our knowledge have explored psychometric properties using data characterized by equal interval scales. This study aims to explore the psychometric properties of the SMQ using Rasch analysis. We ask two questions: How well do the items on the SMQ II function when analyzed in the context of the Rasch model? How reliable and valid are the inferences generated from the SMQ II questionnaire when studying 9th grade science students' motivation? In our pilot study, we administered the SMQ II to a large sample (> 100) of students. We used Winsteps v 3.68.2 to analyze the fit of items with respect to candidate ability. Rasch infit and outfit, mean square, and Z standard values were calculated to determine overall item fit and person fit relative to the Rasch model. Overall reliability for the items was 0.96, and for the persons .91. Given promising initial findings, our study will expand our sample and analytical methods to explore score inferences in greater psychometric detail.

Strand 11: Cultural, Social, and Gender Issues

Poster Session B 4:15pm – 5:15pm, Maryland Ballroom A, B, C, & D

B100. Qualitative Metasynthesis of the Intersectionality of Culturally Responsive and Reform-Based Science Education in K-12 Classrooms Michael Enah Kuo, University of Minnesota Julie C. Brown, University of Minnesota

ABSTRACT:

Abstract For students of color, success in science often comes at the expense of social, cultural, and psychological well being. While reform-based science instruction (i.e., science practices espoused in the NRC (2012) Framework) has been shown to facilitate academic performance of students of color, "inquiry-based instruction without culturally responsive pedagogy [may be] insufficient to effectively engage non-mainstream students in science learning and may even serve to challenge students' cultural ways of knowing" (Meyer & Crawford, 2011, p. 525). Though pockets of research suggest complementarity between reform-based and culturally responsive science instruction, limited evidence exists. In response, we conducted a qualitative metasynthesis of empirical literature on culturally responsive science education to examine the nature and scope of this intersection. Preliminary findings revealed multiple areas of complementarity: analyzing and interpreting data was a practice used to advance sociopolitical consciousness, draw upon students' prior experiences and knowledge, and allow for diverse perspectives to be voiced; culturally responsive instructional practices were used when engaging students in asking scientifically-oriented questions, planning and carrying out investigations, and obtaining evaluating and communicating information; and engineering practices, such as defining problems and designing solutions, were employed to empower students as change agents. Implications for future research will be shared.

B102. The Sociopolitical Turn in Science Education: A Call to Action Jean R. Aguilar-Valdez, Portland State University Jesse Bazzul, OISE, Ontario Institute for Studies in Education) Alexandra Schindel Dimick, University at Buffalo

Daniel Morales-Doyle, University of Illinois at Chicago Nicole Snook, Changemaker High School Regina Suriel, Valdosta State University Sara E. Tolbert, University of Arizona *ABSTRACT:*

This study presents several co-authors calling for a sociopolitical turn in science education research. The sociopolitical turn involves a deeper commitment to political issues, social struggles, and a politicization of science education. Though sociocultural theories are well represented within the science education research community, we hold that a sociocultural treatment does not go far enough in uncovering and naming issues of power and oppression at play in the social and political structures undergirding our understandings of the purposes and practices of science education. We advocate sociopolitical perspectives that would privilege the voices of the subaltern and highlight the politics and power dynamics that underlie systems of oppression. This study serves as a call to action to researchers and practitioners of science education to move beyond sociocultural theory and take a sociopolitical turn within science education, in order to advance social justice in science education in ways that are emancipatory, transformative and liberating. This study is intended as a starting point in the movement to bring this turn into the field by provoking dialogue amongst critical science educators. We also present methodologies, theories and research from among our co-authors that serve as examples of work that engages the sociopolitical turn.

B104. Voice of African American Women in STEM: How Did Social and Cultural Capital Impact Resiliency? Danielle Ferguson, Morgan State University

Catherine Martin-Dunlop, California State University - Long Beach *ABSTRACT:*

The purpose of this qualitative study is to identify and describe the key factors that successful African American women say influenced their persistence and resiliency in the science, technology, engineering and mathematics fields at the K-12 and post-secondary educational levels. The low number of African American women earning terminal degrees in STEM is a national issue. Using a case study approach, the following constructs in the literature, social capital, cultural capital, cultural border crossing, and resiliency, were explored. The findings provide a detailed analysis of the factors eight successful women say affected their resilience in STEM and the role social and cultural capital played in their lives. Implications for recruitment and retention of African American women are discussed.

Strand 12: Educational Technology

Poster Session B 4:15pm – 5:15pm, Maryland Ballroom A, B, C, & D

B106. Examining Flexible Thinking and Resistance to Change According To Field of Study and Technology Expertise

Miri Barak, Technion, Israel Institute of Technology Ariella Levenberg, Technion - Israel Institute of Technology *ABSTRACT:*

The goal of our study was to examine individuals' dispositional inclination to think flexibly or resist change by comparing between STEM and humanities undergraduates, their learning preference, and technology expertise. Our exploratory quantitative study was conducted among 600 undergraduate students from two higher education institutions who answered two online questionnaires: Flexible Thinking in Learning (FTL) and Resistance to Change (RTC). Findings indicated that both STEM and humanities undergraduates have a positive inclination toward open-mindedness to new experiences and use of new technologies. However, data suggests that STEM students adapt more easily to new learning situations and are less inclined to consider changes to be

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a negative experience. Findings also indicated that undergraduate, who prefer to learn in small groups, maintain higher dispositional inclination to think flexibly, compared to those who prefer to learn individually. In addition, undergraduates who are experts in the use of advanced technologies hold higher inclination to think flexibly and lower inclination to resist change compared to their peers. Our results reinforce the supposition that flexible thinking is positively associated with effective group work and expertise in advanced technologies.

B108. Highly Interactive Cloud-Classroom (HIC) Embedded into Undergraduate Chemistry Course Kaushal Kumar Bhagat, National Taiwan Normal University

Chun-Yen Chang, Science Education Center, National Taiwan Normal University **ABSTRACT:**

The aim of the present study was to examine the Highly Interactive Cloud-classroom (HIC) system, which incorporates Augmented Reality (AR) and Cloud-classroom (CCR) to teach the undergraduate chemistry course. A posttest delayed posttest quasi-experimental research design was employed. A total of 92 students (ages 19-20 years old), in a second-year undergraduate program, participated in this 18-week-long experiment, and divided into experimental group and control group. The experimental group (36 males and 10 females) was instructed utilizing HIC system, while the control group (34 males and 12 females) was led through traditional teaching methods. The 95% CIs (Confidence Intervals) were used to conduct the comparisons between the two modes of teaching. The results indicated that participants in the experimental group who used HIC system outperformed in the both posttest and delayed posttest than the control group across three learning dimensions: knowledge, comprehension, and application. Based on these results, HIC system is recommended to be incorporated in the undergraduate chemistry course.

B110. Like Us on Facebook: Students' Attitudes toward Learning Chemistry on Facebook Groups

Shelley Rap, Weizmann Institute of Science

Ron Blonder, Weizmann Institute of Science

ABSTRACT:

Facebook is the most common used Social Network Site (SNS) in the world. However, its utility for academic and learning purposes is still rather limited. Our research is related to students' attitudes towards the use of SNS as a platform for chemistry learning. The Community of Inquiry (CoI) theory suggests that the social component has a significant impact on whether the technology-integrating learning environment will be successful. We were therefore interested in understanding the extent to which students use SNSs in general and what are their attitudes toward the presence of chemistry learning in their SNS. We found that the active Facebook groups for chemistry learning have an overall contributing experience for students' learning, and promoted positive attitudes of students' toward using Facebook groups for learning chemistry.

B112. Mission HydroSci: Next Generation Science Learning Through Virtual Environments

Troy Sadler, University of Missouri James Laffey, University of Missouri Sean Goggins, University of Missouri

ABSTRACT:

Online learning has potential for addressing key challenges in science education, but the potential of technologies that might be used in online settings has rarely been realized for the purposes of science education. Our work documents design and initial testing of a new approach for delivering high quality science learning experiences to online audiences with the goal of supporting Next Generation Science Learning. Mission HydroSci (MHS) is an innovative learning technology with objectives of deeply engaging students in scientific argumentation, scaffolding their learning to argue and integrating the practices of argumentation with important ideas related to water systems. Learner experiences are facilitated through interactions within the MHS virtual environment in which they have opportunities to explore and experiment with water systems, collect evidence relative to challenging water-related problems, interact with non-player characters, and use the collected

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evidence as a basis for building and critiquing arguments. This poster session will highlight key features of the MHS design process and product including early design iterations and results, an emerging theory of change for the design of games for science learning, and ways in which learning progressions can be leveraged for game design.

B114. Research on Blended Learning in K-12 Science Education: A Systematic Review Kent J. Crippen, University of Florida Julie Bokor, University of Florida Gayle N. Evans, University of Florida ABSTRACT:

Blended learning is currently a popular term used to describe a mixture of online and face-to-face instruction that involves student-centered learning and a combination of teaching methods. However, the empirical basis supporting this method is unclear, particularly in the context of K-12 science education. This study involved a systematic review of 90 papers from science education research journals (2000-2014) that met very specific inclusion criteria. Our research questions focused on the demographic, methodological and topological trends in these papers. An analytic framework was created based upon reviews on this topic in other domains. The findings suggest that the existing research is primarily focused on activities at the secondary level where students only have control over the path of learning in a rotation model of blended learning. Assessing student learning from a specific form of activity or instructional method that often involved scaffolding and a visualization was common. Student beliefs and behaviors were often explored as mediating or predicting variables, as was the form of argument as an outcome. Non-cognitive factors, the relationship among factors, learning effects for traditionally underrepresented students and institutional characteristics are needed areas for future research.

B116. On the Same Wavelength: Exploring Team Neurosynchrony during Technology-Enhanced Collaborative Learning

Pavlo D. Antonenko, University of Florida *ABSTRACT:*

The purpose of this study was to explore the efficacy of a neuroimaging based cognitive assessment paradigm – event-related desynchronization of alpha brain waves – for the study of individual and team neurodynamics in the context of an authentic collaborative problem-solving task supported with technology. In this study, individual and team neurodynamics data was derived from both alpha power spectral density values and from Area Under the Curve computations and aligned with (and helped explain) the results of learning performance data. While our results are tentative and far from being conclusive, this study demonstrates that even-related desynchronization of alpha power has the potential to serve as a useful measure for understanding individual students' neurodynamics as well as team neurodynamics during collaborative learning tasks. This measure of cognitive dynamics complements existing frameworks that assess cognition using self-reported data, secondary task procedures, and other psychophysiological measures like pupil dilation and gaze fixations.

B118. Pre-service Teachers' Understanding of Design Technology through Ecofriendly Birdhouse Design Challenge in a STEM Integrated Learning Context

Young Ae Kim, Department of Mathematics & Science Education, University of Georgia Deborah J. Tippins, The University of Georgia

ABSTRACT:

The purpose of this case study is to analyze elementary pre-service teachers' understanding of modeling practices in STEM contexts through designing an ecofriendly birdhouse activity. This study was conducted with two groups of four elementary pre-service teachers enrolled in a required science methods course. In the "Ecofriendly birdhouse design task", participants were provided with a set of consumable materials and were challenged to design a birdhouse that was water resistant, wind resistant, heat insulated, and could hold two

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golf-ball size birds. Audio- and video-recordings, pre-survey, post-reflections, a focus group discussion with all participants, and paired interviews were conducted. Several findings were suggested in this study. Elementary pre-service teachers drew from diverse interdisciplinary knowledge and their modeling process was culturally and socially driven. Also, pre-service teachers understand that modeling practices in design approaches foster students' engagement, creativity, and collaboration. Furthermore, through ecofriendly birdhouse design challenge, pre-service teachers' knowledge of modeling was enhanced and most pre-service teachers see the possibility of using design technology in the classrooms. This paper highlights how the modeling practices can be connected with STEM integrated approaches in science curriculum. In addition, modeling practices and modeling-oriented assessment (MOA) enable more extensive STEM education in science classrooms.

Strand 13: History, Philosophy, and Sociology of Science

Poster Session B

4:15pm – 5:15pm, Maryland Ballroom A, B, C, & D B120. Controversy Mapping for Studying Socioscientific Issues: Case Study of a Local Problem Naira C. Diaz Moreno, University of Almeria M[™]Rut JimÈnez-Liso, University of AlmmerÌa ABSTRACT:

The presentation in the press of news on social dilemmas related to science with different opinions, SSIs, makes them a starting point and a driver of learning for science literacy throughout the population. Such news can be used in the science classroom to show the students different points of view on these subjects on the frontier of science and their social repercussions. In this paper, we attempt to fill the gap existing in how a subject is identified as an SSI, and present the use of "Controversy Mapping" as a specific methodology for studying and finding SSI indicators, applying it to a concrete local topic: the case of water in Almeria (Spain). The use of this mapping enables us to study the SSIs that appear in the news in depth, and after analyzing the links among the actor networks, types of event and socioscientific trends also in the news, find two new SSI indicators generalizable to other issues, and therefore, a good tool for the science classroom.

Strand 14: Environmental Education

Poster Session B

4:15pm - 5:15pm, Maryland Ballroom A, B, C, & D

B122. Pre-Service Elementary School Teacher Learning of Common Ancestry Through Exploration of Local Tree Diversity

Yael Wyner, City College of New York Jennifer Doherty, University of Washington

ABSTRACT:

Noticing local trees and contextualizing them in their evolutionary history is a content area lacking for elementary school teachers. Developing these skills is a key approach for bringing NGSS practices, cross cutting concepts, and life science disciplinary core ideas into elementary school classrooms. This poster describes the impact of an introductory life science course on pre-service elementary school teachers. Course goals were 1) To transition participants from being everyday observers of biodiversity to acting as scientific observers 2) For participants to use their newfound practices to frame the trees they see daily in the patterns of evolutionary history. Findings show that exposure to local trees through coursework improves pre-service teachers ability to observe trees scientifically, providing them with the tools to identify and group trees by relatedness and for helping them understand the evolutionary meaning of relatedness. The inability of preservice teachers to identify even basic differences between trees prior to this course demonstrates the need for developing scientific biodiversity observation skills and an understanding of evolutionary history in pre-service

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elementary school teachers. Pre-service teacher responses indicate that coursework exposure to trees is enough to help them notice, and care about noticing, the trees they see daily.

B124. Role of Renewable Energy and Environmental Political Policies in Introductory Undergraduate Science Education

Rachel Yoho, Arizona State University Binaben H. Vanmali, Arizona State University *ABSTRACT:*

Similar to other perceived controversial topics in the sciences, the teaching of climate change and renewable energy technologies may present a challenge in the classroom because of the influence of mainstream and alternative media on students and teachers alike. Informed civic participation requires a strong understanding of climate change and the motivation to develop renewable energy technologies. However, this understanding relies on a broader knowledge of several science disciplines. We seek to understand better the presentation of the role of national (U.S.) and international policies and politics with respect to climate change, energy technologies, and related environmental factors in undergraduate education. Interviews conducted with undergraduate instructors across the science disciplines alongside analyses of introductory-level textbooks in biology, chemistry, and physics provide new insights on the complex interactions of environment, politics, and education. This paper discusses themes arising from the interviews and textbook analysis data. Findings from this study offer perspectives on the presentation of renewable energy technologies and climate change in textbooks as well as present common situations and responses of introductory-level instructors.

B126. Self-Determination Theory as a Lens for Promoting Scientific Identity and Retention: A Pilot Study Andrew L. McDevitt, Illinois State University

Rebekka Darner Gougis, Illinois State University

ABSTRACT:

Use of self-determination theory (SDT) within the science classroom focuses primarily on ways to integrate intrinsic motivation into students' identity. Experiential learning plays a large role in promoting learning by shaping students' interests, identity and intrinsic aspirations. This phenomenological research study sought to understand how experiential learning experiences helped influence career aspirations of graduate students within ecological disciplines. By determining how their experiences met three basic psychological needs outlined by SDT (competence, autonomy, and relatedness), we were able to examine which regulators drove motivation. Participants developed a genuine enjoyment and appreciation for their discipline as they began engaging in more complicated research. As interest grew, so did levels of competence and autonomy. Students were able to apply their experiences in novel ways which enabled them to see the connectivity of their discipline and develop internal aspirations for science. In addition to aspirations supported by experiential learning opportunities, mentorship, family/cultural support, and the desire for a work-life balance further shaped their career aspirations and satisfied the basic need for relatedness. This boost of confidence and sense of belonging helped participants shed doubts and other external pressures that allowed students to believe they could not achieve or do not belong in science.

B128. Technology-mediated Engagement with Nature: Design Guidelines for Self-guiding, Outdoor-based Mobile Learning Programs

Lucy R. McClain, Penn State University

Heather Toomey Zimmerman, Penn State University

ABSTRACT:

In this study, we present design guidelines for mobile computer integration into outdoor informal programs to support science learning and engagement with nature. We describe the implementation of a self-guiding mobile learning tool—an "e-trailguide"—designed to support family engagement with the natural world along one nature trail at an environmental center. We present data from a qualitative-based case study to investigate one

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family's learning and engagement with trees during their walk on the nature trail with the e-trailguide. Analyses focused on two types of engagement between the learners and the natural world that were facilitated by the etrailguide: observation and pointing. Using these two nature-technology-social engagement patterns, we assess the effectiveness of the design of the e-trailguide in promoting learner engagement with nature. Through our analysis, we developed four design guidelines for mobile computer integration into outdoor informal programs to support science learning: (1) place-based observational questions, (2) place-based textual prompts for focusing observations, (3) drawing activities to record observations, and (4) place-based images used to identify biota in the outdoors. This work provides guidance with regards to how environmental centers and parks can utilize and design mobile programs to engage visitors with nature on an informal, everyday basis.

B130. The Awareness of Middle School Students and Pre-service Teachers on Climate Change Hyoungbum Kim, Chungbuk National University Sophia (Sun Kyung) Jeong, University of Georgia

ABSTRACT:

With the growing attention in climate change, science education programs, which focuses on developing an understanding of the scientific concept, related to climate change is necessary. This study investigated the perception of middle school students and pre-service teachers on climate change. 38 pre-service teachers and 65 grade seven students in Korea were surveyed on their level of understanding and knowledge, models of explanation and their main sources of information about the topics of climate change. The two groups showed a similar pattern in their understanding of the phenomenon of the greenhouse effect. Particularly, both groups showed significantly low level of understanding of greenhouse gases related scientific concepts as well as the definitions of the greenhouse effect. Therefore, this paper suggests that in order to enhance students' scientific engagement in this topic, one should focus on building a stronger program for pre-service teachers, which may include developing college curricula and learning activities that focus on the topics of earth systems.

Strand 15: Policy

Poster Session B

4:15pm – 5:15pm, Maryland Ballroom A, B, C, & D

B132. Relationship of Teachers' Collaboration, Teaching Confidence, and Approaches with Student Science Performance

Su Gao, University of Central Florida Jian Wang, Texas Tech University Dan Li, Iowa State University

ABSTRACT:

Two assumptions have shaped important science education reforms over the two past decades. However, these assumptions have not been carefully verified for empirical support. The first assumption is that collaboration by teachers leads to increased confidence in teaching. The second assumption is that teaching practices are the major influence on their students' science achievement and the approaches that actively engage students in scientific processes help students learn science more effectively. Using structural equational modeling (SEM) and TIMSS 2011 data from eighth-grade classes in Korea and the U.S., this study examines the above assumptions. It revealed that teacher collaboration is not associated with confidence in teaching and its relationship with science teaching approaches is not consistent between the two countries. Further, none of the science teaching approaches predicts student science performance in the data sets. Policy implications are discussed and future research questions are proposed based on these findings.

Concurrent Session #7 8:30am – 10:00pm

Presidential Sponsored Session

Where Should Science Education Be with Respect to the Conversations and Cultural Unrest in Our Academies?
8:30am - 10:00am, Maryland Salon E
Presider: Mary M. Atwater, University of Georgia
Presenters:
Mary M. Atwater, University of Georgia
Malcolm B. Butler, University of Central Florida
Alejandro Martinez Gallard, Georgia Southern University
Leslie S. Jones, Valdosta State University
Peter Okebukola, Crawford University
Elizabeth Mavhunga, University of Witwatersrand
Silva Lizette Ramos de Robles, University of Guadalajar

Strand 1: Science Learning, Understanding and Conceptual Change

Understanding Students Explanations 8:30am - 10:00am, Maryland Salon F **Presider:** Mei-Hung Chiu, National Taiwan Normal University

Assisting Students in Developing Useable Knowledge Structures by Building a Scientific Explanation Over Time

Ann M. Novak, Greenhills School *ABSTRACT:*

This study focuses on the development of students' useable knowledge as they construct four iterations of an explanation across time. The study teases apart students' claim, evidence and reasoning for each iteration then synthesizes them as a whole as learners collect and analyze additional evidence. It investigates the change in level of sophistication of students' science ideas across time, students' use of science ideas to think about and explain evidence over time, and if and how students adjust their claims over time, as new and sometimes contradictory evidence is obtained when investigating a complex phenomenon, the water quality of a local stream. This paper examines: Does an evolving explanation assist students toward developing useable knowledge? The presentation will examine various patterns of student knowledge development over the course of four iterations of the evolving explanation. Results indicate statistically significant differences of both students' science ideas to evidence. Results indicate no statistical significance for science ideas or connections to science ideas as predictive of claims that students made. Challenges arose when students needed to adjust claims when confronted with new evidence.

Evidence Construction: The Constructive Process of Collecting and Interpreting Scientific Evidence and Associated Learning Processes Lauren Barth-Cohen, University of Miami Jonathan Shemwell, University of Maine Daniel K. Capps, University of Maine ABSTRACT: Although the importance of scientific evidence cannot be overstated, research on scientific explanations and arguments has tended to downplay the process by which evidence is generated from observations. Observations of scientific phenomena are key to the inquiry process, but can involve significant challenges. We collected data from a geology professional development workshop for middle school earth science teachers who made observations in the field in order to construct evidence for the relative ages of rocks. Qualitative data analysis of audio records illustrate how the teacher's process of "collecting" evidence through observations can be a more or less constructive process. From contrasting cases, we show that the more constructive process involved successive refinement and clarification of what was observed, while the less constructive process involved an instantaneous recognition process. These processes were influenced by the learners' familiarity with the phenomenon, and in some cases the process of "collecting" evidence, or evidence construction, occurred as a result of contrasts which spurred perceptual differentiation. This kind of evidence construction may yield a form of knowledge that can influence future observations. Furthermore, this knowledge building process is potentially a new type of learning associated with the use of scientific evidence in open-ended inquiry settings.

Making Sense of Student Sense Making in Oral Presentations of Independent Research Projects

Michele Koomen, Gustavus Adolphus College Jonathan Andicoechea, University of Minnesota Gillian Roehrig, University of Minnesota Sarah Weaver, University of Minnesota Narmin Ghalichi, University of Minnesota *ABSTRACT:*

This paper addresses 3 problems/gaps in science education: lack of higher sense making skills in the practice of science a focus on scientific explanations that are oral rather than written, and science fairs as a venue for studying how students develop explanations. In December 2014, we piloted an analytic rubric to assess 18 middle school student practices of science and development of scientific explanation within the framework of regional science fair presentations of independent research projects. Our qualitative (student interviews) and quantitative (rubric scores) analysis revealed that the oral delivery of independent research projects displayed many of the components of our operationalized model of scientific practice, including claims and reasoning of the explanation framework (McNeil & Krajcik, 2012). Linking claims and reasoning back to the broader field and or literature, providing evidence of quantitative or numeric reasoning to support their claims and developing

rebuttals are areas that need greater attention. Our preliminary work suggests the need for greater emphasis in independent research work by students in quantitative reasoning, discussion of explanations and rebuttals.

Thinking Frames Approach: Improving Conceptual Understanding in Thermal Physics Through Student-Generated Diagrams and Explanations Felicity McLure, Curtin University Mihye Won, Curtin University David F. Treagust, Curtin University ABSTRACT:

Constructivist teaching strategies are extensively discussed by educational researchers, but they are inconsistently implemented in school science. The Thinking Frame Approach (TFA) (Newberry & Gilbert, 2011) explicitly encourages students to develop their scientific ideas by producing their own diagrams as well as verbal and written explanations to support conceptual understanding through communication. As a Grade 9 Science teacher, the first author developed a sequence of lessons on the topic of thermal physics based on the TFA, and investigated its impact on students' conceptual understanding and written explanations. Common alternative conceptions about this topic (Clough & Driver, 1985; Lewis, 1994) were challenged through demonstrations, questioning and small group discussions, and students were encouraged to develop scientific explanations through verbal, pictorial and textual representations. Thermal Concept Evaluation (Yeo & Zadnik,

2001) results indicated that students had successfully developed relatively sophisticated scientific understanding on the topic. Conceptual gains in the areas of boiling, heat conductivity, and equilibrium persisted over a sixmonth period as evidenced by delayed post-test results. Written explanations collected over the period of teaching revealed a marked improvement in expressing concepts coherently using scientific vocabulary.

Strand 2: Science Learning: Contexts, Characteristics and Interactions

Motivation, Self-Efficacy and STEM Achievement 8:30am - 10:00am, Maryland Salon A **Presider:** Zahra Hazari, Florida International University

The Affective Side of Interactive Learning: Exploring a Drop in Students' Self-Efficacy

Remy Dou, Florida International University Eric Brewe, Florida International University Justyna Zwolak, Florida International University Geoff Potvin, Florida International University Eric A. Williams, Florida International University Laird Kramer, Florida International University *ABSTRACT:*

The modeling instruction (MI) approach to introductory physics manifests significant gains in student attitudes and conceptual understanding. In light of these findings, we looked at changes in student self-efficacy, considering the construct's powerful role in contributing to individuals' career-decision making process. Students in the Fall 2014 MI course at a public, research university exhibited a significant decrease in total self-efficacy as measured by the Sources of Self-Efficacy in Science Courses – Physics survey. This decrease was also seen on the "verbal persuasion" sub-section of the survey, and took place regardless of student gender, incoming GPA, declared major, or student ethnicity. Given the highly interactive nature of the MI course and the specific drop on the verbal persuasion section of the survey, we suspect that the social nature of the classroom is associated with changes in students' efficacy beliefs. Further exploration of the social fabric of the

classroom may help unravel the mechanisms related to these shifts.

Achievement and Self-Efficacy in Science: An Exploration of Student and Teacher Beliefs in Turkey

Dekant Kiran, Middle East Technical University

Ellen L. Usher, University of Kentucky

ABSTRACT:

The purpose of this study was to investigate the relationships among students' science achievement, science self-efficacy, and their teachers' teaching self-efficacy by using hierarchical data. Participants were 3,286 Turkish seventh grade students and their science teachers (N = 125). Data were collected from a large city in middle Anatolia region of Turkey. Descriptive statistics revealed that students have high science self-efficacy and their achievement is slightly above the national average. Science teachers reported high science teaching self-efficacy. A two-level hierarchical linear modeling analysis was conducted to analyze the nested data. The null model indicated that average science achievement varied across classrooms. Further modeling indicated that students possessing high levels of science self-efficacy are more successful in science than their low self-efficacy counterparts. However, science teachers' self-efficacy was not significantly correlated with science achievement. It was concluded that student self-efficacy in science could be taken into consideration to increase science achievement and that further research is required to examine the relationship between science teacher self-efficacy and science achievement.

Taiwanese Adolescents' Motivational Beliefs and Science Achievement: Evidence of TIMSS 2011

Cheng-Lung Wang, National Central University Pey-Yan Liou, National Central University *ABSTRACT:*

This study aims to examine the pattern of motivational beliefs in learning science and science achievement for Taiwanese eighth-grade students using the TIMSS 2011 dataset. According to the expectancy-value theory developed by Eccle, Wigfield, and their colleagues, motivational beliefs including self-concept, intrinsic value, and extrinsic value were the target constructs to be examined. The results show that the motivational beliefs highly correlate with each other, and each of them has a medium correlation with science achievement along with a similar correlation coefficient. Moreover, self-concept is the most predictive variable for science achievement, followed by extrinsic value and intrinsic value. In line with previous studies, this study, based on the representative Taiwanese sample, contributes to the discussion regarding national variation in students' motivational beliefs.

Effect of the Context-Based Physics Instruction on Achievement of Students with Different Motivation in Physics Haki Pesman, Firat University

ABSTRACT:

When a contemporary teaching method is implemented or tested, it is assumed that all the individuals in a classroom are influenced similarly. However, like the fingers of a hand with differing sizes, students in any classroom have differing traits and there is sometimes evidence that all students in a classroom do not benefit from a treatment in the same way (heterogeneity of regression slopes). In this study, the interaction of students' motivation in physics with the implemented teaching approaches (contextual vs. non-contextual approaches) is investigated by means of the Johnson-Neyman technique. The data come from 194 11th grade science major students who experienced contextual and non-contextual physics instructions in "impulse and momentum". In the contextual approach groups, the impulse and momentum concepts were studied in the context of safety precautions in cars. The Affective Characteristics Questionnaire (ACQ) was administered prior to the implementation of the treatments while the Impulse and Momentum Achievement Test (IMAT) was administered just after the implementations. The Johnson-Neyman technique revealed that the contextual physics instruction is more effective for the students who have high level of motivation in physics while the non-contextual one is more effective for the students who allow level of motivation.

Who Becomes an Engineer? Students` Concepts about Engineers` Work and Its Relation to Career Aspirations Carolin Frank, Leibniz-Institut

Manuela Niethammer, University of Technology Dresden

ABSTRACT:

To foster interest in engineering-related careers an effective approach for shaping job-oriented teaching and learning processes in science lessons is necessary. As precondition empirical evi-dence regarding the characteristics of students which have an influence on their career aspirations is needed. It is well known that interest and performance related variables like self-concept and achievement scores are important for the development of career aspirations. Although vocational choice theories state that the knowledge about a profession has an impact on vocational choice, there is almost no empirical evidence. The aim of the presented project is to describe students` concepts about the work of engineers and to investigate if the concept is related to engineering-related career aspirations. The concept about the work of engineers, interest in engineering, science and engineering self-concept and achievement scores in science and mathematics were sur-veyed with a questionnaire. This instrument was administered to a sample of N=434 10th-grade and 11th-grade students. The findings suggest that certain aspects of the concept about engineers work are related to science career aspiration in addition to interest and performance variables.

Strand 4: Science Teaching--Middle and High School, Grades 5-12): Characteristics and Strategies *Teacher Beliefs and Knowledge*

8:30am - 10:00am, Watertable Salon A **Presider:** Patrick S. Smith, Horizon Research, Inc.

How Science Teachers Responded to Ebola: A National Study of Teacher Instructional Decision Making Patrick S. Smith, Horizon Research, Inc. Keith Esch, Horizon Research Inc. Joan Pasley, Horizon Research, Inc.

ABSTRACT:

This paper reports findings from a study of teacher decision making in a particular context. Specifically, it explores how high school life science teachers decided whether to address the topic of Ebola in their instruction during the 2014-15 school year, when the Ebola outbreak in West Africa was at its peak. The study was situated within a decision-making framework from social psychology: the Theory of Planned Behavior. Researchers recruited over 3,400 K-12 U.S. science teachers for the study, 70 percent of whom ultimately completed the study questionnaire. Questionnaire results were complemented by in-depth interviews with 20 teachers. The analysis for this paper is limited to responses from high school life science teachers (N=997), 89 percent of whom discussed Ebola in at least one of their classes. In comparing the decisions of those who taught about Ebola and those who did not, the study found that teachers weighed various factors quite differently, including curriculum standards, state-administered tests, student interest, and availability of resources for teaching about Ebola. The paper explores implications of the findings for future urgent health-related issues that arise.

Citizen Science Survey of Science Teachers in New England – Practices and Possibilities Maria R. Blewitt, University of Massachusetts Lowell David Lustick, University of Massachusetts Lowell ABSTRACT:

Citizen Science projects (CS) represent an emerging option that secondary science teachers can use to engage diverse learners with authentic inquiry. CS projects originated as informal science learning programs; however, they are now an accessible, cost effective, and community based means of addressing relevant standards based learning experiences in formal classroom settings. To what extent do science teachers know about Citizen Science programs? What types of CS programs do teachers currently use? Using a number of state and region science teacher associations as our data source, we sent out the Survey for Pedagogical Use of Citizen Science to science teachers in New England to determine the extent to which teachers knew about CS programs and utilized aspects of CS in their classrooms. Approximately two thirds of the teachers surveyed (n=260) had heard the term "citizen science" while approximately one third of the teachers surveyed actually participated in a verifiable CS project. Results also indicate that some aspects of CS were more popular than others. Our findings suggest that there is great potential for science teachers to leverage efficient and democratic CS opportunities in their classrooms.

A Matter of Content: Investigating Biology Teachers' Understanding of Socioscientific Issues Jan Alexis Nielsen, University of Copenhagen Sofie Tidemand, University of Copenhagen ABSTRACT:

This paper investigates Danish upper secondary biology teachers' understandings and implementations of socioscientific issues in biology teaching and assessment. We conducted group interviews with 11 biology teachers. On the basis of the talk-in-interaction in the interviews, we designed a questionnaire with open questions to which 100 Danish biology teachers responded. We found that the teachers generally entertained a

content-centered understanding of socioscientific issues, according to which biological content has primacy over the societal contextualization of a given issue. Further, we found that when teachers assess students in relation to socioscientific issues, they focus their assessment on students' ability to invoke biological subject specific content knowledge. We argue that the beliefs and understandings that we identified may undermine the very rationale of introducing socioscientific issues in science teaching. On the basis of our findings, we suggest strategies to support teachers in viably implementing socioscientific issues in their teaching.

Exploring Science Teachers' Content Knowledge and Positioning of Evolutionary Theory Through Classroom Discourse

Margaret M. Lucero, Santa Clara University

ABSTRACT:

Teachers are encouraged to consistently conduct scientific discourse with their students during instruction, but can be made more challenging because of certain topics' controversial nature. Teachers' positioning of these topics during whole-class discourse can have an impact on how students think of these topics. Therefore, it is essential to investigate how teachers use language to approach positioning of a science topic (i.e., evolution) and if this positioning is related to their content knowledge. Drawing from a framework that analyzes discourse within five different components (i.e., focus, orientation, social structure, mood, and participatory nature), the current study offers a detailed description of the language used by a group of science teachers during an instructional unit on evolution in order to determine how their oral practices position evolution and if this positioning is related to their content knowledge as measured by a concept inventory. Most teachers exhibited relatively good to satisfactory content knowledge and video-based analyses indicated half of these teachers characterized evolution as a fact-based concept with no exploration of student perspectives; whereas other teachers adopted an position where student views were freely discussed. Such findings reveal the nuances with teachers' language use and suggest potential avenues for future inquiry.

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

Laboratory Innovations

8:30am - 10:00am, Maryland Salon B **Presider:** Stephen B. Witzig, University of Massachusetts Dartmouth

Wrapping-Up Laboratory Investigations in Undergraduate Biology Courses Kirby Whittington, Florida State University Shannon Gooden, Florida State University Sherry A. Southerland, Florida State University ABSTRACT:

With the large amount of information to be covered within short amounts of time in the context of undergraduate laboratory courses, students rarely have opportunities to cognitively interact with multiple concepts through social interaction after an experiment is complete. This time, known as the wrap-up, is important for the connection between the experiment just completed and previously learned biological concepts. This research takes a nuanced look at how nine University Teaching Assistants [TAs] wrap-up the same biology experiment. Through the use of the SWOP instrument, we looked at the discussion moves of each biology TA and how these moves fostered or denied students the opportunities to interact with current and past scientific ideas to develop a deeper understanding of biological concepts. Our findings suggest that TA's often do not press students for elaboration and instead offer elaboration of content after students have answered simple recall questions. Further, we see that across TA videos, none pressed for justification or sequenced student contributions. The lack of discussion moves that foster student participation in knowledge construction provide

evidence that TA training programs and professional development these areas of pedagogical knowledge needing to be added or extended upon.

Team Learning in a Computer Science Flipped Classroom: Undergraduates' Problem Solving, Conceptual, and Declared Knowledge Yehudit Judy Dori, MIT & Technion Zehavit Kohen, Technion

Albert Meyer, MIT **ABSTRACT:**

The flipped classroom is an active learning approach in which students individually watch lecture videos and read online materials for preparing to class. During the scheduled class meeting times, they solve problems in teams. In our flipped undergraduate Mathematics for Computer Science course, we incorporated an optional team project in probability, a main topic in the course. The research aimed to investigate whether there is a difference in students' learning outcomes in a flipped classroom in general and in the probability topic in particular between students who volunteered to take part in the probability project and those who did not. The study included 225 undergraduates, 82 of whom volunteered to carry out the project in probability. Research tools included pre- and post-course questionnaires that examined students' (a) problem solving skill, (b) conceptual knowledge, and (c) declared knowledge. Our findings indicate that the participation in the probability project had a positive and significant effect on students' conceptual knowledge in probability and a positive but not significant on these students declared knowledge. The improvement grows along with the student's academic level. The high achievers gain the most because they had to explain the subject matter to their lower academic level peers.

Investigating the Role of Reflexive Practices in a Science Laboratory Course

Kristy L. Daniel, Texas State University

Chandrani Mishra, The University of Southern Mississippi

Kari L. Clase, Purdue University

ABSTRACT:

Emphasis on professional practices to develop students' professionalism is currently a major focus in higher education. Reflexive practices has been found to facilitate development of students' professional identity in some fields. Lack of investigation about the benefits of reflexive practices on the development of students' scientific identity led to this study. Development of a scientific identity and students' overall interests and motivation in science is deemed essential for retaining students in STEM fields. This mixed methods study investigates the impact of reflexive practices on the development of students' scientific identity, interests and motivation in a college science laboratory course. We collected data from 86 students in three institutions each featuring a different learning environment which are authentic with reflexive practices, authentic without reflexive practices, and traditional with reflexive practices. Students in reflexive settings responded to weekly reflection prompts throughout the semester. Our data suggest that engaging students in reflexive practices in an authentic learning environment is crucial for the development of their scientific identity, interests, and motivation. This study adds to the existing literature by providing a rationale for science practitioners to incorporate such practices in their courses for the professional development of students and their retention in STEM fields.

Students' Expectations of Collaborative Learning: Case Studies From an Undergraduate Life Sciences Living-Learning Program

Hannah Jardine, University of Maryland, College Park Daniel M. Levin, University of Maryland, College Park

Byrn B. Quimby, University of Maryland, College Park Todd J. Cooke, University of Maryland, College Park *ABSTRACT:*

In response to recent reports addressing undergraduate education reform, a large mid-Atlantic university established a life sciences living-learning program to implement transformed undergraduate life sciences education within the context of a living community. This paper takes a closer look at how two female students participate in collaborative learning as encouraged by the program and how different collaborative learning expectations influence how they participate. There is an assumption, and emerging evidence, that collaborative learning opportunities can be productive for undergraduate science learning, particularly for female and minority students. Life sciences education researchers have also explored the influences of student expectations on their participation in transformed undergraduate courses in the life sciences. However, there is little research on the relationship between student expectations for their learning and their participation in collaborative learning program. Our case studies suggest that students may have different expectations for what it is they think they should be doing in order to learn science collaboratively. Better understanding the diversity of students' collaborative learning expectations will help undergraduate educators think about how to structure collaborative learning opportunities to promote productive collaborative learning.

Strand 6: Science Learning in Informal Contexts

Related Paper Set - Understanding the Implementation and Outcomes of School and Regional Science Fairs 8:30am - 10:00am, Federal Hill

Presider: Jacqueline DeLisi, Education Development Center, Inc

ABSTRACT:

Science Fairs (SFs) represent a widely implemented, yet under-studied phenomena present in schools, districts, and regions across the US. Supporters claim that through engaging students in authentic science projects and presenting them to others, they provide a means of increasing students' interest in and engagement with STEM and their understandings of science and engineering practices. Further, SFs represent a high-value binge between formal classroom instruction and the support students might receive in out of school time programs and resources offered by SFs. Yet little research has been conducted to understand their implementation or relationships to intended student outcomes. This related paper set will describe the variation in implementation of SFs, including their reach, resources, and partnerships; and the potential student outcomes, including student participants' performance on standardized assessments, understandings of the nature of science, and their use of science practices. The results have implications for the ways in which science and SEPs are taught in informal contexts, and the connections to the formal classroom.

Models of School-Based Science Fairs

Abigail Jurist Levy, Education Development Center, Inc. Janna Kook, Education Development Center, Inc Erica T. Fields, Education Development Center, Inc. Tracy McMahon, Education Development Center, Inc Jacqueline DeLisi, Education Development Center, Inc Marian Pasquale, Education Development Center Inc. Leana Nordstrom,

Relationship Between School Participation in Regional Science Fairs and Science Test Scores for That School Richard D. Lahti, Minnesota State University Moorhead

Nature of Science Views Held by Science Fair Coaches and their Students Julie Angle, Oklahoma State University

Assessing Practice of Science in High School Science Fair Frederick Grinnell, University of Texas Simon Dalley, Southern Methodist University Karen Sheperd

Strand 7: Pre-service Science Teacher Education Preservice Elementary Teacher Learning and Identity Development 8:30am - 10:00am, Fells Point Presider: Heidi Masters, University of Wisconsin - La Crosse

A Longitudinal Study of Preservice Elementary Teacher Preparation in Science Chris Ohana, Western Washington University Daniel Hanley, Western Washington University Matthew Miller, Western Washington University ABSTRACT:

In this paper, we summarize two major components of an NSF-funded DRK12 research project. We briefly discuss the research upon which the program is built and two major changes we made in response to the research. We developed a series of science content courses that model effective science teaching and a deep understanding of the science elementary teachers will teach. In addition, we revised our elementary science methods course to focus on recent research in effective science teaching. We present evidence about the impact of these changes on preservice teacher preparation, attitudes and performance. Our data, a mix of quantitative and qualitative, suggest that students in a reformed sequence of science content and methods significantly improve their beliefs, attitudes and skills in teaching elementary science when compared to a comparable set of students in a more traditional program.

Elementary Pre-Service Teachers' Preparedness for Next Generation Science Standards Diane Silva Pimentel, University of New Hampshire ABSTRACT:

The Next Generation Science Standards pose new challenges for elementary teacher preparation. This study investigates pre-service elementary teachers' needs and perspectives related to teaching standards-based science in the elementary classroom. The participants (N=61) in this study were pre-service elementary teachers in their junior, senior, or graduate year enrolled in the elementary science methods course during 2015-2016. This paper focuses primarily on student responses related to the background information they provided about their experiences in learning science and their course history as well as their responses to a questionnaire asking them to rate their comfort level with each of Next Generation Science Standards for elementary grades (K-5). The preparation of pre-service elementary science teachers to teach concepts in the various science disciplines varies greatly by discipline and by teacher. Pre-service teachers seem most confident to teach topics associated with life science, but have had limited preparation in physical, earth, and space sciences beyond high school. This is especially true for grades 3-5 standards. Furthermore, specific elements of the science practices that are meant to be integrated with the science concepts may pose additional challenges for pre-service teachers.

Change of Pre-Service Elementary Teachers' Attention and Pedagogical Reasoning Through Collaborative Video-Based Reflection

Hye Gyoung Yoon, Chuncheon National University of Education

Youngjin Song, University of Northern Colorado *ABSTRACT:*

The study investigated pre-service elementary teachers' attention and pedagogical reasoning change as they go through video-based reflection. Specifically, we compared two reflection cycles before and after pre-service elementary teachers went through the collaborative video-based reflection process in a professional learning community. The primary data were collected from eight pre-service elementary teachers and included their science lesson plans, videotaped lessons, video-reflection papers, and the transcripts from the interviews. Pre-service elementary teachers' attention was categorized in five aspects: student, instruction, subject content knowledge, assessment and classroom management. The level of their pedagogical reasoning about student learning was determined based on evidence level, evidence area and evidence type. The findings reveal that 1) individual reflection is not enough – collaborative reflection is essential to change their attention toward students learning and thinking, 2) pedagogical reasoning levels increase gradually throughout the individual and collaborative video-based reflection processes. The participants not only attributed student learning solely to the characteristics of students but also connected it with their own instruction or science content knowledge and used different types of evidence as they went through two reflection cycles. The analytical framework and findings of this study will be of interest for elementary science teacher educators.

Exploring Pre-Service Science Teachers' Conceptual Understanding of Particulate Nature of Matter Through Ordered Multiple Choice Assessments

Mehmet Aydeniz, The University of Tennessee Kader Bilican, Ataturk University Zubeyde D. Kirbulut, Harran University *ABSTRACT:*

The purpose of this study was to measure the stability of pre-service elementary science teachers' cognitive structure related to particulate nature of matter through Ordered Multiple Choice (OMC) assessments. The participants consisted of 215 pre-service elementary science teachers: 165 female and 50 male, enrolled in four different state universities in Turkey. Data consist of students' responses to the Particulate Nature of Matter assessment (PNM). Results show that students struggled to provide a coherent conceptual understanding across three question tiers. When participants were challenged to justify their answers in Tier 2, even those who performed well on Tier I failed to show the same performance. The percent of students who answered Q1 correctly dropped from 90.2% to 23.3% at Tier 2, from 81.4% to 13.5% for Q5. Furthermore, only 19.1% of the participants felt confident at level 5 or above about their answers to Q1 and 9.5% about their answers to Q5. These results question the adequacy of multiple-choice assessments for measuring students' conceptual understanding and calls for more frequent use of OMC assessments for formative and summative purposes.

Countering Microaggressions in the Science Methods Courses: Perspectives From Teacher Educators of Color Karthigeyan Subramaniam, University of North Texas Sumreen Asim, University of North Texas Eun Young Lee, University of North Texas Kia Rideaux, University of North Texas

ABSTRACT:

The study contributes to the limited knowledge base on how science teacher educators of color conceptualize and operationalize their pedagogy in elementary science methods courses. This study thus explored the perspectives of four science teacher educators of color in an effort to capture how their teacher educating perspectives shaped their pedagogy of teacher education. The research question was: "How do science teacher educators of color conceptualize and operationalize their pedagogy in elementary science methods courses?" The resulting complex constructions of how teacher educators of color conceptualize and operationalize their teaching spaces provides insights into the ongoing processes of changes in identities experienced in response to the personal, contextual, pedagogical, sociological, and social domains within the process of teacher educating.

Strand 8: In-service Science Teacher Education

Related Paper Set - Online Video-Based Lesson Analysis Professional Development for High School Science Teachers 8:30am - 10:00am, James Discussants:

Kathleen Roth, Cal Poly Pomona Foundation

ABSTRACT:

The online professional development (PD) course we describe is advancing knowledge in the field of teacher PD by merging two facets of PD that have hitherto been studied separately and testing hypotheses about the degree to which this pairing enhances learning and practice. These facets are structured constructivist experiences (enacted by the 5E Instructional Model) and experiences grounded in situated cognition learning theory (enacted by video-based lesson analysis process). Teachers reflect on research-based teaching strategies in the lesson analysis process through Science Content Storyline and Student Thinking lenses. The quasi-experimental control group design tests longitudinal impacts on teachers' content knowledge, pedagogical content knowledge, and teaching practices and students' content knowledge, contributing much needed data for future PD projects. The course is creative both in its grounding of PD in classroom experience and in its plan to motivate teachers by leveraging their sense of urgency and the growing scientific data and tools related to alternative energy resources. We also study which aspects of online environments are most effective for teachers. Data collected are informing are helping address significant gaps in our understanding of online PD.

Features, Affordances, and Challenges of an Online Professional Development Program for High School Science Teachers

Betty Stennett, BSCS Susan M. Kowalski, BSCS Karen M. Askinas, BSCS Mark Bloom, BSCS Austin Lukondi, Colorado College Pamela G. Van Scotter, BSCS

Learning to Analyze Teaching Practice in an Online Course Karen M. Askinas, BSCS Susan M. Kowalski, BSCS Mark Bloom, BSCS Betty Stennett, BSCS Pamela G. Van Scotter, BSCS

Enhancing Teacher Content Knowledge About Energy Concepts in an Online Course Mark Bloom, BSCS Susan M. Kowalski, BSCS Karen M. Askinas, Betty Stennett, BSCS Pamela G. Van Scotter, BSCS Examining the Effectiveness of Online Lesson Analysis PD for Enhancing Student Achievement on Energy Concepts Susan M. Kowalski, BSCS Karen M. Askinas, BSCS Mark Bloom, BSCS Betty Stennett, BSCS Pamela G. Van Scotter, BSCS Kathleen J. Roth, Cal Poly Pomona Foundation

Strand 10: Curriculum, Evaluation, and Assessment

Related Paper Set - Assessing Science and Engineering in the Next Generation Science Standards 8:30am - 10:00am, Watertable Salon B

ABSTRACT:

In an educational era that is filled with new standards and new accountability measures, how do researchers and practitioners assess science and engineering practices? And, more importantly, how do we gather validity evidence to accurately assess these practices? This paper set highlights research on aligned assessments to the Next Generation Science Standards and the various approaches to collecting appropriate validity evidence. The first paper discusses validity in light of recent science and engineering education reform and provides an overview of how the subsequent papers are intertwined. The second paper provides validity evidence for an observational protocol, Science Practices Observation Protocol (S-POP), through cognitive/think-aloud interviews. The third paper applies Rasch measurement theory to evaluate the Engineering Design (EDP) test, The fourth paper discusses the Conceptions of Design Test (CDT) and presents validity evidence for its utility in assessing high school students' informed design practices. The fifth paper explores how stealth assessment, machine-generated logs of student behavior in a CAD design, can be used to understand student learning. This related paper set also represents collaboration between science/engineering education researchers, scientist/engineers, and measurement experts to produce robust research that can positively impact teaching and learning.

Many Facets of Validity Evidence Kerrie Douglas, Purdue University Senay Purzer, Purdue University

Developing a Construct-Based Assessment Using Think-Aloud Interviews: An Approach to Collaborative Assessment Design Jade Caines, University of New Hampshire Lara Gengarelly, University of New Hampshire Erik Froburg, University of New Hampshire

The Development and Validation of an Engineering Assessment Jeremy Lingle, Georgia Institute of Technology Meltem Alemdar, Georgia Institute of Technology Stefanie A. Wind, University of Alabama Roxanne A. Moore, Georgia Institute of Technology Marion Usselman, Georgia Tech

Assessing Informed Design Practices of High School Students

Senay Purzer, Purdue University Kerrie Douglas, Purdue University Molly Goldstein, Purdue University

Assessing Informed Design Strategies Using CAD Logs Jie Chao, Concord Consortium Charles Xie, Concord Consortium Saeid Nourian, Concord Consortium Guanhua Chen, University of Miami

Strand 10: Curriculum, Evaluation, and Assessment

Related Paper Set - Developing a System of Assessment for Implementing NGSS in One State 8:30am - 10:00am, Watertable Salon C **Discussants**:

Alicia Alonzo, Michigan State University

Jonathan Osborne, School of Education, Stanford University

ABSTRACT:

The Next Generation Science Standards (NGSS) have been adopted by state X. These new standards represent a radical shift in what is expected of science education articulating a three-dimensional vision of science learning. Moreover, the outcomes are defined in terms of a set of performance expectations of what students are able to do not just know and recall. To implement these new standards, and meet the federally mandated requirements, a new system of assessments is needed. Such assessments are central to communicating the intent of the standards and operationalizing the constructs to be learned. Thus it is critical that the State assessment system be designed to convey and support the intended vision for science education in the NGSS. These 4 papers will explore work to design a system to meet the vision of NGSS, review the existing items that can be found nationally and internationally and their suitability for NGSS, explore the nature of classroom-embedded performance tasks and their suitability, and report on one study that has examined how to measure the scientific practice of arguing from evidence. The issues and challenges for the field will be discussed.

The Challenges Posed by the Demands of NGSS and Possible Solutions

Raymond Pecheone, Stanford University Helen Quinn, Stanford University Jonathan Francis Osborne, School of Education, Stanford University Alicia C. Alonzo, Michigan State University

What Assessments Exist and How Well do they Meet the Needs of NGSS Jill A. Wertheim, Stanford University Alicia C. Alonzo, Michigan State University

The Promise and Challenge of Eliciting and Measuring Evidence of Three-Dimensional Learning Nicole Holthuis, Susan E. Schultz, Stanford University Alicia C. Alonzo, Michigan State University

Assessing Scientific Practices: Issues and Challenges Drawn From the Example of Argumentation J. Bryan Henderson, Arizona State University Jonathan Francis Osborne, School of Education, Stanford University

Alicia C. Alonzo, Michigan State University

Strand 11: Cultural, Social, and Gender Issues

Equity, Power, and Science Education 8:30am - 10:00am, Pride of Baltimore **Presider:** Sara P. Raven, Kent State University

Examining Issues in Critical Science Education: Does the Practice-Research Gap Still Exist? Catherine D. Bhathena, Indiana University School of Education, Indianapolis

ABSTRACT:

The gap between research and practice in teacher education has been well documented (e.g. Dewey, 1904; Korthagen, 2007; Vanderlinde & van Braak, 2010). However, when a critical perspective is taken, a study of this perceived gap includes the examination of systems of power and how to disturb those systems to take action that brings increased equity for students and teachers. This paper uses such a critical lens to examine the research-practice gap in science education. Interviews with practitioners explored the issues they see as most critical to science education today. Their views were then compared to the views of critical science education researchers as revealed in the literature, and five common themes surfaced: (a) impacts of educational policy on science instruction, (b) participation of girls in science classes (c) lack of resources for science teaching, (d) student engagement in science learning, and (e) family engagement in science education. Discussion of these themes and the varying perspectives on each show differences in notions of the power practitioners have to affect change and suggest rethinking how researchers and practitioners collaborate to change the balance of power and work towards equity and justice in science education.

Towards a Critical Theory of STEM Doctoral Completion and Attrition Senetta F. Bancroft, Grand Valley State University

ABSTRACT:

Although the percent of racial/ethnic underrepresented minority students (URMs) earning science, technology, engineering, and mathematics (STEM) undergraduate and master degrees have steadily grown for more than a decade, their concurrent percent of STEM doctoral degrees remain unchanging and low. Tinto's interactionalist theory of individual student departure, much used to explain student retention/attrition in higher education, inadequately explains URMs' educational outcomes. Tinto's theory is inadequate because it cannot account for the effects of persistent inequalities/oppression in U.S. society on educational opportunity. How can the persistent racial gap in STEM doctoral programs be theoretically explained? To address this question, critical capital theory (CCT) was developed and tested. This critical qualitative study focused on the extent to which an initial version of CCT explained URM women science doctoral experiences and career paths. CCT applies the nature and root causes of racial inequalities persistent in U.S. society to STEM doctoral contexts by intertwining elements of critical race theory, Latino critical race theory, forms of capital, and fictive kinship. The process of developing CCT, a model of a revised version of CCT, and implications for stakeholders committed to making meaningful systemic changes to impact racial diversity in STEM higher education are discussed.

Representing Race and Ethnicity, STEM in Children'S Television, and Healthcare: Potential and Setbacks Sheron Mark, University of Louisville

ABSTRACT:

The under-representation of racial and ethnic minorities in science, technology, engineering, and mathematics (STEM) has long persisted despite research and policy interventions (National Center for Science and Engineering Statistics, 2015). One nationally broadcast children's television show featuring a young Black girl as a medical doctor who treats toys as her patients has the potential to engage underrepresented youth in STEM.

The show engages diversity by racially and ethnically characterizing the toys, as well. Initial evidence encouraged further analysis of the patterns of toy characterization with respect to race and ethnicity to determine if there was a significant relationship between the racial/ethnic identity of the patients and their medical diagnoses being attributed to behavioral or internal factors (for example, recklessness) or due to external factors (for example, routine malfunction). Findings thus far have indicated a significant level of disproportionality in racially-/ethnically-identifiable toys and the locus of control (internal or external) of their medical challenges. This research is warranted as television media has the power to educate, but also define ideologies, including those related to racial and ethnic minorities (Avila-Saavedra, 2010; Sowards & Pineda, 2011). We must, therefore, be cognizant of the complex impact of engaging racial/ethnic identities in equity efforts.

Students Developing Agencies for Socio-Political Activism Through Critical Reflective Practices Majd Zouda, University of Toronto

Tomo Nishizawa, John Larry Bencze, University of Toronto

ABSTRACT:

Our world is highly affected by science and technology. Although their benefits are undeniable, their global problematic consequences for individuals, societies and environments are also evident. Citizens' socio-political activism seems paramount to address these consequences. In order to assume such roles, citizens should perceive themselves as responsible and capable of participating in knowledge production and decision making. Schools are a main milieu to develop students' (citizens') agency to activism. This paper examines Venezuelan students' commitment to socio-political activism, and their types of actions on socioscientific issues highly relevant to them. It particularly focuses on students' developing agencies in-relation to systematic reflection-in and on-actions (Schön, 1983). We argue that these practices have improved students' understanding of socioscientific issues and encouraged them to take strategic decisions regarding their actions; that is, two outcomes that seem to increase students' commitment to activism. We discuss the significance of our findings for democratic and activist science education.

Strand 12: Educational Technology

Technology and Student Affective Dispositions 8:30am - 10:00am, Baltimore Salon B **Presider:** Elizabeth Ridgeway, Kodiak Island Borough School District

Augmented Reality in Class Reality: Raising Motivation and Changing Attitudes and Misconceptions. Aviva Klieger, Beit-Berl College Hen Maayan, Beit-Berl College Yossi Marciano, Beit-Berl College Liat Shaked, Beit-Berl College Shlomit Meyer, Beit-Berl College *ABSTRACT:*

This article presents a combination of three studies that examined the effect of augmented reality in raising students' motivation, interest and pleasure in three subjects: biology, environmental science and mathematics. One of the studies also examined the effect of augmented reality on environmental literacy and another study examined, in addition, the augmented reality effect on reducing misconceptions. Studies in STEM (science, technology, engineering and mathematics) requires the understanding of abstract ideas. Through augmented reality, students can visualize and understand these ideas while learning scientific processes. Students' interests, pleasure and motivation were examined mainly by a qualitative method. A quantitative method was used to

examine the influence of augmented reality on changing students' attitudes towards the environment and on reducing misconceptions regarding percentages. The students experienced great pleasure, and were more active, as opposed to the control group. There was a greater willingness to act for the environment by students who studied with augmented reality, and the difference between the two groups was significant. Findings also show that using augmented reality is effective in reducing students' misconceptions. Students who studied with augmented reality showed the biggest reduction in percentage misconceptions compared to the control group. Augmented reality is an effective tool that can help teachers deal with problematic concepts, and makes lessons more relevant to students. Augmented reality can be used in STEM teaching in a variety of ways and for different purposes, such as understanding scientific text, illustrating abstract concepts, changing attitudes and misconceptions, and writing a summary by the students.

Gaming Science: Student Responses to Virtual Agents and Science Tasks in an Educational Video Game Michael Radosta, University at Buffalo

ABSTRACT:

With the implementation of the Next Generation Science Standards, educators will be enticed by the increasing numbers of educational video games where disciplinary content and crosscutting concepts are purportedly applied through science and engineering practices. Despite some initial challenges, the research base on game-based learning has been growing and showing promise. However, a majority of research is quantitative in nature and narrowly focused on content learning gains and motivation. This is problematic, given that many games use narratives and virtual characters to engage students. The stories, characters, and objects are theorized to enhance engagement in a scientific discourse, but the cultural exchange between students and educational game worlds is often unexamined. An example of this phenomenon is Crystal Island, a well-developed game for middle school microbiology. The game has been investigated for its effects on content learning, but there is no qualitative inquiry into how students regard the narrative elements. This qualitative study reports on the responses of academically at-risk students as they played Crystal Island. The findings suggest the game's limited dialogue and mandatory reading tasks overshadowed the narrative, shifting players away from scientific inquiry towards guessing the right answer to win the game.

The Impact of E-Education on at Risk High School Students' Science Achievement and Experiences Pamela P. Phillips, NCSU Margaret R. Blanchard, NCSU

ABSTRACT:

Nationally, at risk students make up to 30% of U.S. students in public schools, many of whom have poor attendance, are disengaged from the learning environment and have low academic achievement. This mixed methods study investigates thirty-two at risk students who were enrolled in one of three e-education science education courses (Biology, Earth and Physical Science) during a summer session in a rural county in a southeastern US state. Research questions: 1) Who are the students in an e-education, online summer school credit recovery course?; 2) Do students' beliefs about their learning environment or other personal factors influence their academic achievement?; and 3) How do students describe their experiences? Artino's social-cognitive model of academic motivation and emotion was used as a theoretical framework. Data included pre and posttests, final exams, SMTSL survey data, time-on-task, and idle time, field notes, and interviews. Students reported an increase in science self-efficacy, satisfaction with their achievement, autonomy, and positive emotions toward e-education. Students who failed the pre-test benefitted the most from the e-education program; whereas students who passed received no academic benefit from the e-program, other than mitigating negative school perceptions. All students earned graduation credit. Implications for policy are discussed.

Social Engagement and Multilingual Aspects of Motivation to Learn in Massive Open Online Courses Miri Barak, Technion, Israel Institute of Technology

ABSTRACT:

Massive open online courses (MOOCs) are becoming increasingly popular in science and engineering education. Due to high attrition and dropout rates, it is important to understand the social and motivational factors of learner's participation. The goal of this study was to examine participants' motivation to learn in different social settings while comparing between learners who studied the same course but in different languages. The study was conducted in the settings of a Nanotechnology and Nanosensors course, delivered twice: in English and Arabic. The findings of a pretest-posttest quasi-experimental study indicated similar motivational patterns for participants from both courses. Completers asserted higher scores for self-determination and self-efficacy, indicating high willpower and confidence in their ability to learn online. Findings also indicated that the more messages the participants posted in the forums, the higher their motivation gain was. However, a 'stop point' was indicated, around 25 forum posts, beyond which there was little progress in students' motivation. In addition, in both MOOCs, positive relationships were indicated between participants' motivation gain and the number of group members working on the final project. Those who studied in groups of four asserted the highest means compared to those who studied individually.

Strand 13: History, Philosophy, and Sociology of Science Nature of Science and Scientific Inquiry Understandings in K-12 Classrooms 8:30am - 10:00am, Baltimore Salon A Presider: Renee S. Schwartz, Georgia State University

Turkish Version of Students' Ideas About Nature of Science Questionnaire: A Validation Study Mustafa Cansiz, Artvin Coruh University Nurcan Cansiz, Artvin Coruh University Yasemin Tas, Ataturk University Sundus Yerdelen, Kafkas University ABSTRACT:

This study aimed to validate Students' Ideas about Nature of Science questionnaire into Turkish to assess middle school students' nature of science views. A total of 380 students from fifth to eighth grade in 4 cities in northeastern region of Turkey participated in the study. This study was conducted in 2 steps. In the first step, in order to investigate 7-factor structure of SINOS in Turkish context, confirmatory factor analysis was conducted. In the second step, in order to investigate how SINOS factors were related to attitudes towards science and value given to science, two hierarchical regression analyses were performed. The confirmatory factor analysis resulted in seven-factor structure for Turkish version of SINOS as similar to the original questionnaire. Hierarchical regression analyses revealed that after controlling for the influence of previous achievement and gender, theory-ladenness and science for girls were positive predictors while durability was a negative predictor of attitudes towards science. This means that NoS dimensions measured by SINOS are related to the attitudes toward science to some extent. Moreover, theory-ladenness, tentativeness, and science for girls positively and significantly predicted value given to science after controlling for the influence of previous achievement and gender. Results were discussed.

Teaching Nature of Science and Scientific Inquiry to Diverse Early Primary Level Students
Judith S. Lederman, Illinois Institute of Technology
Selina Bartels, Illinois Institute of Technology
Norman G. Lederman, Illinois Institute of Technology
ABSTRACT:
Holping to develop Scientific Literacy has been and continues to be a goal of K 12 science of the scientific Literacy has been and continues to be a goal of K 12 science of the science of the

Helping to develop Scientific Literacy has been and continues to be a goal of K-12 science education, as envisioned in various current reform documents. This involves command of scientific knowledge and

understandings of scientific concepts and processes required for personal decision making, participation in civic and cultural affairs and economic productivity (NRC,1996). Attention to this goal and the subsequent learning of NOS and SI need be included in students' science education throughout all grade levels. However, the research on the teaching and learning of NOS and SI with young children is limited (Akerson & Volrich, 2006). This study explores a diverse population of beginning first graders' views of science and scientists and the development of these views after explicit science instruction that includes NOS and SI. The results of this study offer compelling evidence that young children, regardless of their backgrounds, demographics and beginning views about science, are all very capable of learning NOS and SI when appropriate instruction of these constructs are provided. However, it is the responsibility of their science teachers to ensure that NOS and SI are explicitly included in their students' science instruction.

STEAM and the 'Two Cultures': Developing Matured Views on the Nature of Science Through Drama

Gary Weiser, Teachers College Richard H. Novack, Teachers College

ABSTRACT:

In his famous lecture, C.P. Snow (1959) argued the growing chasm between "two cultures" in academia: that of the scientist, mathematician, or engineer and that of the artist, writer, or philosopher. Fifty years later, calls for STEM approaches are being replaced by STEAM initiatives which incorporate art as a needed aspect of well-rounded education. However, little research has been done to describe what that incorporation might look like. In our study we investigated if incorporating discussions of the nature of science into instruction of An Enemy of the People by Henrik Ibsen in an English class, where discussion of NOS views seemed to align with traditional English Language Arts (ELA) discourse rather than the usual focus on scientific concepts of the STEM classroom, yielded tangible improvements in their views. By examining pre-test and post-test responses to the VNOS-C questionnaire , we investigated the viability of incorporating science themes into liberal arts classes as a route to developing matured views of the nature of science.

Sparking Elementary Students' Attention to Ethical Considerations Through Experiences with Engineering Design

Theresa A. Hegedus, High Point University

Heidi B. Carlone, University of North Carolina at Greensboro

ABSTRACT:

Teaching using socioscientific issues (SSIs) has proven a challenge for science educators, limiting its widespread use as a pedagogical tool in contemporary classrooms. Challenges exist due to emphasis on testing and accountability, insufficient curricular resources, lack of professional development, and teacher support. However, SSIs as a context for science learning can provide a positive move toward improving functional scientific literacy by supporting the enhancement of social and moral compassion in students. In this qualitative study, we examined the ways in which SSIs infused as part of an engineering-based curriculum contributed to elementary school students' attention to ethical considerations. We proposed that relatable science and engineering topics situated within SSI contexts provided youth with meaningful learning experiences and the potential to promote socioscientific accountability. Analysis of qualitative data from semi-structured student interviews, classroom observations, and audio recordings of student group work provided evidence that students as early as elementary school can engage productively in social/moral discourse as part of an engineering-based curriculum.

Strand 14: Environmental Education *Partners in Environmental Education* 8:30am - 10:00am. Kent

Presider: Nicole Colston, Oklahoma State University

Using Drawings and Discussion to Learn About Young Children's Perspectives on Nature

Lauren Madden, the College of New Jersey

Jennifer Liang, the College of New Jersey

ABSTRACT:

Though increased attention has been paid to environmental education across the K-16 spectrum, relatively less is known about what the youngest learners know about their environment and nature. This study examined the environmental science content knowledge of young children enrolled at three different early childhood education programs—one public prekindergarten, one cooperative preschool, and one daycare and child development center. The authors conducted short focus group discussions to learn about students' initial understanding, and followed the discussion with a short activity-based lesson. Afterward, students created drawings of what they learned, and one week after initial discussions, the children participated in a follow up focus group discussion. A grounded thematic analysis of data was conducted, and several trends emerged—including that students talked more about animals they were familiar with in the pre-discussions, while in the post-discussions they addressed different ideas such as interactions between plants and animals, and the variety of plants in their local environment. Drawings showed complimentary, though different information, stressing the importance of triangulating data, especially at the early childhood level.

Using Nature-Based Programming to Rethink Who Gets to do Science: Efforts to Increase Diverse Participation

Benjamin L. Tupper, University of Michigan

ABSTRACT:

Environmental education (EE) aims to teach about the environment, for the environment, and in the environment. Since the creation of EE as an academic discipline in the 1960's there has been a lack of voices being heard other than a white, middle and upper class demographics. It is important that EE begins to include a wider diversity of people, cultures, and viewpoints into the dialogue. This study examines two EE organizations that are working to diversify the field by broadening participation and opportunities for youth from traditionally underrepresented groups. The organizations use comprehensive, tuition-free programming to promote themes of personal empowerment, leadership, and community participation. They seek to engage youth and encourage them to reach their full potential while cultivating a passion for science and environmental science specifically. By re-conceptualizing what EE is, how it is delivered, and who gets to participate, these organizations have developed models that may be effectively used by other organizations struggling to reach diverse groups of youth.

Using Systems Theory to Define the Importance of Environmental Educator Communication with Formal Educators

Patricia Patrick, Texas Tech University Jillian Weinstein, Texas Tech University

ABSTRACT:

This qualitative study used Systems Theory to explore the changes that occurred at a zoo after two interventions were enacted: (1) pre-/post-visit zoo activities were shortened and (2) zoo educators made contact with the formal educators prior to the visit. Data were collected from formal educators through pre-/post-field trip questionnaires and interviews, interviews with informal educators, and a researcher's reflective journal. The study took place in two parts. The data from Part I found that the formal educators were not utilizing the pre-/post-visit activities and cited the following reasons: time, resources, and no knowledge of the activities. Once these results were determined, the pre-/post-visit activities were redesigned into short 10-15 minute activities.

Moreover, the zoo increased the communication between the zoo educators and the formal educators prior to the visit and devised a plan to follow up with formal educators after the visit. The results of the study indicate that: (1) students of formal educators who utilized the pre-/post-visit activities used more relevant words during the visit and (2) an increase in the communication between the zoo educators and the formal educators made a direct impact on the formal educators' use of the pre-/post-visit activities.

Using the Environment as a Lens: Critical Environmental Agency During a Field Ecology Program Lacey D. Huffling, Georgia Southern University

ABSTRACT:

Attending to global environmental concerns calls for renewed efforts in environmental education and environmental literacy. Important questions regarding equity and access also need to be considered (NAAEE, 2011). Therefore, Critical Environmental Agency (CEA) was developed to build on the work of Critical Science Agency scholars (Tan, Calabrese Barton, Turner, & Gutiérrez, 2012) while incorporating specific components of environmental education (Greenwood, 2012; NAAEE, 2011). The research question addressed for this paper was: How were youths' critical consciousness of place enabled during a summer field ecology program? An ethnographic study of 16 diverse youth, who participated a summer field ecology program, was conducted. Seeing their environments and communities in new ways contributed greatly to the participants' critical consciousness of place, and three salient themes emerged: Using the environment as a lens, Rediscovering and discovering habitiat, and "Beauty of the Find." Participants deepened their understanding and began developing a critical consciousness of place as they used the environment to frame their thinking, discovered and rediscovered habitats in their local communities, and concentrated on the beauty and fragility of nature. Through the use of photovoice, participants began to understand that their community has inherent environmental value and searched for environmental strengths in the community.

Strand 15: Policy

Symposium - Building Productive Partnerships Among Researchers and Practitioners: Lessons From Five RPPs in Science Education

8:30am - 10:00am, Homeland

Presenters:

William R. Penuel, University of Colorado Jessica J. Thompson, University of Washington Jennifer Richards, University of Washington Savitha Moorthy, SRI International Andrew E Krumm, Philip L. Bell, University of Washington Erin Marie Furtak, University of Colorado Jason Buell, CU Boulder Samuel Severance, University of Colorado Boulder *ABSTRACT:*

Productive partnerships among researchers and practitioners are increasingly viewed as a core strategy for education improvement. In science education, Research-Practice Partnerships (RPPs) are salient in the context of implementing reform-oriented approaches, such as those emphasized in the Framework for K-12 Science Education and the Next Generation Science Standards. To fully develop RPPs as an improvement strategy and to encourage broader participation in RPPs from both researchers and practitioners, the field requires clear examples of how partnerships among researchers and practitioners unfold in practice and concrete strategies for setting direction and making decisions while navigating—and honoring—the priorities of different stakeholders. Our symposium takes up the challenge of advancing these aims among the science education research

community. Five papers are included here, each of which describes an RPP focused on improving science teaching and learning and the approaches used by researchers and practitioners in these RPPs to promote productive partnerships. The contribution of this symposium is to highlight a potentially transformative set of research practices and lessons learned from the field in order to support theory building and the development of practical knowledge.

Concurrent Session #8 2:15pm – 3:45pm

Membership and Election Committee

Administrative Symposium - NARST Live: Co-Author Our Story, Meet Your Board, Get Involved!!!
2:15pm - 3:45pm, Baltimore Salon B
Presiders:
Pauline W. U. Chinn, University of Hawaii at Manoa
Eileen R. Parsons, University of North Carolina at Chapel Hill
Valarie L. Akerson, Indiana University
ABSTRACT:
NARST LIVE: Co-Author Our Story, Meet Your Board, Get Involved!!! Presenters: Eileen Parsons, Pauline
Chinn, Valarie Akerson, Mary Atwater, Mei-Hung Chiu, Tali Tal, Jerome Shaw, Nam-Hwa Kang, Greg Kelly, Selina Bartels, Hsiao-Lin Tuan, Gillian Roehrig, Alicia Alonzo, Jomo Mutegi The session consists of three
segments: overview, question and answer with Board of Directors panel, and round tables hosted and organized by members of NARST's Board of Directors. Objectives of the session are to: 1) communicate with members

about NARST's organization and functioning, 2) present NARST members with an array of ways to participate and engage in leadership roles; and 3) provide opportunities for NARST members to meet, communicate, and interact with current and new members of the Board of Directors. Format: whole group, panel, and round table

International Committee

Administrative Sponsored Symposium - Promoting Cross-Culture Science Education Research

2:15pm - 3:45pm, Watertable Salon C **Presider:** Hsiao-Lin Tuan, NARST International Coordinator **Presenters:** Huann-Shyang Lin, National Sun Yat-Sen University Larry D. Yore University of Victoria, Victoria, Canada Zoubeida R. Dagher, University of Delaware, USA Sibel Erduran, University of Limerick, Limerick, Ireland Ebru Kaya, Bogazici University, Istanbul, Turkey Saouma BouJaoude, American University of Beirut, Beirut, Lebanon Andrew Wild, Stanford University Shelley Rap, Weizmann Institute of Science Allyson Rogan-Klyve, Oregan State University Dommonique Bulls University of North Carolina at Chapel Hill **ABSTRACT:** This sumposium sime at promoting arose culture science advantion received.

This symposium aims at promoting cross-culture science education research. Three papers will be presented at this symposium individually by Prof. Lin, Prof Dagher, and the recipients of PhD school scholarship. Prof Lin, using PISA 2006 datasets of Taiwan and Canada having similar level of science competency, created a model by examining the relationships among science-related interest, enjoyment, self-efficacy, self-concept, leisure time engagement, and future intended interest in science and how these relationships synergistically interact

with environmental awareness and responsibility. Prof Dagher and her research team?s paper regards using LSEP grant to support teacher understanding of scientific practices in Beirut, Lebanon. The team will report how they promote the use of scientific practices in science classes in Lebanon, how to build Lebanese researchers and teacher educators? repertoire for enhancing scientific practices in science education, and finally, how they link researchers and teacher educators in Lebanon, Turkey, Ireland and the USA with the aim of longer-term collaborations. Finally, the recipients of PhD school scholarship, who went to SAARSMTE summer school to share and exchange their research experience with doctoral students from various countries, will introduce their SAARSMTE experience and how the experience will contribute to their future cross-culture science education research.

Strand 1: Science Learning, Understanding and Conceptual Change

Student Beliefs Across Contexts

2:15pm - 3:45pm, Watertable Salon B Presider: Martina Nieswandt, University of Massachusetts, Amherst

Developing General Metacognitive Knowledge Through Synthesis: Distracting Salient Features in Physics Problems

Thanh K. Le, University of Maine Jonathan T. Shemwell, University of Maine MacKenzie R. Stetzer, University of Maine

ABSTRACT:

Supporting metacognition in science instruction can improve conceptual understanding and build scientific thinking skills. Many studies offer effective instructional approaches to support metacognitive regulation. Less frequent are studies focusing on metacognitive knowledge (MK). These studies typically support MK through instructional approaches such as discussion, training, and practice. Although these approaches are useful, they do not use learning strategies that might increase the transferability of MK. In the present study, I explore how to structure contrasting cases to build general MK in the domain of physics learning. Specifically, the general MK is knowing to reflect on how and why distracting salient features in physics problems can influence reasoning. Fifty-six undergraduate students in a second semester calculus-based introductory physics course were randomly assigned a condition: synthesizing sets of contrasting cases within the domain, synthesizing sets of contrasting cases with different domains, and processing the sets individually. Results indicated that synthesizing sets helped students to better recognize and apply the general MK than processing sets individually. There was no difference between synthesis conditions. The finding offers synthesis of contrasting cases as a potential approach to teaching generalized MK. It also has implications for instruction as a standalone or a supplement to build MK.

Effect of a Laboratory Instructional Model on Students' Epistemological Beliefs About Science Nizar El Mehtar, Lebanese University Zalpha Ayoubi, Lebanese University

ABSTRACT:

This study explored the effect of the 'Integrated Discrepant Instructional Model' (IDIM) in chemistry laboratory on grade 10 students' personal epistemological beliefs about science (PEBS) - structure of knowledge, nature of knowing & learning, source of ability to learn, real life applicability, and evolving knowledge. IDIM is composed of seven interconnected phases, guiding students to develop a scientific explanation of an experimental discrepant event using manipulative, cooperative, and reflective techniques. The investigation followed a semi-naturalistic mixed method case study approach with qualitative predominance. Twelve tenth graders from a coeducational school were selected through stratified random sampling to participate in the

study. One inventory, two questionnaires, a focus group interview, multiple informal interviews, and IDIM's debriefing phases were used for data collection. The study was meant to be an in-depth, scrupulous, and multifaceted preliminary exploration, but its outcomes were not intended to be generalizable. Evidences from the different instruments consistently supported a favorable influence of IDIM solely on students' beliefs about the nature of knowing & learning in science. Expectedly, IDIM's influence on PEBS should be more significant, if the model is presented within an integrated curricular approach that is based on 'big ideas' of personal epistemology and science inquiry.

Middle School Student Application of Evolutionary Change to Behavioral Change Scenarios Joshua Premo, Washington State University

andy Cavagnetto, Washington State University

Kenneth J. Kurtz, Binghamton University

ABSTRACT:

Learning evolution is difficult for students and potentially undermined by human cognitive biases. Middle school students are uniquely positioned to show these biases during their first formal exposure to evolution. In this study 223 grade seven middle school students were presented with two scenarios where a group behavioral change takes place and asked whether this would have an impact on future generations. Students provided six times more reasons incorrectly indicating evolutionary change in the second of the scenarios. The majority (63%) of these evolutionary change reasons came from those that reasoned against change in the first scenario and represented 30% of the student sample. Understanding why students selectively misapplied evolutionary change only in the second scenario could provide insight into the conditions by which novice students evaluate evolutionary potential. While the results of this study do not allow for a definitive reason for this misapplication without further testing, it is suggested that when a behavioral change results in organisms more in line with student expectations they are more likely to see plausible for evolutionary change. Given the difficulty of evolution learning, similar misapplication would be expected to continue into future classrooms making these results applicable to all life science educators.

Upper Secondary Students' Self-Perceptions Towards their Actual Achievement in Science Education

Miia Rannikmäe, University of Tartu Regina Soobard, University of Tartu Priit Reiska, Tallinn University Aet Möllits, Tallinn University Jack B. Holbrook, University of Tartu

ABSTRACT:

The purpose of this study was to investigate upper secondary students (grades 10 and 11) science learning through demonstrating cognition associated with scientific processes and comparing students' achievement with their self-perceptions against this. The instrument, consisting of two parts, was compiled based on a review of relevant international literature, plus learning outcomes in the national curriculum thus ensuring the developed test instrument was in line with expected learning outcomes. The first part of the instrument was a cognitive test compiled of items related to components of scientific literacy within the curriculum, while the other part asked students for their self-perceptions against the same components in the cognitive test. The sample was formed from all grade 10 and 11 students from 44 representative schools Findings suggest that there was no significant shift in skills related to scientific literacy between those grades. Even more, students self-perceptions against those skills were not high and they didn't perceive science subjects developing such operational scientific literacy related skills in an appropriate manner. The outcomes suggested there was a need to re-think science teaching and learning approaches, as well as the manner in which science was introduced to students.
Strand 2: Science Learning: Contexts, Characteristics and Interactions Science Teaching & Learning in Elementary School 2:15pm - 3:45pm, Pride of Baltimore Presider: Dave Hunsberger, Potomac Digitek

The Influence of Teachers' Framing of Modeling on Elementary Students' Engagement in the Modeling Practice Li Ke, Michigan State University

Christina V. Schwarz, Michigan State University *ABSTRACT:*

Scientific modeling is one of the core scientific practices that can help learners develop subject matter expertise in addition to understanding the nature of knowledge in the discipline. Despite the increasing emphasis on scientific modeling in the community of science education, little is known about how teachers can support students' scientifically meaningful engagement in scientific modeling, as opposed to procedurally. In this study, we use Epistemologies in Practice framework developed by our larger research group as our theoretical framework to examine students' engagement in modeling practice. By comparing and contrasting two teachers' framing of modeling practices in the same modeling-based unit, we seek to understand what support teachers might provide with students while engaging in modeling and how it might lead to students' engagement in various epistemic aspects of modeling practices. Our findings suggest that 1) how teachers frame the purpose and goals of modeling might have a great influence on how students engage in the practice of modeling. 2) students will engage in a more scientifically meaningful way if the teacher support them in thinking about the epistemic considerations of modeling practices and 3) students' engagement in modeling is more epistemic in nature when they are given more time. Normal 0 false false false EN-US ZH-CN X-NONE Li 0 0 2013-08-16T02:07:00Z 2013-08-16T02:07:00Z 1 199 1138 9 2 1335 14.0 Normal 0 false false false EN-US ZH-CN X-NONE /* Style Definitions */ table.MsoNormalTable {mso-style-name: "Table Normal"; mso-tstyle-rowbandsize:0; mso-tstyle-colband-size:0; mso-style-noshow:yes; mso-style-priority:99; mso-style-parent:""; msopadding-alt:0in 5.4pt 0in 5.4pt; mso-para-margin-top:0in; mso-para-margin-right:0in; mso-para-marginbottom:10.0pt; mso-para-margin-left:0in; line-height:115%; mso-pagination:widow-orphan; font-size:11.0pt; font-family:Calibri; mso-ascii-font-family:Calibri; mso-ascii-theme-font:minor-latin; mso-hansi-fontfamily:Calibri; mso-hansi-theme-font:minor-latin; }

Exploring Links Between Elementary Students' Model-Based Explanations and Teachers' Knowledge and Practice with Scientific Models

Laura Zangori, University of Missouri-Columbia Tina Vo, University of Nebraska-Lincoln Cory T. Forbes, University of Nebraska-Lincoln Christina V. Schwarz, Michigan State University *ABSTRACT:*

The Next Generation Science Standards emphasize that elementary students should engage in the scientific modeling to begin developing robust conceptual understanding of hydrologic phenomena. However, little past research has explored elementary students' learning about groundwater, engagement in scientific modeling, and/or the ways in which elementary teachers understand and support their students in scientific modeling. We are engaged in a multi-year NSF funded project designed to support 3rd-grade students' formulation of model-based explanations (MBE) for hydrologic phenomenon, including groundwater, through curricular and instructional supports. In this quasi-experimental comparative study, we present findings from the first two years of the curricular intervention. We examine the relationship between students' formulation of MBE for groundwater and teachers' conceptions and practices during the baseline curricular intervention year (Year 1) and modeling-enhanced curricular intervention (Year 2). While findings suggest that students made significant gains in MBE about groundwater from the first to second year, the gains were largely due to two of the five

classrooms. Findings from these classrooms suggest that the teachers' ideas about the practices of modeling and their curriculum enactments played a critical role in supporting students' MBE about groundwater.

Unintended Learning in Primary School Practical Science Lessons Jisun Park, Seoul National University Jinwoong Song, Seoul National University Ian Abrahams, University of Lincoln

ABSTRACT:

This study explored the unintended learning that occurred in primary practical science lessons. We use the term 'unintended' learning to distinguish it from 'intended' learning that appears in teachers' learning objectives. Data were collected using audio-visual recordings of twenty four practical science lessons, taught by five teachers, in Korean primary schools with students aged 10–12 years. In addition, audio-visual recordings were made of each small group of students in order to capture their activities and intra-group discourse. Pre-lesson interviews with the teachers were audio-recorded to ascertain their intended learning objectives. From an analysis of the data it emerged that unintended learning was primarily factual knowledge with some elements of conceptual, procedural, and meta-cognitive knowledge. It occurred as a result of mistakes, doing and interaction with others. It was also found that teachers rarely acknowledged unintended learning and, as a consequence, failed to set up the instructional scaffolding that could have maximized the effectiveness of such unintended learning for the whole class. Based on the findings we would argue that teacher needs to be much more aware that unintended learning can, and does, frequently occur and to be better prepared to utilize it as an educational opportunity.

Teaching Science in the Outdoors: Designing Outdoor Inquiry with Elementary School Teachers Kara Haas, Michigan State University Irene S. Bayer, Michigan State University Tali Tal, Technion ABSTRACT:

Our study aims at bridging outdoor and school based inquiry-based learning. Despite calls for increasing the learning of science in informal learning environments, teachers face many challenges in teaching outdoors due to insufficient content and pedagogical content knowledge. The K-12 Framework for Science Education does not discuss informal education in detail, but recognizes the value of such experiences. Therefore, we developed "Teaching Science Outdoors Program" (TSOP) to establish long-term relationships with a group of teachers and support them in developing inquiry-learning units that bridge outdoor and classroom based instruction. This proposal focuses on the design of the program and the ways in which this design enhanced inquiry-based learning of elementary school teachers. The research questions that we followed were: (1) what were the design principles of the TSOP? (2) in what ways did these design principles promote teacher inquiry-based learning? We demonstrate how the teachers appreciated the outdoor components of TSOP and how they improved their understanding of inquiry-based learning. The teachers valued the use of technology but pointed to challenges as well, and they highly supported the collaborative learning in the program. Views about using the NGSS for designing their school-based outdoor learning units were mixed.

Theorizing Relevance for Science Education Susan Kirch, New York University Kara M. Naidoo, New York University Ben Higgins, East Side Union High School District **ABSTRACT:**

Many educators think that if they show students why or how a topic, concept, or way of thinking is relevant, then students will adopt the educator's perspective and become interested and willing to work on a particular learning task. In this study we (1) review the notion of relevance in education and propose new theoretical tools for thinking and analyzing relevance specifically for teaching by expanding on the works of Dewey, Vygotsky, and Langer; (2) examine how teachers viewed the role of relevance in reflections on their own teaching; (3) describe how various teachers attempted to make relevance with, or for, students in practice; and (4) propose ways that relevance can be generated by and with students during everyday instruction.

Strand 3: Science Teaching--Primary School, Grades preK-6): Characteristics and Strategies *Issues in Early Childhood Science Education*

2:15pm - 3:45pm, Kent **Presider:** Emily J.S. Kang, Adelphi University

Centres of Care: A Guiding Principal in Primary Science Curriculum Enactment for Students From Low Socioeconomic and Refugee Backgrounds.

Carolina Castano-Rodriguez, Australian Catholic University

Lyn Carter, Australian Catholic University

Jenny L. Martin, Australian Catholic University

ABSTRACT:

The purpose of the presentation is two fold. Firstly, we present findings from an ontological study of the sociomaterial realities of teaching science in a low socioeconomic and culturally diverse school context. Secondly, we add insight into the long standing problem of importing science into the primary school curriculum, assumptions made about the professional identity of primary teachers and the representation of both in science education research. The research asks, What human and non-human agencies do participants identify as important in the enactment of science learning? Framed as participatory ethnography, the study involves participants in a school-initiated program to widen the purposes of science education using an innovate approach derived from ethics of care theory. 0 0 1 118 676 Australian Catholic University 5 1 793 14.0 Normal 0 false false false EN-AU JA X-NONE /* Style Definitions */ table.MsoNormalTable {mso-style-name:"Table Normal"; mso-tstyle-rowband-size:0; mso-tstyle-colband-size:0; mso-style-noshow:yes; mso-style-priority:99; mso-style-parent:""; mso-padding-alt:0cm 5.4pt 0cm 5.4pt; mso-para-margin:0cm; mso-para-marginbottom:.0001pt; mso-pagination:widow-orphan; font-size:10.0pt; font-family:"Times New Roman"; border:none; mso-fareast-language:EN-AU;}

Less Use of Scientific Terminology in the Primary Science Classroom: A Means of Concept Development? Jon P. James, University of Bristol

ABSTRACT:

The language of science has the potential to aid high order conceptual explanation, but emphasis on verbal correctness can frequently limit children's ability to conceptualise scientific ideas. This study takes a sociocultural perspective and investigates whether an approach that separated the language and conceptual dimensions of science teaching could influence the discourse and learning of primary age children. Planning meetings were carried out with teachers in which concepts were isolated from the scientific terms traditionally associated with them. Recordings were made of classroom discourse and of the interviews that took place with the teachers. Data was analysed for cohesion in discourse and the level of exploratory discourse that took place. This analysis indicated that there was an increased focus on exploratory discourse in the classroom with enhanced confidence in explaining concepts using everyday language. Evidence was also seen of greater identity affiliation with the social discourse of science for both staff and pupils, particularly among less able boys and those with literacy difficulties. The study reveals the importance of pedagogical approaches that focus on language and conceptual development for engaging children who may experience identity conflict in the science classroom.

Making the Case for STEM in Early Childhood Education Christine D. Tippett, University of Ottawa Todd Milford, University of Victoria ABSTRACT:

STEM in early childhood education is an area currently given little attention, which is unfortunate since young children are natural scientists and engineers. Here, we present our mixed methods case study investigation of STEM in a Pre-Kindergarten (Pre-K) classroom, in collaboration with two educators. We developed a list of potential characteristics of an effective and appropriate STEM curriculum for young children, created a classroom observation protocol, and then collected data from multiple stakeholders (teachers, students, and parents) examining how STEM activities were incorporated in Pre-K, students' understanding of STEM activities, and parents' thoughts about STEM curriculum. Educators saw STEM as a useful approach to planning activities that fostered student curiosity about the world around them. Taking a STEM perspective allowed the ECEs to be more intentional and reflective in their teaching and facilitated the integration of subject areas. Students appeared to participate enthusiastically in STEM activities, demonstrating an appropriate understanding of concepts and articulating questions related to these activities. Parents viewed STEM as an important aspect of their child's Pre-K education. These results suggest that there is a place for STEM in early childhood education, although additional research is needed.

Understanding Young Children'S Argumentation as Dialogical Relations

Mijung Kim, University of Alberta Wolff-Michael Roth, University of Victoria

ABSTRACT:

The current practice of teaching argumentation focuses on mastering the structure of argumentation schemes, yet, this approach lacks the dynamics of epistemic criteria of children's reasoning and decision-making. The common approach also does not address practice of argumentation in the lower elementary grades (K–3), since these children do not master—similar to grammar—the structure of argumentation and, therefore, are considered not ready for processing argumentative discourse. Because of this reason, there is little research focusing on lower primary school students' argumentation as social relations by investigating how primary school children related claims and evidence and how they arrive at conclusions. We study how second- and third-grade children develop the practice of evidence through social relations, especially burden of proof. The findings show (a) the capacity of connecting claim and evidence/responding to the burden of proof and critical move varies, (b) the teacher struggled with removing children's favored ideas though the turn taking of the burden of proof, and 3) at the end of the practice of the burden of proof, children and the teacher reached the moment to resolve the conflict of evidence. The findings on the nature of dialogical reasoning and teacher's role provide further discussion on pedagogical approach to children's reasoning and decision making.

Strand 4: Science Teaching--Middle and High School, Grades 5-12): Characteristics and Strategies *Perspectives on Science Teachers' Learning and Practice* 2:15pm - 3:45pm, Gibson

Presider: Ellen Barnett, University of Missouri

Examining the Alignment Between Teachers' Classroom Instruction and the Next Generation Science Standards Jarod Kawasaki, University of California - Los Angeles William A. Sandoval, University of California, Los Angeles ABSTRACT: The demands of the NGSS require teachers to re-orient their classroom instruction in a short amount of time. Professional development efforts around the NGSS focus on building teachers' understanding of the new standards and supporting them in designing classroom instruction around the goals of standards. Teachers, though, enter professional development with varied experiences and understandings of the NGSS, necessitating professional development that meets these differentiated needs. It is important to understand the varied experiences of teacher learners in order support them in understanding and enacting the goals of the NGSS during this time of transition. To depict teachers' varied experiences, we examined teachers' classroom instruction and their alignment with the NGSS. We interviewed and observed seven secondary science teachers around their use of the science and engineering practices in their classroom teaching. We argue that coordinating between teachers' descriptions of their classroom instruction and observations of their actual teaching provide a clear picture of their instructional goals with which we can compare to the goals of the NGSS to understand the alignment with the NGSS.

Three Perspectives of High School Physics Teaching and Learning

Dennis W Sunal, University of Alabama Cynthia Szymanski Sunal, The University of Alabama John Dantzler, University of Alabama at Birmingham James W. Harrell, University of Alabama Marilyn Stephens, University of Alabama Tara Ray, University of Alabama-Tuscaloosa Michelle Wooten, University of Alabama Mohan Aggarwal, Alabama A&M University *ABSTRACT:*

ABSTRACT: Although here a

Although here are many reports and assumptions made about teaching physics in American high schools, there is a lack of empirical studies of common instructional events occurring in physics classrooms. This study investigated common classroom conditions and strategies making up classroom physics teaching and related the findings to teacher professional development agendas. Classrooms in 72 schools were investigated in a mixed design descriptive study among a large representative sample group of schools and teachers from a diverse, geographically large population. Three separate parallel studies were conducted in a convergent parallel design. Results found important differences in the way teachers reported their classrooms as compared to students or classroom observers. The results provide an unique picture of interrelated variables currently affecting physics teaching. Implications have impact on the way physics teachers are prepared and how professional development needs of in-service physics teachers can be developed.

How Secondary Biology Teachers Characterized their Learning Within a Professional Learning Community Implementing NGSS

Ellen M. Barnett, University of Missouri Patricia J. Friedrichsen, University of Missouri-Columbia *ABSTRACT:*

Next Generation Science Standards (NGSS) provide a new vision for science education. Teachers implementing NGSS must develop an understanding of, and design curriculum aligned with, this vision. Mature Professional Learning Communities (PLCs) may support teacher learning and provide teachers collaboration time needed to re-envision practice and overcome reform implementation challenges. However, there are few studies of mature PLC's in science education. This study described how science teachers in a mature PLC characterized their learning in light of their efforts to negotiate the meaning of and implement NGSS. Interview analysis revealed that teachers did not imagine a new vision of science teaching and learning because they felt their prior vision was consistent with NGSS. They felt NGSS affirmed their vision and allowed them to modify their practice in

ways that were consistent with their prior vision. Teachers felt the PLC allowed them to overcome challenges e.g., cutting content and assessing students' achievement of scientific practices. These findings fill a gap within literature because they offer a rare view of science teachers' reform efforts and learning within a mature community. Implications include 1) policies that foster teacher collaboration, and 2) research that explores how more traditional teachers have successfully implemented reform.

Professional Learning Experiences of Beginner Science Teachers Melanie A. Sadeck, Cape Peninsula University of Technology ABSTRACT:

This paper describes a qualitative study to explore the professional learning experiences of beginner teachers (BT) in their first year of teaching science. The research sought to provide answers to the following questions: What are the BTs learning? Who are they learning from? When are they learning? How are they learning? Why are they learning what they are learning? What are the perceptions of key role players regarding the professional learning of BTs. The study uses situated learning theory as a base so these questions were all considered within the context of the learning spaces of the BTs. This socio-interpretivist study uses a multiple case study approach. Questionnaires, semi-structured interviews and observations were used to collect data from a sample of beginner science teachers six months after they first started teaching. Principals, curriculum advisors, heads of department and mentors were also interviewed to provide insight into the context of the learning. Views of national and provincial roleplayers and policy relating to the professional learning of beginner teachers was also explored.

Strand 6: Science Learning in Informal Contexts

Learning STEM in Informal Settings

2:15pm - 3:45pm, Fells Point **Presider:** Kelly Riedinger, David Heil & Associates, Inc.

Recruiting STEM Graduate Students for K-12 Education: Development of an Instrument for Identifying Candidates

Stephanie B. Wortel, Stony Brook University Angela M. Kelly, Stony Brook University Meghan P. Groome, New York Academy of Sciences Minsu Ha, Stony Brook University, SUNY)

ABSTRACT:

The Mentoring in Afterschool Settings Program (MASP) was launched as a public-private partnership in a large urban city in the US in the fall of 2010 with dual goals: to provide no-cost, local informal STEM enrichment to underserved middle school students and to build the teaching and communication skills of a large number of STEM graduate students and post-doctoral researchers through a clinical service learning opportunity. The program has been shown to impact both affective and cognitive constructs for middle school participants, but a secondary and unintended impact was also noticed in the STEM graduate student and post-doc (mentors) participant population. Correspondence over the first eight cohorts of participating mentors revealed that at least ten percent of mentors were considering a K-12 teaching career. A more careful and thorough study of the interests and anticipated behaviors of mentors in the MASP was needed. The authors anticipated that an instrument could help identify likely candidates for recruitment into the potential K-12 STEM teacher pool. Such an instrument was developed, piloted, and used to identify teacher candidates in the fall 2014 cohort of MASP.

Investigating How the Intensity of the STEM Program Matters: A Comparative Study John C. Bedward, Buena Vista University Margaret R. Blanchard, North Carolina State University

Steve McDonald, North Carolina State Uniersity

ABSTRACT:

In the US and across the globe, there is an increased focus on developing student career interest in Science, Technology, Engineering and Mathematics (STEM), particularly for underrepresented students. In response, a growing number of informal STEM programs are being launched. Researchers cite the need for research that examines which students engage in STEM activities and what features of these programs benefit them. In this mixed-methods study, informed by social cognitive career theory, we collected data on students from five neighboring, low SES middle schools, who were predominantly African American. We analyzed differences in students' STEM self-efficacy (n=171), STEM interests (n=464), and perceptions of school (n =137) between students in an intensive STEM program (STEM-I), students at a STEM intervention middle school but not in the program, and students at the comparison school with no STEM program. Quantitative results reveal significant benefits for participants in the STEM-I program for almost all measured factors. The students who received the intervention fared better than the comparison group. To try to understand these differences, 41 students from the STEM-I program were interviewed. Critical factors seemed to be positive STEM-I experiences, close friendships, and comfort and a sense of belonging on the college campus.

Examination of Students' Attitudes Towards STEM and Interest in STEM Careers: A STEM Camp Example Niyazi Erdogan, Balikesir University

Ayse T. Oner, Texas A&M University, Aggie STEM Robert M. Capraro, Texas A&M University, Aggie STEM Mary Margaret Capraro, Texas A&M University, Aggie STEM *ABSTRACT:*

Informal learning environments have a critical potential to improve citizens' STEM literacy level and encourage students to have future careers in STEM areas. Students who had informal learning experiences developed greater confidence in their STEM abilities; therefore, it is noteworthy to investigate students' attitudes toward STEM disciplines and interest in STEM careers after their experiences to understand how effectiveness of the proposed programs. In this study, our goal was to examine middle and high school students' attitudes toward STEM disciplines, confidence in 21st century skills, and interest in STEM careers after attending a two-week long STEM camp. The results showed that students' STEM career understanding and interest was positively changes after the camp. In addition male students had higher attitude scores than females in engineering and technology were changed after the camp, where they had opportunity to understand which skills that they need to have to be successful in STEM disciplines by given activities.

STEM Professionals' Perspectives on the Importance of Science Fair Participation and the Practices of Science Kathleen A. Fadigan, Pennsylvania State University

Penny L. Hammrich, Drexel University

ABSTRACT:

The objectives of this qualitative case study are to examine science fair participation through the lens of 435 STEM professionals who volunteered as science fair judges for a county-level, urban science fair and to determine to what extent their perceptions of science fair participation align with the Science and Engineering Practices outlined in the Next Generation Science Standards (NGSS). Results indicate the judges' perceive science fairs as positively promoting STEM interest and developing competence in the practices of science and engineering. Additionally, several judges discussed how their own science fair experiences positively

influenced their sustained interest in STEM. Implications point the further consideration of utilizing science fairs in schools and in informal setting to meet the goals of the NGSS.

Strand 8: In-service Science Teacher Education Professional Development for Science Teachers 2:15pm - 3:45pm, Watertable Salon A Presider: Gail Richmond, Michigan State University

A Statewide Support Program for Beginning Secondary Science Teachers: Results From a Randomized-Controlled Trial Investigation

Shannon L. Dubois, Valparaiso University Jennifer L. Maeng, University of Virginia Randy L. Bell, Oregon State University

ABSTRACT:

While some understanding of beginning science teacher learning and instruction in the United States exists, little is known about how science-specific induction programs for beginning teachers support science teacher learning and instruction. To increase the knowledge in this area, this study investigated the impact of a statewide induction program on beginning teachers' confidence, understandings, and implementation of reformbased science instruction. This randomized controlled trial investigation included 134 beginning science teachers in three cohorts based on participation year. In this embedded mixed-methods study, the data consisted of perceptions surveys, interviews, and classroom observations. Results suggested that the induction program helped develop participants' confidence and agency in implementing nature of science (NOS) and inquiry instruction. Additionally, data revealed that participants' understandings of NOS and problem-based learning (PBL) developed over time significantly greater than control teachers' understandings. Finally, all types of reform-based instruction were more frequently seen in treatment than control participants' practices, yet the implementation of these types of instruction developed differently across the first two years. The study suggests the need to provide ample opportunities for beginning science teachers to learn reform-based instructional approaches beyond initial certification programs, and that science-specific induction programs can be a form of ongoing support.

Immersive Clinical Professional Development (ICPD) as a Model for Supporting 21st Century Science Educators

Brian J. Foley, California State University, Northridge John M. Reveles, California State University, Northridge Kelly Castillo, Fullerton School District

ABSTRACT:

Given the rapid integration of technology into the classroom and the introduction of the Common Core State Standards (CCSS) and the Next Generation Science Standards (NGSS), the need to update 21st Century teaching in the US has led to calls for effective professional development for in-service teachers. This paper presents the results of an innovative in-service science teacher professional development model designed to address these calls. Immersive Clinical Professional Development (ICPD) is a pedagogical model in which teachers learn through teaching in highly-scaffolded low-stakes teaching environment. This study looks at ICPD as a way for science teachers to master computer supported collaborative learning (CSCL) methods. We have trained over 100 science teachers in CSCL instruction for the past four years. Changes in the teachers' attitudes and instructional practices were tracked as they learned to use technology to foster collaboration among their students. Through the ICPD experience, teachers became more familiar with the technological tools, their

pedagogy changed and they began to see technology as transforming their instruction. Our findings discuss implications for teacher preparation in light of the NGSS.

Measuring In-Service Teacher Readiness to Engage in Professional Development: A Self-Regulated Learning Microanalysis

Erin E. Peters-Burton, George Mason University

ABSTRACT:

Teachers play an essential role in establishing an effective learning environment for student learning and continuing education for in-service teachers is crucial for this end. However, teachers who participate in PD often do not have deep learning experiences that carry over the PD objectives into practice. The purpose of this paper is to demonstrate the relationship of teacher goal-setting, task value, and self-efficacy measured through a self-regulated learning (SRL) microanalysis with teacher achievement in the PD experience across the same PD contexts with two different groups of teachers. A SRL microanalysis was conducted along with pre- and posttests with two groups of teachers, ones who had a pre-requisite course and one group who did not. The study revealed that goal setting and self-efficacy of learning were the most related to successful outcomes of PD. In particular, an analysis of teacher goal setting was predictive of the learning that occurred in the PD and the subsequent adaptation to practice. SRL microanalysis obtains more nuanced information than self-report questionnaires and can be useful to informing researchers and PD facilitators about teacher learning while a PD is in process, which gives PD facilitators the opportunity to change the learning environment in real-time.

Teachers' Disciplinary Engagement in an Online Professional Development Course

Lama Jaber, Florida State University Vesal Dini, Tufts University David Hammer, Tufts University Ethan Danahy, Tufts University *ABSTRACT:*

This paper describes in-service teachers' engagement in scientific inquiry in a blended online professional development course. We examine and characterize the shift we saw in teachers' engagement on at least two levels: first, in how teachers enacted sense-making practices, and second, in how they oriented to the online community as an epistemic resource to explore, validate, and challenge ideas, and to launch new lines of inquiry. This shift, we argue, was supported by a responsive teaching approach that put their thinking at the center, and by a flexible digital platform that facilitated collaborative knowledge-building and the organic evolution of the online learning spaces. The study contributes to research on disciplinary engagement by showing that, within an online mostly text-based medium, learners can 1) stably engage in sense-making, and 2) collaborate towards achieving epistemic goals. We end with recommendations for the design of responsive online professional development learning communities that promote learners' agency and the collaborative building and refinement of knowledge.

Evaluation of a Continuing Professional Development Program About Nature of Science: Five Level Evaluation Model

Eda ERDAS, Kastamonu University Serhat Irez, Marmara University Nihal Dogan, Abant Izzet Baysal University Yalcin Yalaki, Hacettepe University Gultekin Cakmakci, Hacettepe University Zekai Berk Altiner, Marmara University Zeynep Neslihan Koylu, Marmara University *ABSTRACT:* This study is about a large-scale teacher professional development project aimed at supporting middle school in-service science teachers' nature of science (NOS) views, beliefs, and practices. The purpose of this study is to evaluate the effectiveness of a large-scale continuing professional development (CPD) program designed to improve teachers' NOS views, beliefs, and practices. In this project, a CPD program was implemented for a year with voluntary attendance of 18 middle school science teachers and their students. The intervention process with the science teachers consisted of ten monthly meetings over two semesters. Data were collected and evaluated based on 'five level evaluation model'. These levels are reaction, learning, beliefs, transfer and results. Teacher reactions about CPD program were collected making interviews at the end of the study using five openended questions. Teachers' learning about NOS was assessed by pre-post semi-structured interviews using VNOS-C. Teachers' beliefs about teaching and learning NOS were assessed using two likert-type scales as prepost tests. Teacher's practices about NOS were assessed capturing videos during their classroom practices. The findings obtained from the project demonstrate that the CPD program was effective to improve teachers' NOS views, beliefs, and classroom practices.

Strand 9: Reflective Practice *Reflective Practice* 2:15pm - 3:45pm, James **Presider:** Sueann I. Bottoms, Oregon State University

Axiology, the Subject and the Chair

Wayne Melville, Lakehead University Todd Campbell, University of Connecticut Doug Jones, Lakehead District School Board

ABSTRACT:

This paper addresses two gaps in the literature related to science department chairs: the axiological relationship between the chair and science, the subject, and the perceptions of the chair with respect to teaching and learning within their departments. For this work, axiology is used to understand how the chair's values towards the subject influence his own perceived capacity to lead reformed discourse within his department. A narrative inquiry methodology was used to consider the chair's experiences in the development of his identify over his life span in the form of two stories: 1) the relationship between the chair and science, the subject and 2) the perceptions of the chair with regards to teacher learning within the department. The findings revealed that the work and career of the chair were authored by strong elements of personal continuity and points of stability around the valuing of science, the subject, even as this valuing evolved from being more focused on epistemic values early in his career, to being more concerned with universal values connected to his legacy and his department later in his career.

Critical Perspectives on Cogenerative Dialogue and Video Analysis on Science Teaching and Learning in the Elementary Classroom

Sonya N. Martin, Seoul National University Christina Siry, University of Luxembourg Michele Gilbert-Dixon, Six Rivers Montessori, Arcata CA, USA *ABSTRACT:*

We critically examine the efficacy of utilizing cogenerative dialogues as a tool for mediating dialogic pedagogy between teachers and young children by employing Freirian and Bhaktinian notions of dialogue to raise questions about how this tool can help educators and students to engage in dialogue to inform pedagogical decision-making in science classrooms. We draw from vignettes captured from video recordings of cogenerative dialogues and enacted science lessons to illustrate salient aspects of cogenerative dialogues as a pedagogical tool for teachers and a methodological tool for researchers to engage in rights-based research with adults and children. We highlight how dialogic structures can contribute to both ontological and epistemological shifts in participants' understandings about what it means to teach and learn science in the primary grades. We suggest adaptations for educators and researchers who want to use cogenerative dialogues with young children and conclude with a discussion about why this research is particularly salient in the context of science teaching and learning with regards to enhancing students' participation in science, expanding opportunities for elementary teachers' professional development as science educators, and improving science teacher educators' understandings about how children and teachers experience science teaching and learning at the primary grades.

Integrating STEM into Leadership Curriculum

Xiaoyang Gong, University of Maryland

Thomas E. Davis, University of Maryland

ABSTRACT:

As an important source for instructional leadership and teacher support, school principals play a critical role in improving the quality of STEM teachers. In this paper, we described how a certificate program prepared prospective principals with effective instructional leadership in STEM disciplines. Compared with general principal training programs, the STEM leadership program provides more opportunities for prospective principals to reflect practices and solve problems by incorporating following principles and activities: educational partnership, adult learning, STEM video club and internship. The methodology of action research is applied to investigate the effectiveness of this professional development program and to provide suggestions to future continuous improvement. Quantitative and qualitative data will be collected to accomplish the above goal including pre- and post- motivational questionnaires and open responses from program candidates, interviews with the principal investigator, district administrators and the Wallace liaison. This study provides new insights to design and evaluate professional development programs.

Planning Instruction by Implementing 5E Model into an Undergraduate Physics Laboratory: Action Research Study

Ozden Sengul, Georgia State University Renee S. Schwartz, Georgia State University

ABSTRACT:

This study is a reflective approach to teaching and learning practices in an undergraduate physics laboratory in an urban university. Instructor-as-researcher plans, observes, acts, and reflects on teaching and learning process by implementing 5E instructional model during the Spring 2015 and Summer 2015 semesters. Instructor reflectively explores how 5E model can be implemented into lesson planning and assessment for three-hour laboratory instruction having different components. We report the changes in the instructional practices, challenges and actions taken to overcome, and students' reactions to changes. Data include weekly lesson plans, pre/post reflections of the instructor, and students' reflections on the instructional practices. Student learning outcomes were also recorded through formative assessments. Results indicate that the instructor had difficulty in the implementation of 5E model in terms of time commitment and curriculum constraints. Through reflection and utilization of different actions, the instructor developed her ability to implement 5E model into laboratory instruction. This development was also reflected on students' engagement in the activities. This study is an example of a physics laboratory instructor's attempt to change instructional strategies, and may be useful for other laboratory instructors, who are willing to improve their teaching practices and students' learning.

Strand 11: Cultural, Social, and Gender Issues

Symposium - Science Education in Complex Multilingual Contexts: Challenges and Insights From the Mediterranean and MENa, Middle East and North Africa) Regions

2:15pm - 3:45pm, Baltimore Salon A **Presider:** Sara Salloum, Long Island University **Presenters:**

Sara Salloum, Long Island University Saouma B. Boujaoude, American University of Beirut Tamer G. Amin, American University of Beirut Mariona Espinet, Universitat AutÚnoma de Barcelona, Catalonia, Spain Charles Bonello, University of Malta Diala Badreddine, American University of Beirut ABSTRACT:

ABSTRACT:

Multilingual science education in diverse contexts is often beset with multi-layered tensions inherent in language-in-education policy and practice, which implicate challenges of quality education and issues of social justice and identity. Among these are: use of a second language excluding minority languages versus native language as a sense-making resource; socioeconomic mobility versus cultural rootedness; modernization versus identity preservation. Complexity of issues is increased by interrelations between multilingual education and societal life. For example, socioeconomic or ethnic factors impact significantly different stakeholders' perceptions of language-in-education policies. Issues around multilingual education are especially relevant to science education since Global English is integral to the discourses of science and technology. Therefore, developing proficiency in an international language such as English provides access to these discourses but can be harmful to the quality of science education. The proposed symposium aims at examining the abovementioned tensions in the highly complex sociopolitical and multi-linguistic context of the Mediterranean and MENA (Middle East and North Africa) regions. The symposium brings researchers from different countries in the region. Presentations will highlight key insights and challenges of multilingual science education. Finally, participants and attendees will discuss issues in the various contexts making connections to multilingual education around the world.

Strand 13: History, Philosophy, and Sociology of Science Framing and Expanding Constructions of Scientific Knowledge

2:15pm - 3:45pm, Federal Hill **Presider:** Fouad Abd-El-Khalick, University of Illinois at Urbana-Champaign

A Wiser Goal for K-12 Science Education

John Y. Myers, University of Illinois at Urbana-Champaign Fouad Abd-El-Khalick, University of Illinois at Urbana-Champaign *ABSTRACT:*

In response to repeatedly failing to achieve scientific literacy for all (National Science Foundation, 1996, 2000, 2004, 2008, 2012), the present paper argues for and defends a new, more practical aim for K-12 science education, that is, of developing scientific wisdom (SW). The authors explored various historical and contemporary interpretations of wisdom to eventually synthesize and defend a working definition of SW. Possible arguments against and counterarguments for the parameters of SW are elucidated. We further argue that the development of SW is unique from the goal of scientific literacy because it focuses on learning relevant scientifically justified beliefs to one's life and living rationally with "good sense" (Duhem, 1915), instead of learning inert and unutilized knowledge that simply goes forgotten.

Construction of Nature of Technology Conceptual Framework Hyunok Lee, Ewha Womans University, Republic of Korea Dana L. Zeidler, University of South Florida

Hyunju Lee, Ewha Womans University *ABSTRACT:*

Informed SSI decision-making is one of the competencies expected of students in the age of technology. Nature of Technology (NOT), as a component of scientific literacy, can likely inform students' SSI decision-making. Furthermore, boundaries of science and technology in modern society have become blurred due to the overlap of the two despite a difference in vernacular and culture. Under these circumstances, a need for consideration of NOT emerges naturally to capture an understanding of the technological aspects of SSI decision-making. Therefore, this study proposes a conceptual framework for Nature of Technology (NOT) that could be utilized in the field of science education in order to promote scientific literacy. In order to construct the NOT framework, researchers conducted extensive literature review and multiple discussions with experts in the field of philosophy of technology, history of technology, and engineering as well as in science education. As a result, the NOT framework developed includes four dimensions that reflect various modes of manifestation in technology; 1) Technology as Artifacts, 2) Technology as Knowledge, 3) Technology as Practice and 4) Technology as Systems. Each of the four dimensions was further divided into three sub-components for a total of 12 elements.

Transforming Teachers' Thinking About Engaging Students in Scientific Modeling in School Classrooms Barbara A. Crawford, The University of Georgia

ABSTRACT:

Many science educators view models and modeling as central to science and to the teaching of science (i.e. Gilbert, 2004). A goal of contemporary science teaching in the United States is to support children in inquiry, modeling, and complex reasoning, which will contribute to future critical thinkers in the 21st century. This conceptual paper addresses the promises of teachers engaging students in modeling practices. It also grapples with the issues associated with teachers' abilities, knowledge of, and intentions to teach K-12 students about scientific models and modeling. There is growing pressure on science teachers in the United States to limit time spent engaging students in model-based inquiry, due to high stakes testing and other constraints. The paper will describe a teacher professional development model for supporting teachers in using models and modeling with their children, and learning about nature of science (NOS) in the context of an authentic science investigation. Finally, the paper will end with suggestions for future research and the intersections of learning about NOS and scientific modeling.

Strand 14: Environmental Education

Symposium - Urban Agriculture: An Untapped Context for STEM Learning

2:15pm - 3:45pm, Homeland
Presider: Amie Patchen, Boston College
Presenters:
Dilafruz R. Williams, Portland State University
Sybil S. Kelley, Portland State University
Cary Sneider, Portland State University
Kerri LaCharite, Chatham University
Christopher D. Murakami, University of Missouri-Columbia
Heather Gillich, University of Missouri
Bruna Irene Grimberg, Montana State University
Fabian Menalled, Montana State University
Mike Barnett, Boston College
Amie Patchen, Boston College
ABSTRACT:

This symposium will explore how urban agriculture can serve as an innovative and creative approach to engaging youth in truly integrated science studies. In fact, one of the most frequent and widely supported calls for change in STEM (Science, Technology, Engineering, and Mathematics) education is for newly envisioned curriculum that integrates, science, technology, engineering, and math content and skills (Honey, Pearson, & Schweingruber, 2014). Yet, most curriculum that currently exists is still focused on individual disciplines with little connection between the disciplines. This approach often leaves youth without an understanding of how the scientific disciplines are connected to each other which is problematic given that many of the more important scientific discoveries are occurring at the boundaries of the traditional scientific disciplines. Authors in this symposium will examine how urban agriculture programs support student learning across STEM (science, technology, engineering, and mathematics) areas, the challenges in doing so in both in-school and out-of-school contexts, and how to design curriculum for urban agricultural educational experiences that capitalize upon its inherently interdisciplinary nature.

Concurrent Session #9 4:00pm – 5:30pm

Strand 1: Science Learning, Understanding and Conceptual Change

Related Paper Set - Learning Progressions for Global Carbon Cycling and Climate Change

4:00pm - 5:30pm, Federal Hill

ABSTRACT:

This paper set presents results from a project that has been working since 2003 to develop and validate learning progressions leading to environmental science literacy. The project focuses on environmental science literacy for a particular domain: carbon-transforming processes in socio-ecological systems at multiple scales. This includes: cellular and organismal metabolism in plants, animals, and decomposers; energy flow and carbon cycling at ecosystem and global scales; carbon sequestration; and combustion of fossil fuels. The learning progressions in this domain informed development of six teaching units with associated teacher professional development and a supporting online assessment system. The four papers in this session report on how our learning progressions research has served as the foundation for (a) investigations of students' learning over time, (b) exploration of a range of science and engineering practices (including making explanations and predictions, interpreting and analyzing data and constructing arguments from evidence); and (b) investigations of students' reasoning at larger scales in time and space, especially global carbon cycling and climate change.

Does Principle-Oriented Instruction Improve Student Performance in Novel Contexts?

Charles W. Anderson, Michigan State University Jennifer H. Doherty, University of Washington Jinho Kim, University of California, Berkeley Tian Xia, University of California, Berkeley Karen Draney, University of California, Berkeley

Refining an Inquiry-Based Learning Progression Framework That Describes Students' Approach to Scientific Practices and Uncertainty Emily E. Scott, Michigan State University

Jenny M. Dauer, University of Nebraska- Lincoln

Jennifer H. Doherty, University of Washington

Charles W. Anderson, Michigan State University

A Learning Progression Framework for Students' Interpretation of Earth Systems Data Joyce M. Parker, Michigan State University Beth A. Covitt, University of Montana - spectrUM Discovery Area May Lee, Michigan State University Charles W. Anderson, Michigan State University

Exploring Connections Among Environmental Science Learning Progression Frameworks Addressing Diverse Scientific Practices Beth A. Covitt, University of Montana - spectrUM Discovery Area Joyce M. Parker, Michigan State University Charles W. Anderson, Michigan State University

Strand 2: Science Learning: Contexts, Characteristics and Interactions Related Paper Set - Creating Equitable Access for Underrepresented STEM Students: Professors' Inroads

Toward University Changes

4:00pm - 5:30pm, Maryland Salon F Presider: Xiufeng Liu, State University of New York at Buffalo, SUNY)

ABSTRACT:

The common thread shared by each of these research projects is an examination of intentional shifts in higher education regarding teaching, learning, and assessment in STEM courses. Each paper presents findings from a different professor conducting research on their learning context as they make specific attempts to adjust STEM in higher education for underrepresented audiences. Areas of impact included learning environments surrounding female engineers, young poor/urban engineering recruits, deaf chemistry students, and novice engineering educational researchers. These studies add richness and depth to existing descriptive research regarding each learning context with an added goal of enriching the responsiveness of professors to accommodate multiple views of science pedagogy, scientific content, and assessment of STEM learning. There is now an entire field of professionals entering into the reform conversation and much of the engineering educational research literature is silent with regard to accepted findings and progress made regarding the gap for underrepresented learners. Hence, three of the four papers in this paper set focus upon engineering education and the fourth examines chemistry learning in an attempt to expand access to STEM students and their achievement.

Where Are All the Female Engineers?: An Insider's View of Socialization and Power Jeanne W. Christman, Rochester Institute of Technology Randy K. Yerrick, SUNY- UB

Narrowing the Gap: One Project Lead the Way Director Asks, 'Are We Really Leading?' George H. Zion, Rochester Institute of Technology Xiufeng Liu, State University of New York at Buffalo, SUNY Jeanne W. Christman, Rochester Institute of Technology George H. Zion, Rochester Institute of Technology Annemarie Ross, RIT/NTID Xiufeng Liu, State University of New York at Buffalo, SUNY

Seeing What Others Hear: Regarding STEM Diversity, Writing, and Learning Chemistry Annemarie Ross, RIT/NTID

Randy K. Yerrick, SUNY- UB

Learning to Engineer My Educational Experience Michael Eastman, Rochester Institute of Technology Randy K. Yerrick, SUNY- UB

Strand 2: Science Learning: Contexts, Characteristics and Interactions Related Paper Set - Investigating Epistemic Agency: Creating Space for Students and Teachers to Actively Construct Scientific Knowledge

4:00pm - 5:30pm, Baltimore Salon A Discussant: David Hammer

ABSTRACT:

Recent reforms in science education emphasize that students take active roles in their learning through engaging in scientific practices (NGSS Lead States, 2013; NRC, 2012). Broadly speaking, learners should have epistemic agency, or the positioning and capacity to shape the knowledge and knowledge-related practices of a community (Damsa, et al., 2010; Pickering, 1995; Stroupe, 2014). However, promoting and supporting students' epistemic agency can be challenging. In addition to the content and pedagogical knowledge required by reformed standards, teachers also must expertly facilitate the social dynamics of their classrooms such that the classroom discourse productively builds scientific ideas. This session explores the complexity of the kind of work involved in facilitating productive discourse that positions middle school students, high school students, and high school science teachers as epistemic agency and its role in science learning. It also highlights some of the challenges that students and teachers face in positioning one another as epistemic agents. Lastly, the papers presented contribute practical guidance on how to foster epistemic agency. These practical tools are critical for supporting ambitious instruction that is attentive to student thinking (Windschitl, Thompson, & Braaten, 2011).

Epistemic Agency in the Science Classroom Aliza Stein, Northwestern University

Developing a Culture of Caring to Support Epistemic Agency Christina Krist, Northwestern University Michael J. Novak, Park View School and Northwestern University

Negotiating Students Epistemic Agency and Epistemic Authority in Physics Discussions Enrique Suarez, University of Colorado, Boulder

Shared Epistemic Goals and Patterns of Participation in a Teacher Learning Community Jason Buell, University of Colorado, Boulder

Strand 4: Science Teaching--Middle and High School, Grades 5-12): Characteristics and Strategies Strategies for Professional Development
4:00pm - 5:30pm, Watertable Salon B
Presider: Christopher A. Bogiages, Knowles Science Teaching Foundation

Comparing Students' Talking in Lessons Using Different Instructional Approaches

Lin Zhang, Providence College **ABSTRACT:**

Teaching science through hands-on, inquiry-based investigations has been a predominant instructional approach suggested by the educational community. The use of this approach to developing students' scientific talk has also been viewed as beneficial. Recent studies, however, have challenged this view. To develop an in-depth understanding of the issues in the literature, this study set a research agenda to understand whether and how engaging students in inquiry-based investigation tasks as an instructional approach without extra add-on interventions particularly promotes students' science talk. That said, this study compared hands-on, inquirybased investigation lessons with other types of instruction and examined students' talking developed in the lessons using these different instructional approaches. Students' just-in-time conversations were collected, coded, and compared. Trends were found and analyzed for identifying the type of inquiry-based teaching that might lead to unproductive learning. Suggestions on how inquiry investigation should be implemented in science classrooms are provided for discussion.

Content Knowledge Development When Teaching Out-of-Field: The First Five Years

Ryan Nixon, Brigham Young University Kathleen M. Hill, Pennsylvania State University Julie A. Luft, University of Georgia **ABSTRACT:**

Content knowledge (CK) is an important component of teacher knowledge. Studies indicate that CK develops as teachers amass experience in the classroom. However, little is known about the development of teachers' CK over the early years, particularly with teachers who are assigned to teach outside of their specialization. This study investigates the development of secondary science teachers' CK over the first five years of teaching, with half of the participants teaching out-of-field. Discipline-specific concept maps were generated by participants at the beginning and end of the five-year period and were scored for correctness, complexity, and connectedness. Results indicated that the CK of the teachers as a whole did not develop over the five years. However, when comparing the scores of in-field and out-of-field teachers, the connectedness of the teachers' CK was significantly different in the first year, but then became more similar over time. Additionally, the in-field teachers experienced similar CK development over the five years. Contrastingly, the out-of-field teachers had varied development with some experiencing significant development while others made minimal improvement. These findings indicate that the needs of in-field and out-of-field teachers differ, which can inform policy as well as professional development for new teachers needing content support.

Significant Events in the Development of Teachers' Topic Specific Professional Knowledge for Teaching Chemical Bonding

Rene Toerien, University of Cape Town Marissa S. Rollnick, Wits University Annemarie Hattingh, University of Cape Town

ABSTRACT:

Pedagogical content knowledge (PCK) has been the focus of many research studies, yet the development of PCK is not yet fully understood. This study aims to investigate the role that significant events play in the development of selected teachers' topic specific professional knowledge (TSPK) for teaching chemical bonding. The study employed a new model known as the Model of Teacher Professional Knowledge and Skill, including PCK, which provides a promising conceptualization of the interplay between different knowledge bases. The study utilized a technique known as story-lines coupled with in-depth interviews with four practicing teachers. Significant events, as identified by the teachers to have played a role in the development of their knowledge, were identified through a grounded analysis process. Interview transcripts were further analyzed to identify the role these events played. Findings reveal that events such as the change in curricula, gaining teaching

experience and furthering their education were perceived to be significant. Colleagues and students also played a role. Significant events built the teacher's general professional knowledge base, which in turn supported the development of TSPK. This study contributes to a better understanding of how teachers develop TSPK and the kinds of evens that initiate such development.

The Influence of Innovative, RRI Support Teaching Materials on Science Teachers' Practical Knowledge Drdane Bayram-Jacobs, Delft University of Technology Ineke Henze-Rietveld, Delft University of Technology **ABSTRACT:**

The research reported in this study focuses on the influence of innovative and RRI support science teaching materials on teachers development of practical knowledge (PK) to support student skills to deal with science issues in society. To capture the complexity of teacher PK, we applied a multi-method design which focuses on specific well-defined aspects of this knowledge, based on the components of the Magnusson's et al. (1999) model. The data were collected through different instruments such as PK forms, lesson plans, self-evaluation forms, semi-structured interviews, and reflection papers. The participants of this study are the six students of the Chemistry master program of the Science Education and Communication department at one of the Dutch Universities of Technology. Data were analyzed by considering the Magnusson's et al. (1999) four components of PCK. It is found that teachers' PK for two dimensions (1. students' abilities and needs, 2. instructional strategies) have developed through the enactment of the lesson with RRI support materials. From the results of the study, ideas should be generated to help teachers to develop the beliefs, knowledge and classroom practice for RRI teaching, with the ultimate goal to equip the next generation for active engagement in science.

Strand 4: Science Teaching--Middle and High School, Grades 5-12): Characteristics and Strategies
Socioscientific Issues in Science Education
4:00pm - 5:30pm, Kent
Presider: Niyazi Erdogan, Balikesir University

Characteristics of Students' Socioscientific Issues: Peer Argumentations and their Impact on Students' Moral Sensitivity

Eunhang Lee, University of South Florida Dana L. Zeidler, University of South Florida *ABSTRACT:*

This study investigates how peer argumentations about socioscientific issues (SSI) affect high school students' moral sensitivity. We developed a 12-hour SSI program unit, including a peer argumentation activity implemented during class time. Thirteen high school juniors in an SSI class debated 4 SSI topics and completed an argumentative writing exercise. They were interviewed to examine the characteristics of SSI discourse and how it influenced their moral sensitivity. The results revealed that students (1) built their own source of scientific knowledge about SSI in a small group, (2) reinforced their own personal opinions, and (3) adjusted their personal opinions to make a group decision during the SSI peer discussions. Students' moral sensitivity improved through SSI peer argumentations. The students recognized moral aspects of a situation, were aware of and felt empathy for how possible resolutions could affect others, anticipated possible consequences in society (such as side effects), and examined different perspectives of a set of circumstances. These results lend support that the students are able to reason deeply and improve their moral sensitivity through SSI peer argumentation.

Studies of Two Teachers Developing Argumentative Dialogues on a Socio-Scientific Issue in a Middle School Yaozhen Pan, Illinois Institute of Technology Norman G. Lederman, Illinois Institute of Technology

ABSTRACT:

This study reports the process of instructional practices that teachers sought to teach a socio-scientific issue (SSI) adapting argumentation in seventh grade classrooms in the mainland of China. The research worked with two science teachers over three months with the aim of developing an argumentative dialogic approach to teaching science. It sought to explore how the two teachers designed a lesson about land development and natural resources protection and how they practicly supported their students in engaging in argumentation by examining the learning objectives and instructional strategies (IS). Data resources included pre-and post interviews of the two teachers, lesson plans and videotapes of the lessons. Results from the analysis suggested that both the teachers' enacted IS for argumentative practices were greatly increased comparing to the planning IS, especially on helping students form the claims, getting the evidences on reasoning, proposing questions, responsing to questions and rebutting. It could be inferred that students encounting difficulties in these components, which should be the challenges when developing argumentative practices in science class. The teacher with clearer objectives orienting argumentative practices developed a more successful lesson. The findings of the research could be considered in the design of future professional development and pre-service teacher education.

The Classroom Observation Protocol for Socioscientific Issue-Based Instruction: Development and Implementation of a New Instrument

Mustafa S. Topcu, Yildiz Technical University Sasithep Pitiporntapin, University of Missouri Jaimie Foulk, University of Missouri Troy Sadler, University of Missouri

ABSTRACT:

The purposes of this study are to develop and validate a classroom observation protocol for SSI-based instruction and to test this protocol in three different countries (USA, Turkey, and Thailand). Development of the protocol consisted of four steps: (1) Examining and reviewing previous classroom observation protocols and frameworks for SSI-based instruction; (2) Regular weekly meetings involving writing, reviewing and revising items and sections of the protocol; (3) Testing the protocol with inter-rater agreement; and (4) Further validation of the protocol. Based on a comprehensive review of literature on SSI-based instruction frameworks and previously developed observation protocols, discussion with the experts on SSI-based instruction design, the inter-rater reliability study with a sample of one US high school honors biology class, the protocol with three main sections was developed and validated. The sections of "background information" and "description of the classroom" were mostly related to participants' demographic information. The section of "lesson implementation" included five categories: focus of instruction, characteristics of instruction, role of teacher, role of students and classroom environment. Science teachers from US and Thailand, who implemented a whole-unit SSI-based instruction, showed well-developed SSI-based instruction practices as opposed to other Thai and Turkish teachers who implemented a one-period SSI-based instruction.

Development of a Socio-Scientific Issues, SSI)-Based Instruction for Middle School Students

Nejla Atabey, Milas National Education Directorate

Mustafa S. Topcu, Yildiz Technical University

Abdulkadir Genel, Mugla Sitki KoÁman «niversitesi

ABSTRACT:

The main aim of the study is to develop a Socio-scientific Issues (SSI)-based instruction in the context of "Human and Environment" Unit and to explore effects of this instruction on 7th grade students' learning science content. Action research as a research methodology was used for this study. The teacher implemented SSI-based instruction during an 8,5-week time-period. Four hours per week and for total 34 hours SSI-based instruction were implemented. We utilized the SSI-based instruction framework of Presley et al. (2013) to

design a SSI-based instruction and explore the experiences of a teacher in implementing SSI. Our findings revealed that this framework is useful for effective SSI-based instruction, however; more research is still needed using SSI-based instruction for unit designs in science lessons and how the framework used in this study supports science teachers for an effective SSI-based instruction. Research is also needed on other science units and how teachers negotiate scientific content underlying SSI to align with state- and national-level objectives. We claim that the remarkable finding on improvement of content knowledge is a result of successful strategies implemented by the teacher: classroom environment should be collaborative, respectful and have big student participation in SSI-based instructions.

Strand 5: College Science Teaching and Learning, Grades 13-20) Deeper Issues in Concepts and Assessment 4:00pm - 5:30pm, James Presider: David F. Treagust, Curtin University

Student Performance Outcomes Related to Cognitive Levels of Formative Assessment Questioning and Its Associated Feedback Christina S. Melki, Corban University Heidi Masters, University of Wisconsin - La Crosse ABSTRACT:

Formative assessment is important for improving student learning and can be easily facilitated by personal response systems (clickers). A critical component of formative assessment is feedback. The objective of this study was to identify the amount of feedback critical and sufficient to improve student exam performance. A mixed methods approach was employed to examine how students performed on course exams when low-, mid-, and high-level clicker questions were asked in class and different depths of feedback were given. Low-level questions included fact-based and comprehension questions, mid-level questions involved application, and high-level questions included analysis and evaluation. The results showed while students appreciate the preparation for exam questions afforded by the clicker questions, there is no simple correlation in students' performance between the difficulty of the clicker and exam questions. Furthermore, the feedback given to students did not have any statistically significant effect on their exam performance. This presentation will discuss these results, the limitations and confounding factors that may have contributed to the insignificance, implications regarding the relationship between the level of difficulty of clicker questions asked in class versus the exam, as well as suggestions for providing immediate but varied feedback.

Engineering Student'S Perceptions of the Future: Transferability and Replication of Time Perspective Classifications

Justin Major, University of Nevada, Reno Hank Boone, University of Nevada, Reno Marissa Tsugawa, University of Nevada, Reno Catherine McGough, Clemson University Lisa C. Benson, Clemson University Adam Kirn, University of Nevada, Reno *ABSTRACT:*

Our previous research has examined students' perceptions of the future, their perceptions of solving problems in engineering courses, and the interactions between the two. Previous results describe three categories (cone types) of student perceptions about their futures and the interactions between future and present, distinguished by differences between the distance into the future that students project goals, connections they made between their future goals and activities in the present, and their perceived usefulness of their present tasks. In this study,

we conducted a conceptual replication study of this previous work. The theoretical frameworks for this study are Future Time Perspective and Future Possible Selves. A Directed Content Analysis (DCA) was used to replicate results of previous research. DCA was used for the validation of a priori codes and to allow new themes to emerge from the data. The population of the replication study was seven self-selected participants from an introductory engineering course at a Western land-grant institution. Students in this replication were categorized into two of the three cones defined in the original study. Characteristics of students reflected prior results; however, emergent themes highlight variations not previously considered and challenge the model of discrete cones of student motivation.

Situated and Expert-Guided Discussion of Engineering Ethics in Student Teams

Eun Ah Lee, University of Texas at Dallas Nicholas Gans, University of Texas at Dallas Magdalena G Grohman, University of Texas at Dallas Maarco Tacca, University of Texas at Dallas Matthew J. Brown, University of Texas at Dallas *ABSTRACT:*

The focus of engineering ethics education has been shifted from merely preventing harm to ensuring social responsibility of engineering, however, students' understanding of engineering ethics remained narrow and rigid despite the shift in college engineering education. To explore engineering students' understanding of engineering ethics, particularly focusing on social implications of engineering ethics, we studied socially situated and expert-guided ethics discussion among student teams. We selected three teams' discussion segments to study the outcome of student teams' discussion in different types of ethics advising environment; no advisor, ethics advisor present, and ethics advisors in collaboration. Micro-scale discourse analysis based on cognitive ethnography was conducted to find cultural models of each team's understanding of engineering ethics. We also conducted cultural historical activity theory (CHAT) analysis to see what influenced different cultural models. We found that the team with ethics advisors in the collaborative environment achieved broader understanding in social implications of engineering ethics during the discussion than other teams. The result of CHAT analysis also showed that there was a difference in rule, community, and division of labor during the discussion activity among three teams, and that these differences may have influenced the difference in cultural models.

Synthesis Physics Problem Solving: Factors Influencing Concept Recognition and Application Bashirah Ibrahim, The Ohio State University Lin Ding, The Ohio State University ABSTRACT:

The study reports on the factors influencing students' ability to recognise the relevant concepts and correctly apply them when solving synthesis physics problems (i.e tasks requiring multiple concepts). Two versions of the same problem were designed but with different mathematical complexity levels whereby the equations become increasingly more complicated although the physics remain the same. The two tasks portray the same situation of a disk sliding on a frictionless surface while a projectile is released from a spring launcher attached to the edge of the disk. Three fundamental principles, conservation of energy, linear momentum, and angular momentum, are needed. Physics students, in their second year, were randomly assigned to complete one version of the problem (n = 33 for simple and complex task respectively). Individual interviews were conducted on a separate group of eight students. Results show that mathematical complexity, familiarity and confidence in a concept, and in-depth understanding of the task have an effect on the students' concept recognition and application. An implication of this study includes maximising problem solving as a learning as well as assessment tool.

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

Science Faculty Instructional Practices 4:00pm - 5:30pm, Baltimore Salon B Presider: Issam H. Abi-El-Mona, Rowan University

A Model for STEM Faculty Professional Development:Lessons Learned Susan M Gomez Zwiep, CSU Long Beach ABSTRACT:

This study was conducted within a college of Natural Sciences in a large urban university. In recent years, the college leadership has becoming increasingly focused on student achievement, an in particular the achievement of underrepresented minorities (URMs) in STEM fields. Two research questions guided this study: 1. What was the effect of faculty participation in a Faculty Learning Community on completion rates for their targeted courses? 2. What trends in the types of pedagogical changes faculty choose to implement in their courses as a result of participation? Results from this mixed method study suggest that participation was effective in improving completion rates. However, faculty selection and use of pedagogical approaches varied providing implications regarding their perceptions of teaching and learning.

Comparing Self-Report and Observational Data: An Investigation of Faculty Instructional Practices

Emily M. Walter, California State University - Fresno

Cody T. Williams, Western Michigan University

Charles R. Henderson, Western Michigan University

Andrea L. Beach, Western Michigan University

Megan Grunert Kowalske, Western Michigan University

ABSTRACT:

Stakeholders need a comprehensive portrait of baseline and continuing instructional practices to plan and enact meaningful change initiatives (AAAS, 2013). Faculty self-report can be a particularly useful method to document instructional practices, as surveys are easy to administer and can get at practices that are difficult to observe. However, some authors suggest that it is problematic to assume self-reported practice reflects actual practice (Ebert-May et al., 2011; Hora et al., 2012). In this study, we investigate the accuracy of faculty self-report using the Postsecondary Instructional Practices Survey (PIPS; Authors, 2014) and Teaching Dimensions Observation Protocol (TDOP; Hora et al., 2012). As with the correlations documented between the TPI (Wieman & Gilbert, 2014) and the COPUS (Smith et al., 2013), we found significant correlations between PIPS self-report data and observed practices. The key element in these correlations was that TDOP codes and PIPS items referred to the same concrete teaching practices (Table 2), including the instructor asking questions, students speaking to one another, and students problem solving. Lecture practices were somewhat more complex to interpret. Although lecture practices significantly correlated with the PIPS content delivery factor (p < .05), lecture practices did not significantly correlate with individual PIPS items related to lecture.

Exploring the Constraints to Undergraduate STEM Instructors' Use of Research-Based Instructional Strategies Grant E. Gardner, Middle Tennessee State University

Evelyn Brown, East Carolina University

ABSTRACT:

Despite recent research and policy documents intended to reform the way that instruction is delivered in undergraduate STEM classrooms traditional, teacher-centered instruction prevails. Historically, studies have focused on the barriers external to the instructor (time, resources, etc.) as opposed to internal, cognitive variables. This study provides data regarding instructional practices, perceived external barriers, and perceived internal barriers of n = 104 STEM instructors at two institutions of higher education. Findings demonstrate that

despite identifying with their role as a teacher, strong responsive and transitional teaching beliefs, and learning oriented motivations, instructors tend to have low levels of awareness for the diversity of Research-Based Instructional Strategies (RBIS) and rarely utilize them in their classroom. Findings are presented in the context of instructional change theory and professional development for undergraduate STEM faculty.

Institution-Based Instructional Improvement: Establishing Relational Expertise Through Disciplinary Unit Social Network Analysis

Kathleen M. Quardokus Fisher, Oregon State University Ann Sitomer, Oregon State University Jana L. Bouwma-Gearhart, Oregon State University Milo Koretsky, Oregon State University

ABSTRACT:

Instructional change initiatives at institutions of higher education often involve stakeholders with a variety of disciplinary expertise. These participants bring perspectives and knowledge rooted in disciplines and apply these when envisioning goals, making decisions, and engaging in activities. Relational experts enable the collaborative work of change initiatives by attending to participant needs through an understanding and leveraging of these diverse perspectives. In this study, we document use of social network analysis to establish relational expertise of project leadership regarding teaching and learning and to infer relational experts within participating disciplinary units. We used network Euclidean distance to identify the topics of teaching and learning that are most salient within participant discussions and betweenness centrality to identify potential localized relational experts. Discussions of general instructional activities (e.g., how to teach, what to teach) were more frequent than discussions about specific instructional issues (e.g., grading issues, student diversity issues). These results establish relational expertise that can help us to attend better to teaching and learning needs and interests situated in the perspectives and knowledge of participants. Furthermore, we identified local relational experts currently involved in our change initiative that might further aid in constructing shared vision towards instructional change.

Strand 6: Science Learning in Informal Contexts

Early Learners and Family Science

4:00pm - 5:30pm, Watertable Salon A Presider: Terence Patrick McClafferty, Charles Darwin University

Head Start on Engineering: Supporting Engineering Interest Development in Early Childhood Scott Pattison, Institute for Learning Innovation; Oregon Museum of Science and Industry **ABSTRACT:**

This poster will present a theoretical model of early childhood, engineering-related interest development that builds on prior literature and two years of research with Head Start families. The model is being developed through the NSF-funded Head Start on Engineering research and practice project, which is studying early childhood interest development and piloting family-based programs for engaging parents and children with the topic of engineering. The project responds to the critical need to develop and maintain a robust and diverse engineering workforce within the US and growing evidence that interests developed during early childhood may have long-term implications for learning and career trajectories. The model underlying the HSE project emphasizes the co-regulatory and reciprocal relationships between parents and their children, explicates the proximal processes during parent-child interactions that likely drive early childhood interest development, differentiates between proximal processes and the more distal factors of parent and child characteristics, draws attention to the contextual factors that shape these processes, and posits four critical feedback loops. Drawing from asset-based perspectives on learning, the model suggests approaches to helping other Head Start families

support their young children's developing engineering-related interests while still honoring the culturally situated beliefs, values, and realities within their communities.

Engaging Preschool-Age Children in Multimodal Evidence-Based Explanations for Astronomy Phenomena During Museum Programs

Julia Plummer, Pennsylvania State University Amy R. Ricketts, Pennsylvania State University **ABSTRACT:**

Preschool-age audiences are a key demographic for science museums and other informal settings. However, little research has considered methods of engaging this age group in the practices of science in this setting. We implemented three iterations of four astronomy workshops at a children's science museum to investigate how an early childhood museum educator co-constructed astronomy explanations with 3-5 year old children. Analysis revealed the importance of considering how children had access to both first- and second-hand data sources; children co-constructed explanations with the museum educator during experimentation that generated first-hand data and in situations where only second-hand data (photographs) were available. We found that attending to children's use of gestures and their manipulation of the physical environment, such as when modeling or creating representations, is central to understanding how children co-constructed claims based on evidence in these astronomy-based museum programs.

Evaluating a Science Center's Impact on Family Learning and Science Literacy

Terence Patrick McClafferty, Charles Darwin University

Leonie J. Rennie, Curtin University

ABSTRACT:

This paper describes an ongoing evaluation framework designed to assess a science center's impact on science learning in family-leisure time visits and its overall contribution to science literacy in the community. The evaluation framework was designed to be consistent with the Center's Vision and Mission to maximize its value to the Center. The research was carried out in two phases. In Phase 1, an Impact Exit Survey was designed to assess visitors of all ages immediate responses to their visit. The results indicated that the Center provided visitors with an interesting, enjoyable, stimulating, and educational experience. In Phase 2, three further surveys were designed: a new-visitor survey on entry, an exit survey for new and repeat visitors, and a follow-up survey administered online a month after the visit. The findings revealed that, consistent with other research on family learning, that adults seek out the Center for entertainment and education relating to science and technology, not just for themselves but for their family. Adults responded positively and perceived their children to respond very positively in terms of increasing their awareness, interest, capability and participation in science and technology during and after their visit to the Center.

Opportunities for Meaning-Making in Library-Based Science/Literacy Workshops

Danielle Ford, University of Delaware Dale McCreedy, the Franklin Institute Julia Skolnik, the Franklin Institute

Tara Cox, the Franklin Institute

ABSTRACT:

The [researchers'] family and afterschool workshops integrate science read-alouds with inquiry-based explorations. In sessions offered at public libraries and other informal science institutions, trained facilitators introduce science concepts through children's literature read-alouds, and then invite children and their families to explore those concepts with scientific materials. To understand if and how participants develop understandings of scientific content, we use ethnographic methods to document the modalities - written and visual texts; gestures and material manipulations; and discourse - used to make meaning. Cases that illustrate a range of meaning-making events are presented. The extent to which these events can provide evidence of productive science learning is also considered.

Strand 7: Pre-service Science Teacher Education Symposium - Teaching English Learners Through Science-Language Integration: Linking a Conceptual Framework to Secondary Teacher Preparation 4:00pm - 5:30pm, Gibson Presider: Trish L. Stoddart, University of California, Santa Cruz **Presenters:** Edward G. Lyon, Sonoma State University Sara E. Tolbert, University of Arizona Jorge Solis, University of Texas at San Antonio Trish L. Stoddart, University of California, Santa Cruz George C. Bunch, University of California, Santa Cruz Barry Roth, University of Arizona Ivan Salinas, University of Arizona Corey Knox, University of Arizona Joanne Couling, University of California, Santa Cruz Malcom Butler, University of Central Florida

ABSTRACT:

In this symposium, we discuss a secondary science teacher preparation intervention (namely, redesigned science method courses and professional development for mentor teachers across four institutions) that uses a set of instructional practices, centered on the integration of science, language, and literacy, to prepare secondary pre-service science teachers to teach science in classrooms with English Learners. In addition to discussing how a core set of instructional practices were embedded within pre-service teacher preparation, we report on three analyses to show the impact of the intervention on (1) pre-service teacher implementation of Project-promoted practices during student teaching, (2) pre-service teacher knowledge/beliefs in science teaching for ELs, and (3) the relationship between science method instructor teaching and pre-service teacher practice. The analyses collectively provide preliminary evidence that links a conceptual framework of science-language-literacy integration to science teacher preparation. We aim to use findings to spark discussion among authors and with audience members about how to advance empirical research in pre-service science teacher education.

Strand 7: Pre-service Science Teacher Education Preservice Teachers and Learning to Notice Student Thinking and Science Practices 4:00pm - 5:30pm, Fells Point Presider: Elizabeth Wright, University of Washington

Pre-Service Teachers' Lesson Reflections: Attending, Analyzing, and Responding to Elementary Students' Thinking for Engineering Design Elaine M. Silva Mangiante, Salve Regina University

Adam Moore, University of Rhode Island

ABSTRACT:

The Next Generation Science Standards provide an expanded vision for K-12 science education that includes an emphasis on engineering practices that were not part of previous science education standards. For elementary pre-service teachers (PSTs) to adopt this reform, they would need to develop understanding of how to facilitate students' problem scoping, design generation/evaluation, and solution optimization. This study examined

PSTs' level of focus on student thinking (low, medium, or high) for professional noticing (attending, analyzing, and responding) and attention to engineering core ideas in their four written lesson reflections from an engineering challenge practicum with fourth grade students. The results indicated that PSTs were able to describe the students' ideas as they generated, tested, evaluated, and improved designs. However, their reflections were unsophisticated overall when analyzing and responding to their students' ideas. With regard to the engineering core ideas, the PSTs reflected the least on defining and delimiting the engineering problem, focusing more on the core ideas of students' idea generation to solve the problem and students' ideas for optimizing their design. The data indicated variability among the PSTs in their ability to reflect on student thinking for an engineering unit. We suggest implications and recommendations for teacher educators.

Examining Secondary Science Pre-Service Teachers' Planning for High-Level Questioning in Lesson Planning Danielle K. Ross, Northern Arizona University

ABSTRACT:

One of the most common ways teachers can scaffold student discourse is by using appropriate questioning strategies. Through the teacher's repeated use of these probing questioning strategies, students begin to apply their own form of probing questions during argument formation and throughout the discussion relying less on teacher questioning. Questioning has been extensively studied in mathematics education. In this mixed methods study, pre-service teachers' planning for high-level questions was examined over the course of a year-long graduate teacher preparation program.

Exploring Prospective Elementary Teachers' Engineering Teaching Responsiveness Through a Video Case Diagnosis Task

Tejaswini S. Dalvi, University of Massachusetts Boston Kristen B. Wendell, Tufts University

ABSTRACT:

The shift to include engineering design at the elementary grade levels in the Next Generation Science Standards calls for transformation in the preparation of new elementary teachers. Elementary teachers need not only to understand the practices of engineering, but also to recognize how these practices look when translated into elementary classrooms and to see that science ideas are part of the knowledge that undergirds productive engineering practice. In other words, elementary teachers need capacity for engineering teaching responsiveness. In our work, we attempt to develop and track this capacity over time in novice elementary teachers. To measure engineering teaching responsiveness, we use a video case diagnosis task. Teachers view a video of elementary students working on an engineering practices, and (3) suggest possible teacher moves in response to those student ideas and practices. We administered the video case task at three points in time while 41 new elementary teachers were learning strategies for teaching elementary engineering. In this paper we report on the evolution of the teachers' engineering teaching responsiveness over time, and we discuss implications for further work.

Investigating Factors Shaping Agency and Resilience of Science Teacher Candidates in High-Poverty Schools Gail Richmond, Michigan State University

Kraig A. Wray, Michigan State University

ABSTRACT:

Across the nation, there is a shortage of science teachers, especially where the need is greatest-- schools in communities with significant poverty. The high teacher turnover rate is the result of issues facing teachers. In this study we investigate the responses of teacher candidates placed in high-poverty schools during the most intense period of their preparation for teaching careers. Using a framework which places agency and professional identity at its center, we investigate how these constructs might be used to explain what candidates

perceive as challenges and how they respond to these. We present cases of two secondary science interns committed to teaching in a high-needs context. and show that in spite of contextual challenges faced regularly, these interns maintain a strong hold on their values and work to help their students achieve the goals associated with these values. The values of the interns represent those of the preparation program: deep content understanding and student-teacher relationship development. We conclude from our analysis that it is this resilience, which has typically been examined in experienced rather than beginning teachers that establishes the foundation for the retention of teachers in the profession, particularly those whose careers are in particularly challenging contexts.

Pre-Service Science Teachers' Efficacy in Using Dialogical Argumentation for Teaching Integrated Science-Indigenous Knowledge Lessons.

Keith R. Langenhoven, Uiversity of the Western Cape Meshach Mobolaji Ogunniyi, University of the Western Cape Cynthia G. Fakudze, University of Cape Town

ABSTRACT:

South American countries, but South Africa has an IKS Policy embedded in National Curricula. There are differing nuances found in the various South African science curricula for instance science teachers should consider and understand the Physical Sciences syllabus referring to Indigenous Knowledge Systems (IKS) as embedded in African philosophical thinking and social practices that has evolved over many years. These nuances however do not detract from the important fact that IKS requires integration, acknowledgement and validation in South African science syllabi (Department of Education, 2002; 2004a, b & c). It will be argued that despite the good intentions of the new curriculum policy, science teachers in the school system experience immense challenges in implementing the integration of science and IK in a science lesson due to pedagogical incapacity, in the form of a suitable model for promoting science teaching and learning in a social constructivist classroom. The findings suggest the need for wider collaboration to acknowledge in science. The findings suggest the need for wider collaboration of indigenous knowledge in science can make to the incorporation of indigenous knowledge in science.

Strand 7: Pre-service Science Teacher Education

Related Paper Set - Preparing Novices for Ambitious Instruction: A Look at Different Opportunities in Learning Settings

4:00pm - 5:30pm, Maryland Salon A

ABSTRACT:

In this related paper set we will discuss empirical five research projects that have actively worked to shift science methods courses towards ambitious instruction during the past several years. Ambitious instruction is an instructional framework that supports students' learning across ethnic, racial, class, and gender categories while scaffolding their legitimate participation in the conceptual, epistemic, social, and material features of a discipline. Our hope is that this session will illuminate some successes and tensions that arise during the planning, instruction, and reflection of such methods courses. In addition, we will describe specific learning opportunities we provided to preservice teachers that enhanced the novices' engagement with ambitious instruction.

"Macroteaching": Extending and Authenticating Peer Teaching Opportunities Amelia Wenk Gotwals, Michigan State University David Stroupe, Michigan State University Study 2: Planning for Elicitation of Students' Ideas: A Lesson Study Approach Douglas B. Larkin, Montclair State University

Designing Opportunities for Preservice Science Teachers to Learn Formative Assessment Hosun Kang, University of California Irvine

Approximations of Ambitious Practice in a Compressed Science Teacher Program John Settlage, University of Connecticut Elizabeth Raynor,

Negotiating Tensions While Developing Ambitious Science Teaching Practices Scott McDonald, Pennsylvania State University Arzu Ozcelik, Penn State University

Strand 8: In-service Science Teacher Education

Related Paper Set - A Multi-Pronged Exploration of a STEM Teacher Leadership Framework 4:00pm - 5:30pm, Pride of Baltimore

ABSTRACT:

STEM teacher leadership represents the intersection of two important educational foci in the U.S.: STEM education and teacher leadership. This paper set includes studies that explore a conceptual framework for STEM teacher leadership both theoretically and empirically. Within that set we will describe how the conceptual framework has evolved, as well as what we have learned about the impact of that framework on the teacher and leadership development of a group of 32 teaching fellows (TFs) and master teaching fellows (MTFs) in the Noyce-funded I-IMPACT project. Paper 1 will describe the development of the framework and initial insights concerning the internalization of key principles from it by the MTFs. Paper 2 will describe how used social network analysis has been used to examine the MTFs participation in various communities of practice. Paper 3 looks at how the EQUIP observation protocol has been utilized to examine MTF-TF mentoring interactions. Paper 4 explores how the Multifactor Leadership Questionnaire can be utilized to trace the leadership development of both the TFs and MTFs. Finally, paper 5 considers how both utilization-focused and theory-driven evaluation frameworks can be used to examine identity development and teacher leadership capacity of project participants.

Tempering Our Understanding: Determining and Increasing the Strength of a Framework for STEM Teacher Leadership Brett Criswell, University of Kentucky

Greg Rushton, Stony Brook University

Exploratory Analysis of Science Teacher Leaders' Communities of Practice Subject / Problem Samuel J. Polizzi, Kennesaw State University William Coyle, Greg Rushton, Stony Brook University

Using EQUIP to Guide Reflective Conversations Donna J. Barrett, Metro RESA David Rosengrant, Kennesaw State University Tracking the Growth of Teacher Leaders Using the Multifactor Leadership Questionnaire, MLQ) Michelle L. Head, Kennesaw State University Amanda Edwards, Lyric Portwood, Kennesaw State Unibersity Greg Rushton, Stony Brook University

Evaluation of a Noyce Program: Development of Teacher Leaders in STEM Education Meltem Alemdar, Georgia institute of technology Christopher Cappelli, Georgia Institute of Technology

Strand 10: Curriculum, Evaluation, and Assessment

Curriculum and Assessment in the NGSS Era 4:00pm - 5:30pm, Maryland Salon B **Presider:** Eva Erdosne Toth, West Virginia University

Using an Allergy Curricular Unit to Address the Three NGSS Dimensions with Grades 2-3 Christopher Burnett, Baylor College of Medicine Nancy Moreno, Baylor College of Medicine Alana Newell, Baylor College of Medicine ABSTRACT:

Underrepresented minority and low socioeconomic status children face a disproportionate diagnosis of diseases like asthma. Despite this, these students also have low "health literacy" and few opportunities to engage in authentic science and engineering practices as recommended by The Next Generation Science Standards to build skills necessary for health literacy and STEM careers. The Allergy Busters! curricular materials lays a foundation for health and science literacy using allergies, a condition by which many students are affected. This study looks at the field test for the curricular unit with 791 diverse students in a large urban area. Results suggest that the unit builds student science content knowledge, increases student interest in science and science-related careers.

Integrated Learning Progression Facilitated Instruction Advancing Synergetic Development of Energy Understanding and Scientific Explanation Yao Jianxin, Beijing Normal University Yuying Guo, Beijing Normal University Knut Neumann, Leibniz Institute for Science Education, IPN) Kiel ABSTRACT: Science learning should integrate scientific practices discipline core ideas and crosscutting concepts. The

Science learning should integrate scientific practices, discipline core ideas and crosscutting concepts. Therefore we developed an integrated learning progression fusing energy understanding and scientific explanation. A quasi-experiment was conducted to examine: at what learning outcomes and to what extent the instruction facilitated by the integrated learning progression can be more fruitful, when comparing to traditional instruction. Using video analysis and pre/post tests, we found that: (1) integrated learning progression based teacher training influenced the treatment groups' instruction. (2) Both groups' performances were improved, but students in the treatment group demonstrated better understanding of energy and better competence of scientific explanation. This proposal ends with discussions about implication to future curriculum design and teacher professional development.

Detect the Components of Scientific Modeling Competence

Xiaoming Zhai, Department of Physics, Beijing Normal University Min Li, University of Washington Yuying Guo, Department of Physics, Beijing Normal University Dongsheng Dong, University of Washington

ABSTRACT:

Scientific modeling competence is eliciting more and more concerns in science curriculum development, instruction as well as assessment. This study collected data from a large-scale physics test, and examined the 11factors with 3 dimensions of scientific modeling competence. Focusing on two different situation-problems, we developed an 11-factors' coding scheme, in which each has 3 to 4 levels. We obtained difficulty measures of items by using the Rasch model to analyze the codes of students' responses. Paired t-test indicated that three factors are situation-independent while the other eight are situation-dependent. Correlation analysis revealed a comparatively stable progression structure of these eight situation-dependent factors at three levels. Students are easy to conceptualize the objects and events, and to identify the system and its interactions with environment. The most difficulty for students is to establish relationships between variables and produced an explanatory or predictive model with inference capability, which is considered as core ability for scientific modeling. The relationship of the three dimensions was also analyzed by one-way ANOVA for each of the two items. No progression-oriented structure was identified among the three dimensions, indicating any one dimension is not necessary condition to the other two dimensions.

Using Multiple Models to Support Students' Integrated Understandings About Water Systems Sarah J. Fick, Wake Forest University

ABSTRACT:

The NGSS propose a specific combination of a single disciplinary core idea, science and engineering practice, and crosscutting concept for each performance expectation, but how to support students to develop an integrated understanding of these dimensions is left unclear. As many scramble to develop NGSS aligned curricular units, this research focuses on the outcomes of a unit aligned with the three dimensions of a single performance expectation. This unit used multiple models of water systems, to support the development of integrated understandings about the disciplinary core idea and crosscutting concept. By analyzing students' in-class models, and the classroom conversation around the models through applying NGSS related codes to the individual statements, this work highlights successes and areas for improvement in the sequence and connectedness of the models. There is clear evidence of students' integrated understandings developed during the course of the unit, though students appear to need additional support for connecting the micro- and macro-scales in their models.

Strand 10: Curriculum, Evaluation, and Assessment

Related Paper Set - Automated Analysis of Written Assessments in STEM: Methodological Issues 4:00pm - 5:30pm, Maryland Salon E

Presider: Mark Urban-Lurain, Michigan State University

ABSTRACT:

Constructed response (CR) assessments, in which respondents use their own language to demonstrate knowledge, are widely viewed as providing greater insight into student cognition than closed form (e.g., multiple-choice) assessments. In the past, financial and time constraints made CR assessments challenging to execute and evaluate for large numbers of responses. The papers in this set use computerized tools to identify concepts (normative and naive) in written responses, allow iterative development of emergent coding schemes and create statistical scoring models of text. The goal is to develop accurate and reliable scoring models that are

able to score written responses at levels equal to human expert scorers. This paper set provides an overview of computerized text analysis and features four papers highlighting different applications, methodological challenges and approaches to using these techniques in STEM teaching and teacher professional development. Attendees will 1) gain an understanding of the techniques applied to automated analysis of written assessments; 2) see the methods applied in different domains of STEM education, including science teacher education; 3) learn about methodological constraints; and 4) learn about the current status of this large collaborative project and its future directions.

The Development of Constructed Response Astronomy Assessment Items Matthew M. Steele, Michigan State University John Merrill, Michigan State University Kevin C. Haudek, Michigan State University Mark Urban-Lurain, Michigan State University

Applying Automated Analysis to Develop a Cost-Effective Measure of Science Teacher Pedagogical Content Knowledge Molly Stuhlsatz, BSCS Christopher Wilson, BSCS Zoe E. Buck Bracey, BSCS Kevin C. Haudek, Michigan State University John Merrill, Michigan State University Mark Urban-Lurain, Michigan State University

Automated Analysis Provides Insights on the Challenges to Understanding the Processes Underlying the Flow of Genetic Information Rosa Moscarella, Michigan State University Alexandria L. Mazur, Michigan State University Luanna B. Prevost, University of South Florida Matthew M. Steele, Michigan State University Karen Pelletreau, University of Maine Michelle K Smith, University of Maine Jennifer K Knight, University of Colorado - Boulder Kevin C. Haudek, Michigan State University

Mark Urban-Lurain, Michigan State University

John Merrill, Michigan State University

Predicting the Accuracy of Computer Scoring of Text: Probabilistic, Multi-Model, and Semantic Similarity Approaches Minsu Ha, Stony Brook University, SUNY Ross H. Nehm, SUNY Stony Brook

Strand 11: Cultural, Social, and Gender Issues
Symposium - A Mini-Course on Race/Racism and Critical Race Theory for Application in Science Education
Research
4:00pm - 5:30pm, Watertable Salon C
Presenters:
Felicia Moore Mensah, Teachers College, Columbia University

Jomo W. Mutegi, Indian University Eileen C. Parsons, University of North Carolina at Chapel Hill Leon Walls, University of Vermont Konstantinos Alexakos, Brooklyn College-CUNY Leah D. Pride, CUNY Graduate Center Alejandro J. Gallard, Georgia Southern University *ABSTRACT:*

Abstract Understandings of race/racism and critical race theory have emerged in the social sciences and very recently in science education scholarship. However, we have noticed that theoretical, methodological, and pedagogical understandings of race/racism and critical race theory may be used with greater relevancy and application in science education. Hence, one way to promote greater understanding is to have discussions of race/racism and critical race theory by science education researchers and educators who engage in this work and who can offer insights into addressing race/racism and critical race theory within their specific areas of interest. The proposed symposium brings together science education scholars with an interest in race/racism and critical race theory in science education. This symposium, or the mini-course, is an innovative and engaging format for NARST members, and for scholars interested in using critical and sociocultural perspectives in their research. Of particular interest will be for NARST members as critical scholars may approach the study and teaching of race/racism and critical race theory in their research.

Strand 13: History, Philosophy, and Sociology of Science

Examinations of, and Supports For, Scientific and Pseudoscientific Explanations 4:00pm - 5:30pm, Homeland **Presider:** Shakhnoza Kayumova, University of Massachusetts-Dartmouth

Aim, Working Status and Scientific Status of Crystal Healing as Pseudoscience From Middle School Students' Perspectives

Duygu Metin, Abant Izzet Baysal University Jale Cakiroglu, Middle East Technical University Gulsen Leblebicioglu, Abant Izzet Baysal University

ABSTRACT:

Practices which are done under the name of science or seem to be scientific such as astrology or crystal healing can be defined as pseudoscience. Major issue in science education is to train scientifically literate individuals. Ability of realizing and criticizing flawed research process and claims of pseudoscience was referred as one of the crucial parts of science literacy by some researchers (Hodson, 2008; Hurd, 1998). This study explored middle school students' comprehensions about inherent aim of pseudoscientific applications regarding crystals, and their judgments about working status and scientific status about crystal healing and their underlying reasons for their thinking. This study was qualitative in nature. Fourteen students were interviewed on protocol consisting of pseudoscientific claims and two scenarios including flawed research process about crystals. The results indicated that the students generally used weak reasoning patterns that were closer to that of pseudoscientists. They generally did not use scientific reasoning as it was expected. The students were gullible about the aim, working status, and scientific status of pseudoscience in crystal healing context. They were not aware of the commercial stake of crystal healing and they did not consider the methods of the applications in judging working and scientific status.

Constructing Scientific Explanations: How Philosophically Informed Models Can Guide Instruction, Learning, and Assessment in NGSS

Sahar K. Alameh, University of Illinois and Urbana Champaign

Fouad Abd-El-Khalick, University of Illinois at Urbana-Champaign Jonathan Waskan, University of Illinois at Urbana-Champaign **ABSTRACT:**

In the Next Generation Science Standards, scientific explanation is regarded as a main goal for science, a tool for learning about science, and a way of answering scientific questions. However, the NGSS do not offer conceptualization of the nature of scientific explanation. Equally important, research in science education has not yet developed a robust analog for scientific explanations. 'Scientific explanation' seems to be ill defined among researchers, science teachers and, in turn, science students. Researchers in science education recently have been calling for a clear conceptualization of scientific explanation for science education. The goal of this paper is to provide an overview of the different philosophical models of scientific explanation through a comprehensive review of the primary philosophical literature. The nature of each model, its structure and applications, its limitations and any associated criticisms will be discussed. Finally, understanding the nature of scientific explanation by reference to underlying philosophical models helped develop a functional model of explanation for K-12 science teaching and learning. In this paper, we synthesize the review to generate a functional model of scientific explanation. The candidate models are presented both in their original philosophical forms as well as in forms for use in K-12 science classrooms.

Educating Students for Science Policy: The Need for a Multidisciplinary Approach Peter S. Garik, Boston University

ABSTRACT:

The thesis of this paper is that the preparation of students to contribute as citizens in decisions about policies that rely on science content knowledge cannot be conducted in the science classroom alone and in many instances can be better addressed in the social studies classroom. The argument for this perspective is based on an appraisal of current science education, science standards, expectations of teachers, teachers' expectations, and the observable state of politics in the United States today. The conclusion of this argument is that for Grades K-12 science educators must work with history and social studies educators to prepare students to be voters who can participate in making informed decisions about social policies that depend on scientific knowledge. Specifically, a new set of case histories needs to be created that reflect the history of science policy that has developed since World War II.

The History of Nature of Science Representation in State Science Standards: A Systematic Assessment

Ryan Summers, University of Illinois - Urbana/Champaign John Maddux, University of Illinois at Urbana-Champaign Robert Wallon, University of Illinois at Urbana-Champaign Sahar K. Alameh, University of Illinois at Urbana Champaign Jeanne Brunner, University of Illinois at Urbana-Champaign John Y. Myers, University of Illinois at Urbana-Champaign Aybuke Pabuccu, Abant Izzet Baysal University Gulsum Akyol, Aksaray University Christina Silliman, University of Illinois at Urbana-Champaign Fouad Abd-El-Khalick, University of Illinois at Urbana-Champaign

ABSTRACT:

The present study reports on an analysis of 129 state science standards documents, collected from all 50 states representing the past three decades, for their treatment of key aspects of nature of science (NOS). We used to a structured rubric to score each document for its treatment of 10 different NOS aspects. Results indicate that the inclusion and representation of some NOS aspects have improved dramatically over the past several decades (e.g., empirical NOS), while others continue to be totally missed (e.g., theory-laden NOS) or poorly addressed (e.g., inferential NOS). The identification of historical patterns in the treatment of NOS in state science

standards (which inform the design of instructional materials and resources) allowed inferences to be made about the extent to which these patterns were consistent with advances in philosophy of science and extent to which NOS was addressed in science textbooks, as well as the treatment of NOS in current state standards and the NGSS.

Concurrent Session #10 8:30am – 10:00am

Research Committee

Sponsored Poster Symposium – Sandra K. Abell Institute for Doctoral Students 8:30am - 10:00am, Maryland Salon E Presider: Joseph Polman, The University of Colorado, Boulder Erin Marie Furtak, The University of Colorado, Boulder ABSTRACT:

The Sandra K. Abell Institute for Doctoral Students (SKAIDS) is a NARST sponsored summer institute designed to support the education and professional development of doctoral students involved in the study of science education. The 2015 Institute, led by Joseph Polman and Erin Marie Furtak was held on the campus of the University of Colorado in Boulder. This poster session features the research of 2015 SKAIDS participants.

Exploring the Articulation of Scientific Practices of Modeling and Argumentation in a Sequence on Genetic Diseases

Noa Ageitos, University of Santiago de Compostela

Teachers Communicating with Informal Science Educators: Addressing the Need for a Collaborative Tool James Ammons, University of Georgia

Integrating STEM: Online Teacher Professional Development Tasneem Anwar, University of Minnesota

How a Community of Teachers Redesigned Curricula in Response to NGSS Ellen Barnett, University of Missouri

Critical YPAR for Reimagining Urban Environmental Education Marissa Bellino, The Graduate Center, City University of New York

Aligning Goals of Science Teacher Preparation to Enacted Teaching Practices Nellista Bes, Montclair State University

Who Learns From Teacher Evaluation and Why? Chris Bradford, University of Wisconsin-Madison

Culturally Relevant Science: Perspectives of African American Students Participating in an Informal Science Program Domonique Bulls, University of North Carolina at Chapel Hill

Learning in the Science Classroom: A Phenomenological Study of Students' Instructional Experiences with Early Career Teachers Ben Campbell, University of Georgia

Many Stories: Preservice Elementary Teachers' Identities as Teachers of Science and Students Martha Canipe, University of Arizona *Coaching Teachers in the Design of Assessments to Support Students' Scientific Explanations* Joanne Couling, University of California Santa Cruz, UCSC)

Teachers' Sensemaking about Curriculum Materials across Settings Elizabeth X. de los Santos, Michigan State University

Changes in Pre-Service Teachers' Understanding and Acceptance of a Model of Socioscientific Issues-based Teaching Jaimie Foulk, University of Missouri

Constructive Alignment in a Large-Enrollment Undergraduate Biology Course Emphasizing Student-Centered Active Learning John Ivanovitch, Oregon State University

How Classrooms Learn to Use Epistemic Considerations for Building Scientific Knowledge Christina, Stina) Krist, Northwestern University

"Being a Good Person in a Bad System:" Agency, Structure, and Change for Sustainability Hannah Miller, Michigan State University

Meanings of Evidence and its Uses: A 3-year Longitudinal Study in a Class of Kindergartners Sabela F. Monteira, Universidade de Santiago de Compostela

Examination of Persistence in Biology by Average Achieving Students Biscah Syombua Munyaka, University of Northern Colorado

Understanding Positioning in a Teacher Learning Group Amy Ricketts, Penn State University

The Effect of the Next Generation Science Standards on Teachers' Classroom Practice Allyson Rogan-Klyve, Oregon State University

Teacher Perceived Practical Knowledge Development throughout a Research-Practice Partnership: An Intersectionality Perspective Tamara, TJ) Smolek, Michigan State University

Enactment of Ambitious Instruction in an Undergraduate General Biology Laboratory Course for Nonscience Majors Anna Strimaitis, Florida State University

Leveraging the Cultural Practices of Science for Making Classroom Discourse Accessible to Emerging Bilingual Students Enrique Suarez, University of Colorado at Boulder

High School Science Teachers' Perceptions of how Others Think Science Should be Taught Andrew Wild, Stanford University
Strand 1: Science Learning, Understanding and Conceptual Change Learning Progressions and Student Understanding in Biology 8:30am - 10:00am, Baltimore Salon A Presider: Ravit Golan Duncan, Rutgers University

Data Driven Refinements of a Genetics Learning Progression: Mapping an Understanding of Classical Genetics

Moraima Castro-Faix, Rutgers University Jason Rothman, Rutgers University Rozaliya Seryapov, Rutgers University Ravit Golan Duncan, Rutgers University *ABSTRACT:*

Learning progressions are theoretical models that describe learning of key ideas over extended periods of time. These progressions need to be tested and refined in order to productively inform instruction and assessment. In this paper we report our attempts to revise a genetics learning progression. In particular we focus on two constructs that embody core ideas in classical genetics. The revisions are based on analysis of interview data obtained from thirty-five 11th grade students who, prior to the interviews, engaged in a four-week unit that addressed these concepts in genetics. We found that while many of the students held ideas that aligned with the hypothetical progression, there were also several ideas in the data that required substantial revisions to the constructs including the splitting a construct into three sub-ideas, which resulted in a more coherent construct that captured distinct dimensions of student reasoning. Revisions also included adding new levels and splitting existing levels to more accurately describe student understanding. The research we present offers insights about a methodological approach that can be used to test and refine progressions, as well as insights about student learning in genetics and ways to help students move towards more sophisticated understandings.

How Is the Body'S Systemic Nature Manifested Amongst High School Biology Students?

Orit Ben Zvi Assaraf, Ben-Gurion University of the Negev Israel Jaklin Tripto, Ben-Gurion University of the Negev Israel Zohar Snapir, Ben-Gurion University of the Negev Israel Miriam Amit, Ben-Gurion University of the Negev Israel *ABSTRACT:*

This study follows two groups of students (67 in all) through the three years of their high school biology education and examines the development of their systems thinking - specifically their models of the human body as a system. Both groups were composed of biology majors, but the students in one group also participated in a PBL-based extension program called "Medical Systems". Data was gathered by means of concept maps, which the students completed at four strategic stages of the learning process: beginning of 10th grade, end of 10th grade, end of 11th grade and end of 12th grade. At the end of the three year learning process, the students' showed more complex system models. They included a wider range of concepts in their maps, spanning hierarchy levels ranging from the molecular and cellular to the system level. We also found an increase in references to dynamic interactions, but this did not encourage the students to use cellular level processes when explaining phenomena that occur at the systems level. The impact of the PBL teaching method was strongly evident in the complexity of the Medical Systems program students' concept maps, which heavily emphasized "hierarchy" and "diseases" as system characteristics.

The Effect of Students' Visual Reading Strategies on Understanding Representations in Biology Miriam Brandstetter, University of Duisburg Essen Christine Florian, University of Duisburg Essen Angela Sandmann, University of Duisburg Essen

ABSTRACT:

Visual representations are frequently used as learning material in biology and understanding of the depicted information might be challenging for students. The model of understanding visual representations differentiates between the cognitive activities "identification" and "integration" but yet it is unclear what kind of effective visual reading strategies students use. In order to differentiate students' visual reading strategies forty-two ninth graders were ask to think aloud while trying to understand representations of blood circulation and patellar reflex. Based on the analysis of protocols of thinking aloud a category system (16 categories) was developed which describes students' activities. N = 4351 single statements (propositions) were categorized and principal component analysis revealed: students who often show activities of the patterns "information inference from representation", and "recall prior knowledge and elaborate with depicted information", significantly show better understanding of the representation. The findings contribute to insights of students' actual learning activities while trying to understand visual representations in biology and can be applied to design effective learning material.

Using Alternative Instructional Sequences to Test a Learning Progression in Genetics Jinnie Choi, Rutgers University Ravit Golan Duncan, Rutgers University Moraima Castro-Faix, Rutgers University Veronica L. Cavera, Rutgers University

ABSTRACT:

Learning progressions are hypothetical models of how learning in a domain develops over time with appropriate instruction. Progressions focus on core ideas in science and are a key feature of the Next Generation Science Standards. In the domain of genetics there are two independently developed alternative LPs. The main difference between the two progressions hinges on their assumptions regarding the accessibility of classical (Mendelian) versus molecular genetics and the order in which they should be taught. To test which progression is a better fit with students' actual learning we developed two modules in classical and molecular genetics and alternated their sequence in an implementation study with 285 high school students taking introductory biology. We developed a set of 56 ordered-multiple-choice items with each item mapping onto one of five constructs in the progression (three constructs for molecular genetics ideas and two for classical genetics). Response options for the items reflect different levels of sophistication in reasoning about the particular construct. Using multidimensional item response modeling, we found that there were no statistically significant differences between two instructional sequences in terms of student gains. However, there was a trend of slightly higher gains for the molecular-first sequence for all five constructs.

Strand 2: Science Learning: Contexts, Characteristics and Interactions

Related Paper Set - Epistemic Framing and Agency in Modeling Classrooms

8:30am - 10:00am, Maryland Salon B

Discussants:

Brian Reiser, Northwestern University

ABSTRACT:

This paper set examines the challenge of keeping the intellectual activity in modeling classrooms centered on students' ideas. A common assumption across the papers is the epistemic framing, how teachers and students understand what counts as knowledge and who counts as a knowledge producer, will influence students' epistemic agency. Each of the papers examines the ways in which epistemic frames are generated and maintained in modeling classrooms. Yet each brings a different perspective, drawing together analyses of the

design of model-based activities and teacher goals and intentions with analyses of in situ patterns of teacher discourse and student activity. As a whole, the paper set draws out some of the challenges in framing modeling classrooms in ways that support students' agency. The papers also explore possible solutions in the form of design frameworks and promising pedagogical techniques. Finally, the set raises ongoing questions about general mechanisms that establish, maintain, or disrupt epistemic frames and the consequences for students' epistemic agency.

"Models of" Versus "Models For": Implications for Designing Lessons to Support Students' Epistemic Agency Julia Gouvea, Tufts University Cynthia Passmore, University of California-Davis Brian J. Reiser, Northwestern University

Successes and Challenges in Promoting Student Sense Making in Modeling Classrooms Chris D. Griesemer, University of California Davis Abraham S. Lo, University of California, Davis Candice R. Guy, University of California, Davis Emily Harris, University of California, Davis Cynthia Passmore, University of California-Davis

Examining the Effect of Teacher Responsiveness to Student Ideas on Student Modeling in a MBI Unit Ron Gray, Northern Arizona University Allyson M. Rogan-Klyve, Central Washington University

Redirection and Other Methodological Conceptions in a Modeling Based Learning, MBL) Environment Todd Campbell, University of Connecticut

Strand 2: Science Learning: Contexts, Characteristics and Interactions

Related Paper Set - Examining Elementary School Students' Interactions with Engineering Design and the Factors Affecting their Learning

8:30am - 10:00am, Maryland Salon F **Discussant:** Michael Falk, Johns Hopkins University *ABSTRACT:*

Researchers from engineering, science, and technology education explore elementary school student learning and design thinking in engineering-informed contexts. Underpinning each paper is the central aim of examining students' interactions with engineering design and the factors affecting their learning of and interest in science and engineering design. Using a myriad of evidence-based strategies, approaches, and measures, researchers address one or more of the following questions: What are different ways of measuring students' conceptual understanding of science and engineering? To what extent does the context of learning science and engineering influence students' understanding of engineering and design thinking? How and what do students transfer when they engage in engineering design beyond the classroom? In what ways does the instructional approach to design impact students' learning, interest, and/or understanding of engineering? In this session we engage in a disciplined dialogue on what we value most among the various contexts, characteristics and interactions influencing student learning of science and engineering as we enter a new era of standards and assessments in science education.

Characterizing Elementary School Students' Science Conceptual Understandings Through Engineering Design as a Context for Learning

Brenda M. Capobianco, Purdue University Hongji Gui, Purdue University

Assessing Elementary Students Transfer Science and Engineering Practices in the Context of Engineering Design Todd Kelley, Purdue University Euisuk Sung, Purdue University

Understanding Out-of-School-Time Elementary Students' Conceptions of the Engineering Design Process Catherine Kruchten, The John Hopkins University Carolyn A. Parker, The John Hopkins University Audrey Moshfeghian, Johns Hopkins University

Enhanced Interest and Attitudes Towards Engineering After Two Years of a Community Focused STEM Partnership

Carolyn A. Parker, The John Hopkins University Erica L. Smith, Johns Hopkins University David E. McKinney, the Johns Hopkins University

Strand 4: Science Teaching--Middle and High School, Grades 5-12): Characteristics and Strategies *New Approaches to Science Instruction*

8:30am - 10:00am, Fells Point **Presider:** Billy Mcclune, Queen's University

Science Teaching: Integrating Indigenous Knowledge into the Science Curriculum an Interdisciplinary Approach to Academic Success

Willard S. Gilbert, Northern Arizona University

ABSTRACT:

Science Teaching: Integrating Indigenous Knowledge into the Science Curriculum an Interdisciplinary Approach to Academic Success Abstract The Native Science Connections Research Project (NSCRP), a five year grant funded by the National Science Foundation collaborated with ten schools, thirteen elementary classroom teachers and 225 students from four American Indian Nations: Navajo, Hopi, San Carlos and Zuni nations. This research project provides needed empirical evidence that demonstrates what works for American Indian students in achieving academic success in an era of accountability as marked by the No Child Left Behind (NCLB) Act of 2001. The overarching curriculum design is the Native Science Connections Supplemental Curriculum. This scientifically research-based instruction established an instruction and curriculum model (Lololma) that has been replicated with various American Indian tribes. It builds systematically upon the premise that integrating native language, culture and traditions (ways of knowing) into the existing school curriculum improves student science academic achievement and attitudes while simultaneously revitalizing and preserving tribal cultural knowledge. The investigator tested the hypotheses 1) that American Indian students would learn the school science curriculum better if they were also grounded in their own "native" science perspectives and related cultural knowledge, and after exposure to native cultural knowledge and perspectives, 2) that Native American students would also improve their attitudes toward science education.

Comparative Case Study: Whole-Class Discussion Strategies for Using Dynamic and Static Images of Scientific

Models

Norman T. Price, UMASS Amherst/ SRRI John J. Clement, University of Massachusetts *ABSTRACT:*

Classroom-based studies are needed to describe and compare discussion strategies for using static and dynamic images in large groups to reach the modeling goals of a lesson. This study analyzes three experienced middle school teachers' large group discussions with displayed visuals about the particulate model of matter. Each teacher taught a lesson to one half of his students using a projected static image, and the other half of his students using a projected static image mode used during large group discussion but had similar content goals, lab activities, and handouts. Quantitative analysis of prepost data found significant gain differences between the two image mode conditions, suggesting that students who were assigned to the simulation condition learned more than students who were assigned to the static image condition. Video and transcripts of large group discussions from 12 lessons were analyzed using codes for a set of image-based discussion strategies. Results suggest that the simulation mode offered greater affordances than the static mode for planning and enacting discussions. The identified strategies should help teachers focus student reasoning on generating, evaluating, and modifying their explanatory models when using an image in large group discussion.

Equipping Young People to Engage with Media Driven Science Experiences: Beyond Science Knowledge to Science Literacy and Discerning Consumers of News.

Billy Mcclune, Queen's University

ABSTRACT:

This proposal for a workshop focuses on development of literacy skills through promotion of science literacy. It is based on classroom resources designed to support a curricular intervention for pupils (age 10-13 years) and is aimed at supporting critical engagement with science based media reports. The resource materials provide a framework for introducing critical reading activities related to media reports with a science component. In particular it addresses the credibility of the text through critical question activities and certainty of the text through evaluation of limiting clauses and emotive language. Together these activities provide the foundation for a reader response to the media text. The study that underpins the resource materials focused on core elements of knowledge, skills and attitudes identified in previous studies that characterize critical consumers of science presented as news. This was an empirical study based on classroom observation. Data included responses from individual pupils, in addition video recording of group activity and intentional conversations between pupils and teachers were scrutinised. And will form part of the workshop presentation. Analysis focused on core tasks relating to different elements of critical reading. Pupils demonstrated a grasp of questioning and evaluating text, however the capacity to translate this experience in support of a critical response to a media report with a science component is limited in assessing the credibility of text and as an element in critical reading. This workshop suggests how resource materials might be used with any media text to provide pupils with a framework that will encourage critical thinking in relation to science based media by suggesting a systematic approach to critical reading

Beginning Science Teachers' Communications with Families

Nena E. Bloom, Northern Arizona University

Shadow W.J. Armfield, Northern Arizona University

ABSTRACT:

Science learning occurs in both formal and informal spaces. Families are critical for developing student learning and interest in science because they provide important sources of knowledge, support and motivation. Two-way communication between teachers and families can be used to build relationships between homes and schools, leverage family knowledge of learners, and create successful environments for science learning that will support

both teaching and student learning. Communication between first year science teachers and families was examined to determine what methods teachers used to communicate with families, and the types of information that were communicated between teachers and families. Demographic data, interview data, observations and documentation of communication through logs and artifacts were collected from seven first year science teachers. Results indicated that the methods teachers used for communication impacted the frequency and efficacy of their communication. Teachers and families communicated about a number of important issues, but topics that could improve learning experiences and science futures for their students were rarely discussed, such as advancement in science, student learning in science or family funds of knowledge. Implications for teacher preparation and induction programs are discussed.

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

Instructional Practices - Chemistry 8:30am - 10:00am, Watertable Salon B **Presider:** Yehudit Judy Dori, MIT

Project-Based Learning in General Chemistry for Engineers: An Initial Pilot Study

Kent J. Crippen, University of Florida Maria Korolov, University of Florida Treavor Boyer, University of Florida Chang-Yu Wu, University of Florida Trisha de Torres, University of Florida Philip Brucat, University of Florida

ABSTRACT:

Engineering education cannot expect to meet the demands of a global, diverse, and knowledge-based society without addressing a well-established issue of student retention. Change Chem is a curriculum reform model created to address this issue for freshman, in particular, traditionally underrepresented student groups. This paper reports on a pilot study of Change Chem, which uses collaborative problem-based learning with model-eliciting activities to transform the discussion section of general chemistry so as to better retain freshman who are engineering majors. The study involved a quasi-experimental design with a treatment (i.e. reformed curriculum) and comparison condition (i.e. business as usual) that was completed over a two-semester sequence. After the first course, all groups gained in their perception of learning, but the comparison had higher grades. Self-efficacy and professional persistence decreased for students using Change Chem. After the second course, the comparison group did not outperform the treatment on any variable. In fact, the Change Chem group increased in three key motivational variables, suggesting a treatment effect that may require a longer duration. These results indicate that Change Chem supports learning and motivation for all students, important elements for long-term retention. Plans for additional re-design of the model and further study are discussed.

Mathematization as One Core Problem of Solving Chemistry Questions

Lennart Kimpel, University of Duisburg-Essen, Chemistry Education

Elke Sumfleth, Universitaet Duisburg-Essen

ABSTRACT:

Several tests at universities seem to be very difficult for chemistry students. A comparison of high school tests and first year general chemistry tests as well as interviews with first year students showed that mathematization is a particularly huge problem because there is much more math needed at university and many different formulas have to be memorized. This study wants to identify preconditions for successfully working with chemical calculations. It can be seen that formula knowledge and mathematical skills do not suffice to solve chemical calculations. The results have led to two problematic fields: the first one is choosing the correct

formula for solving the chemical calculation whereas the second field deals with using mathematical skills in chemical contexts.

Perceived Impacts of a Research Experience for Undergraduate Chemistry Majors Adriana R. Lunsford, Texas A&M University

ABSTRACT:

Though academic chemistry tends to be a research intensive field and the importance of including research experiences in students' college education has been increasingly discussed, not every undergraduate degree program in chemistry requires a research experience to complete the degree requirements and graduate. This project developed out of autoethnographic inspiration while reflecting upon my change of educational paths from pursuing a Ph.D. in Chemistry to pursuing a M.Ed. and Ph.D. in Curriculum and Instruction with an emphasis in Science Education. In order to investigate various elements and perceived impacts of participating in a research experience for undergraduate chemistry majors, four individuals were interviewed about their involvement in a Tier One research University's NSF-REU Summer Research Program as undergraduate students. After interviewing four students who had participated in an NSF-REU Program, four themes developed out of their responses: characteristics of building a "successful" undergraduate research experience, importance of mentors and group collaborative dynamics, improving laboratory skills through research, and seeing that graduate school is a possible goal.

The Influence of Interdisciplinary Laboratories on Undergraduate Biology and Chemistry Students' Nature of Science Understanding

Margery Gardner, Syracuse University John W. Tillotson, Syracuse University

ABSTRACT:

A science major's first-year experience is influential as they begin to formulate an academic focus. Improving nature of science (NOS) understanding at this formative period, better prepares students for challenging future coursework. By creating a sound NOS foundation, students can forge long-lasting conceptual frameworks that can extend from schooling to career. This study features findings from a three-year NSF funded research project at a STEM focused college. 'Project Synergy' was developed to build relevance between disciplines through authentic collaborations between biology and chemistry content. Practices of science were explicitly addressed using an integrated teaching model where students participated in inquiry-based projects involving such topics as microscopy and redox reactions. Through a variety of qualitative methods, this study focused on the impact of this interdisciplinary laboratory-based intervention on student NOS understanding. The researcher found knowledge gains in both treatment and control groups. This study found that a first-year integrated laboratory-based learning model improved student NOS understandings of science. Interdisciplinary models of instruction should be considered as a means to combat naïve NOS conceptions due to their authentic depiction of scientific processes. Findings suggest that this instructional model may be most effective when merged with well-established explicit-reflective approaches.

Strand 5: College Science Teaching and Learning, Grades 13-20)
Agents of Change
8:30am - 10:00am, Federal Hill
Presider: Eleanor W. Close, Texas State University

Developing Physics Identity and Competence Through Participation in a "Learning Assistant" Community of Practice Eleanor W. Close, Texas State University

Jessica Conn, Texas State University Hunter G. Close, Texas State University **ABSTRACT:**

This paper examines the impact of participation in a Physics Learning Assistant (LA) program on undergraduate students' self-concepts and engagement in the physics community, using the concept of the community of practice and its intimate relationship to identity. The LA model of undergraduate STEM program reform and teacher recruitment has been found to increase LAs' physics learning and their interest in physics content. We are interested in how participation in the program influences LAs' physics identity development; in particular, how being part of the LA community changes participants' self-evaluations and their day-to-day practice. Qualitative analysis of written artifacts and interviews suggests that membership in the collaborative physics education community of practice created through the LA program increases LAs' engagement in negotiation of meaning in both instructor and student roles, shifts their concept of competence, and expands their sense of belonging and recognition. We are developing a survey instrument to track changes in practice and their relationship to physics identity development.

Factors Related to Student Choice of Academic Major and Persistence in STEM

Adam V. Maltese, Indiana University Eunju Jung, Indianna University

ABSTRACT:

The interventions needed to significantly increase the number of students majoring in STEM remain unclear. We use Social Cognitive Career Theory as an encompassing framework for understanding course enrollment and major selection choices as steps along the way to career or other key outcome of interest. SCCT centers on the basic idea that academic and career choices are based on the interaction of personal (e.g., self-efficacy), environmental (e.g., supports, barriers), and behavioral (e.g., goal implementation) factors (Lent et al., 1994; 2000). What we believe to be unique about this study is the nature of the sample and the holistic nature of data collection. Because of the longitudinal aspects, this analysis will contribute to understanding factors related to retention and degree completion. To analyze these data we will employ multilevel modeling. We are uncovering interesting results. First, a notable percentage of students shifted their identified majors between when they applied to university, when they committed and enrolled in courses and then again when they matriculated. Based on survey data and interviews, students are indicating that their experiences in introductory courses related to performance, interest and teaching – both good and bad – are influencing their choices.

Do Teaching Assistants Matter? Assessment of Teaching Assistants Impact on Student Outcomes in a General Chemistry Laboratory

Lindsay B. Wheeler, University of Virginia Jennifer Maeng, University of Virginia Jennifer Chiu, University of Virginia Randy L. Bell, Oregon State University

ABSTRACT:

This study explores the relationship between teaching assistants (TAs) and student learning in undergraduate science laboratory classes. TAs typically instruct laboratory courses, yet little, if any, research examines professional development (PD) for TAs or relationships between instructors and students in laboratory settings. This quantitative study explored how TAs' content knowledge, beliefs about teaching, and teaching confidence change as a result of PD and how TAs' prior experience, content knowledge, beliefs, and teaching confidence relates to student learning. Participants included 19 TAs and their 529 students at a public university. PD supported TAs to lead inquiry-based general chemistry laboratory classes, involving a week-long workshop and 14 weekly follow-up meetings. Results demonstrate that TAs' content knowledge significantly improved during and after PD, and that TAs' content knowledge gains related to students' content knowledge gains. Thus,

continued work examining TA PD, TA characteristics, TA practice, and student learning in inquiry-based laboratory contexts is warranted.

Impacting STEM Performance: Undergraduate Teaching Assistants as a Fulcrum for Elevating Instructional Practices

Stephanie B. Philipp, University of Louisville Melissa L. Shirley Thomas R. Tretter, University of Louisville Christine V. Rich, University of Louisville

ABSTRACT:

We have developed a program using trained and supported undergraduate teaching assistants (UTAs) to enhance instruction in the two-semester general chemistry sequence for STEM majors The focus of this study was investigating UTA impact on second-semester student performance. Preliminary results show that 1) students who had a UTA second semester scored significantly higher on the final exam than students who had an untrained graduate teaching assistant; 2) students who had a UTA for either or both semesters scored substantially higher on the second-semester final exam than students who had no UTA either semester; and 3) UTA exposure in the second semester had a substantially more positive impact on second-semester final exam performance compared to either no UTA or having a first-semester-only UTA. Taken together, these results suggest that having a UTA at least one semester does have an effect on second-semester general chemistry final exam score. This program was reasonably sustainable across multiple departments, reached hundreds of students and kindled faculty interest in adopting research-based instructional strategies in their own practices.

What do Graduate Teaching Assistants Understand About Teaching Organic Chemistry?
Bette Davidowitz, University of Cape Town
Marissa S. Rollnick, Wits University
Marietjie Potgieter, University of Pretoria
ABSTRACT:
Multiple understandings of Pedagogical Content Knowledge, PCK, have emerged since S

Multiple understandings of Pedagogical Content Knowledge, PCK, have emerged since Shulman's seminal paper (1986). There is general consensus that PCK is knowledge unique to teachers and different from, but supported by content knowledge, CK. Several studies have investigated the relationship between teachers' CK and PCK at topic level using the construct of Topic Specific PCK, TSPCK. While CK is a necessary requirement for the development of PCK, good CK does not necessarily translate high levels of PCK. Since many tertiary institutions employ graduate teaching assistants (TAs) who are content specialists with limited teaching training and experience we were interested to explore what TAs understand about teaching a particular topic. In this study the CK and TSPCK of TAs in organic chemistry was investigated and compared with a cohort of high school teachers. The correlation co-efficient for teachers is higher than those published for studies in chemistry which use questionnaires as a data source. The correlation co-efficient is lower for chemists which was expected as they have very little in the way of formal training to teach. The findings do, however, show that graduate TAs have developed some understanding about teaching organic chemistry despite the lack of formal training.

Strand 5: College Science Teaching and Learning, Grades 13-20)
Scholarship of Teaching
8:30am - 10:00am, Kent
Presider: Eva Erdosne Toth, West Virginia University

How Participatory Action Research Supports a College Science Instructor's Science Teacher Assessment

Literacy

Morgan L. Presley, Drury University ABSTRACT:

The purpose of this study was to investigate how engaging in participatory action research (PAR) can support a college instructor's science teacher assessment literacy. The findings of this study demonstrate that engaging in PAR can support the development of science teacher assessment literacy. This experience helped my participant gain confidence in his beliefs about teaching and learning, expand his knowledge of formative assessments strategies, and develop his knowledge of interpretation of assessment data. This study also demonstrated that engagement in PAR can be a feasible and an effective form of professional development that is tailored to individual faculty members. This study also highlights the importance of establishing an open relationship between faculty and researchers, the need to understand the teaching context and the constraints it poses, and an explicit discussion of goals for the collaboration. These enhance the ability of PAR to provide professional development that is tailored to the individual faculty member's needs and circumstances. This study raises questions about the extent to which faculty science assessment literacy may be constrained by departmental policies and the degree to which PAR can achieve its emancipatory aims when faculty have limited academic freedom.

Instructors' Perspectives on Inter-Disciplinary Health Sciences Co-Teaching in Higher Education

Arpana Dhar, Curtin University David F. Treagust, Curtin University Georgina M. Fyfe, Curtin University **ABSTRACT:**

Due to effect of democratisation of knowledge and access, globalisation, flexible learning demands from students and health care industry demands for a more inter-disciplinary experience, the tertiary education sector has to develop credible teaching and learning strategies that meet the needs of students and employers while being financially sustainable. One viable strategy is the introduction of co-teaching practices to engender greater educator-student interactions and promote inter-disciplinary teaching. Co-teaching involves educators experienced in different disciplines teaching together a particular group of students sharing ownership, accountability and responsibility though their participation might vary in different sessions (Friend & Cook, 2010). It has found its effectiveness in pre-service education, special education, primary and secondary education, professional development and higher education (Dieker & Murawski 2003, Roth & Tobin 2007). This study reflects on the experiences of educators co-teaching in a core Health Sciences undergraduate unit giving an insight into various aspects of co-teaching. The data was generated from extensive interviews, class observations and surveys completed by the educators. This paper presents some of the findings of the complex nature of this strategic collaborative practice.

Reciprocal Learning in Science Professional Development: Faculty Shift their Practice

Caron Inouye, California State University, East Bay Kathryn N. Hayes, California State University, East Bay Christine Lee, California State University East Bay Jeff Seitz, California State University, East Bay Dawn O'Connor, California State University, East Bay Rachelle DiStefano, Cal State University East Bay **ABSTRACT:**

Extensive research demonstrates how science professional development (PD) led by higher education (IHE) faculty supports K-12 teacher science content gains and shifts in instructional practice. However, relatively few studies have examined the impacts of MSP partnerships on the science faculty. Promising preliminary studies demonstrate that faculty may be engaging in a reciprocal learning process with K-12 science teachers, leading

to shifts in IHE faculty instructional practice. Drawing on socio-cultural learning theory, we extend and refine the nascent literature by demonstrating in what ways faculty participating as PD providers for K-12 science teachers reshape their pedagogical practices, and what social and structural contexts contributed to this shift. Analysis of faculty interviews revealed that their instruction became more student centered, involved more inquiry and problem-solving, and was more interactive. Faculty attributed these shifts to exposure to excellent teaching strategies through three major avenues: Planning and delivering PD (often with the County Office science coaches), observing coach presentations and modelling of pedagogies, and participating in Lesson Study. These were facilitated in turn by the contextualized social interactions that built relationships between faculty and teachers and coaches.

University Engineering Instructors' Perceptions of their Need for Professional Development David F. Treagust, Curtin University

Caroline Selepe, Tshwane University of Technology

A. L. Chandrasegaran, Curtin University

ABSTRACT:

This study investigated 24 engineering instructors' perceptions about their own teaching knowledge in the Faculty of Engineering at a South African university in a mixed methods design using the Teachers' Beliefs about Teaching and Learning in Engineering (TBTLE) instrument consisting of 25 items. The study found that many instructors had limited knowledge about teaching. The instructors raised concerns about their ineffectiveness of teaching methodologies and assessment practices to facilitate meaningful learning. In addition, instructors raised dissatisfaction with the some aspects of the engineering curriculum structure and psychosocial factors of an affective nature as possible causes of teaching and learning difficulties. The findings have the potential to influence curriculum reform in engineering in South Africa. In conclusion, the study has revealed that the TBTLE instrument, used for the first time in a higher education environment, was successful in eliciting instructors' perceptions about teaching and learning practices in engineering classrooms.

Strand 6: Science Learning in Informal Contexts

Informal Science with K-12 Schools and Teachers 8:30am - 10:00am, Pride of Baltimore **Presider:** Jennifer Dewitt, King's College London

Mismatch of Goals and Assessments: Analysis of Zoo and Aquarium Provided Teacher Professional Development

Joy Kubarek, PEER Associates Judith Lederman, Illinois Institute of Technology

ABSTRACT:

Informal science institutions are a significant provider of science teacher professional development. As pressure continues to critically analyze the work of teachers and their effectiveness in the classroom, it is important to understand how informal science institutions contribute to effective change in teacher science content knowledge and pedagogy. This research study analyzed zoo and aquarium provided teacher professional development to respond to the research questions: How do zoos and aquaria determine and assess their goals for teacher professional development? How do these goals align with effective teacher change for science content knowledge and pedagogy? Theoretical frameworks for high quality teacher professional development, effective evaluation of teacher professional development, and learning in informal science settings guided the research. The sample for the study was AZA accredited zoos and aquariums providing teacher professional development (N=107). Data collection consisted of an online questionnaire, follow-up interviews, and content analysis of teacher professional development artifacts. Analysis revealed that by and

large zoos and aquariums are lacking in their provision of science teacher professional development. Most professional development focuses on content or resources, neglecting pedagogy. Assessments mismatch the goals and rely heavily on self-report and satisfaction measures.

Pregnant Pauses: Science Museums, Schools and a Controversial Exhibition Erminia G. Pedretti, University of Toronto Ana Maria Navas Iannini, University of Toronto **ABSTRACT:**

Recently, science centres and museums have begun to develop contemporary and often provocative installations (e.g., Renewable Energies: Time to Decide; Sex: A Tell All) with all the social and political trappings of the day. These displays often referred to as critical exhibitions (Pedretti, 2002), tend to approach socioscientific issues through diverse perspectives (often exposing and/or generating controversy) and to actively engage visitors. In this paper, we explore responses from, and relationships between, school and museum communities, in the context of critical exhibitions. Using case study methodology, we present findings related to the case/exhibit Preventing Youth Pregnancy (São Paulo, Brazil), a display that approaches complex socioscientific issues, such as sexual practices and sexually transmitted diseases, through narratives, role play and drama. Through semi-structured interviews, observation, field notes and collection of documents, we focused on visiting teachers' and students' experiences with the exhibit, as well as curators and museum educators' expectations about it. Relevant findings are framed by three major themes: building connections between the formal and the informal sector through collaboration, building connections with youth culture, and building pathways for change.

How to Assess Learning School Visits? Personal Meaning Maps as a Tool for Assessing Learning Cl-udia Faria, Institute of Education of The University of Lisbon **ABSTRACT:**

In this work we analyse the potentiality of using personal meaning maps (PMM) to assess the impact of a marine hands-on activity on students' understanding about biodiversity and scientific procedures. The activity was focused on the theme of biodiversity and it involved a pre-visit task, a field trip and a post-visit session. The activity was implemented with 149 primary school students. During the activity students had the opportunity to collect and analyse data directly from the field. Students were asked to create two PMMs, at the beginning of each activity, and to create two new ones after its end. We used two types of PMMs, centered on the key-words "Biodiversity" and "Doing science". PMMs were subjected to content analysis. The analysis of the PMMs revealed that in general there was a progression in their complexity at the end of the activity. In fact, in the post-visit there was an increase of related items and much more concrete examples of distinct organisms or of science materials and procedures were included. As a conclusion, it seems that PMMs are good tools to show students' progress towards concepts' learning and help to diagnose student's ideas on a particular subject, with primary school levels.

Exploring the Sky: Investigating Discourse Dynamics in an Atmospheric Science Educational Outreach Program

Kathryn J. Boyd, Colorado State University Meena M. Balgopal, Colorado State University Thomas Birner, Colorado State University

ABSTRACT:

Educational outreach programs led by scientists have many goals: to teach content, increase interest in the sciences, and improve understanding of the nature of science (NOS). Like teachers, outreach educators strive for interactive engagement with students. One question that arises is whether student discourse differs during interactions with a visiting science expert compared with a classroom teacher. This study sought to answer this question using discourse analysis in a 10th grade Earth Science class at a public high school. An atmospheric science professor used historical stories of discoveries to introduce concepts about the middle atmosphere while reinforcing the NOS through interactive storytelling. On a separate day the teacher implemented a lesson on plate tectonics grounded in NOS. Both lessons were video-recorded. Data were triangulated with presenter interviews and student assessments collected during class. Levels of questioning by students and expert (scientist and teacher) were studied using a published inquiry rubric. Preliminary results indicate that the scientist used higher inquiry-based questioning strategies than the teacher; however the teacher explored the content at a deeper level than the scientist. Such trade-offs warrant consideration, especially when developing outreach curricula.

Strand 7: Pre-service Science Teacher Education

Symposium - A Design Charrette to Explore Models for Engaging Science Preservice Teachers in Engineering

8:30am - 10:00am, James

Presider: Christine Schnittka, Auburn University

Presenters:

R. Charles Dershimer, University of Michigan Carolin Frank, Leibniz Institute for Science and Mathematics Education

Frackson Mumba, University of Virginia

Jennie Chiu, University of Virginia

Alonzo B. Alexander, North Carolina State University

Timothy A. Goodale, North Carolina State University

Christine Schnittka, Auburn University

ABSTRACT:

Currently, STEM teacher education programs in the United States do not traditionally include any formal or informal classroom experiences to support preservice teachers with the development of disciplinary knowledge in engineering. This Symposium will address the question "How do different teacher education institutions engage science certification students with learning about engineering?" The symposium will be run as an engineering design charrette to allow audience members to engage meaningfully with panel members. This will allow for a generative discussion around the presented instructional frameworks for engaging preservice teachers with learning about engineering. Symposium discussion will address program design implications associated with linking engineering knowledge to the enactment of engineering practices.

Strand 8: In-service Science Teacher Education

Teacher Perspectives and PCK 8:30am - 10:00am, Homeland **Presider:** Mary K. Nyaema, University of Iowa

AP Science Redesign: Teachers' Perspectives on their Schools' AP Culture and Implications for Student Success Abigail Jurist Levy, Education Development Center, Inc. Ayana M. McCoy, University of Massachusetts Boston Kim M. Frumin, Harvard University Arthur Eisenkraft, University of Massachusetts Boston Christopher Dede, Harvard Graduate School of Education Barry J. Fishman, University of Michigan Christian Fischer, University of Michigan

Frances Lawrenz, University of Minnesota

Yueming Jia, Education Development Center, Inc.

ABSTRACT:

In 2012, the College Board implemented the first of their redesigned Advanced Placement (AP) Science courses, which affected approximately 20,000 AP science teachers and their students. This redesign is a significant transformation, and has implications for students and their families, as well as teachers and their schools. The National Science Foundation has funded a large-scale, mixed method study to explore, among other things, the relationship between teachers' patterns of professional develop activity, their own and their schools' characteristics, and students' AP exam outcomes. From this larger study, this paper presents one set of findings that describes the experiences of 57 AP Science teachers in order to understand how schools' AP culture can impact students' AP outcomes regardless of the PD in which teachers have engaged.

Effects of an ISEP Professional Development on Teachers' PCK and Students' Understanding of Science Yang Yang, University at Buffalo

Xiufeng Liu, State University of New York at Buffalo, SUNY)

Michelle R. Eades-Baird, State University of New York at Buffalo, SUNY)

ABSTRACT:

This study examined the impact of the professional development on teacher's pedagogical content knowledge (PCK) in science and their students' understanding of science from grade 4 to 8 in an interdisciplinary science and engineering partnership. Teachers were provided with summer research opportunities and monthly professional learning session to enhance interdisciplinary science teaching and learning since 2012. The study involved students and teachers at five elementary/middle schools in an urban school district during the 2013 to 2014 school years. The regression analyses indicated significantly positive association between attendance hours of professional learning session/summer placement and teacher's PCK test scores. Students' test scores were calibrated across grades and time by Rasch modeling. The two-level hierarchical linear models illustrated that students' ability was positively related to their self-reported self-efficacy in science learning, understanding of nature of science, and their teacher's attitude and expectation on students' work when the variables of demographics are controlled. A further mediation test showed the effect of length of professional development on students' ability was fully mediated by students' understanding of nature of science.

Examining Physics Teachers' Technological Pedagogical Content Knowledge After a Professional Development Program: Multiple Case Study Merve Senturk, Gazi University Meltem Irmak, Gazi University Jale Ercan, Gazi University Duygu Yilmaz, Gazi University Mehmet F. Tasar, Gazi University

ABSTRACT:

The main goal of this research was examining technological pedagogical content knowledge (TPACK) of two physics teachers who participated in a professional development program about use of animations and simulations in physics teaching. This study employed a multiple case study design to understand teachers' TPACK. Data sources of present study were semi structured interviews and classroom observations. Data analysis revealed that both of the teachers have positive perceptions about integrating technology in classroom. It may be said that none of them had any effort to select suitable curriculum materials. Because they thought that the process of preparing the lesson enriched technological tools was hard. When it comes to students' understanding, none of the teachers used technology to reveal students' prior knowledge and alternative conceptions. Moreover, teachers did not apply technology to facilitate assessment and evaluation. Although the

teachers had technology knowledge and have been using it for years, their knowledge and practices about appropriate integration of technology, pedagogy and content knowledge is limited. These results suggest that providing opportunities for teacher to create an effective physics lesson is important.

Investigating In-Service Science Teachers' Orientations and Practices Toward Developing Socioscientific Issues Based Instruction

Stephen B. Witzig, University of Massachusetts Dartmouth

ABSTRACT:

Reforms in science teaching and learning are at the forefront of science teacher educators' research and practice. A new framework for K-12 science education is shaping science standards nationwide. Furthermore, research encouraging us to recast traditional science instruction in ways that fosters scientific literacy using a socioscientific issues (SSI) based approach to science teaching has been examined. This qualitative study was guided using case study methodology to address the following over-arching research question: How do inservice teachers' orientations and practices toward teaching science though SSI-based instruction develop while engaged in a marine science course? I posit the following three assertions: 1) SSI-based instruction facilitated in-service teachers' purposes and goals for teaching science through student-centered approaches; 2) In-service teachers found research-based teaching frameworks helpful in navigating the development of SSI-based instruction, though found constraints of implementation that they discussed were outside of their control; and, 3) In-service teachers found SSI-based instruction aligned with, and modeled well, science teaching practices though admitted that more support structures would be helpful for full implementation. I discuss the implications of the findings as well as provide suggestions for future research in this area to continue the dialogue about our roles as science teacher educators.

The Pedagogical Content Knowledge of Pollution Held by Secondary Chemistry Teachers in Country A Farah Shamaa, American University of Beirut

Saouma B. Boujaoude, American University of Beirut

ABSTRACT:

The purpose of this study was to investigate PCK of six experienced and novice chemistry teachers of pollution and relate their PCK to educational level and years of experience. Two teachers were certified and three had more than six years of experience. Three instruments were used: A lesson-planning assignment followed by semi-structured interviews; a video-taped teaching session followed by a self-evaluation and a guided case analysis and content representation (CoRe) matrices followed by semi-structured interviews. Data were coded and quotes for each teacher were placed under one of three categories: PCK in planning, PCK in action, and PCK in reflection. Each of the quotes was then categorized as either poor, moderate, or proficient based on a rubric. Findings revealed that teachers' PCK profiles varied along a continuum ranging from poor to moderate. Experience and certification influenced the PCK score positively but none of the teachers achieved proficiency. Teachers scored highest on PCK in planning and lowest on PCK in reflecting. Possibly the school learning environment might not offer opportunities for teachers to reflect on their PCK dimensions following instruction and, teacher education programs do not seem to prepare teachers to integrate all PCK dimensions when teaching any topic.

Strand 10: Curriculum, Evaluation, and Assessment
Symposium - Building Responsible NGSS-Aligned Curriculum and Assessments in an Era of Accountability
8:30am - 10:00am, Baltimore Salon B
Presider: Suzanne M. Wilson, University of Connecticut
Presenters:
Barbara Nagle, University of California-Berkeley

James B. Short, American Museum of Natural History Suzanne M. Wilson, University of Connecticut Anna MacPherson, American Museum of Natural History John Howarth, University of California-Berkeley Maia Willcox, University of California-Berkeley Bianca Montrosse-Moorhead, University of Connecticut Kristen Juskiewicz, University of Connecticut Katherine L. Mcneill, Boston College Jamie N. Mikeska, ETS *ABSTRACT:*

Implementing the Next Generation Science Standards will require considerable investment in building new curricula, teacher/school capacity, and assessments. Building on previous collaborative work between a museum and a large urban school district to engage teachers in learning about scientific investigations, the authors report on their efforts to develop a NGSS-aligned middle school curriculum ecosystems unit and associated professional development, collaborate with teachers in the field testing and revision of that curriculum, and develop embedded student and teacher assessments. In the doing of this work, a central question has emerged around which this symposium is organized: While responding to NGSS in an era of accountability, how can you responsibly build and embed formative and summative assessments of student and teacher learning in the work?

Strand 10: Curriculum, Evaluation, and Assessment

Related Paper Set - Challenges and Solutions to Assessing Three-Dimensional Science Proficiency 8:30am - 10:00am, Watertable Salon A

ABSTRACT:

This related paper set has three primary goals. First, presenters from four research programs will discuss solutions to challenges associated with developing science assessments aligned with the Framework for K-12 Science Education (NRC, 2012). Second, a discussant will critically synthesize these solutions. Third, session attendees will participate in a substantive discussion with presenters to articulate other challenges, discuss solutions, and identify future research directions and collaborations. This session focuses on three key challenges to assessment development that have emerged from the efforts to address the three dimensions of the Framework: (1) how assessment tasks address the three performance dimensions, (2) how tasks address crosscutting concepts in particular, and (3) the potential of tasks for formative classroom use. The four papers present contrasting solutions to three challenges. Paper 1 describes Learning Performances, which are intermediate performance targets that build toward NGSS Performance Expectations. Paper 2 illustrates how the three dimensions of the Framework can be mapped onto science and mathematics proficiency scales to inform diagnostic reporting. Paper 3 builds on a learning progression for the assessment tasks that engage students with computer-based simulations.

Using Learning Performances to Design Three-Dimensional Assessments of Science Proficiency

Kevin W. McElhaney, SRI International Brian D. Gane, University of Illinois at Chicago James W Pellegrino, University of Illinois at Chicago Christopher J. Harris, SRI International Lou DiBello, Learning Sciences Research Institute-UIC Joseph S. Krajcik, Michigan State University Connecting and Assessing Mathematics-Related Science Practices, Crosscutting Concepts and Disciplinary Core Ideas Using Learning Progressions Malcolm Bauer, Educational Testing Service Hui Jin, Educational Testing Service Lei Liu, Educational Testing Service

Developing Assessment for Scientific Argumentation Jonathan Francis Osborne, School of Education, Stanford University

Multidimensional Assessment in Simscientists Edys S. Quellmalz, WestEd Barbara C. Buckley, WestEd Matt Silberglitt, WestEd

Strand 11: Cultural, Social, and Gender Issues *Culturally Congruent Approaches to Science Education* 8:30am - 10:00am, Watertable Salon C **Presider:** Irasema Ortega, University of Alaska-Anchorage

Supplemental and Optional Take-Home Projects for Culturally and Linguistically Diverse Learners: Formal and the Informal

Geeta Verma, University of Colorado Denver Helen Douglass, University of Colorado Denver Brandy Bourdeaux, University of Colorado Denver *ABSTRACT:*

Research suggests that CLD students have difficulty making meaning in the science classroom due to incongruence between the academic language/culture inherent in the science curriculum and that of students' culture(s) and experiences (Lee and Fradd, 1998). This study explored ways in which elementary- aged culturally and linguistically diverse (CLD) students engaged with supplemental and optional take home-projects (SOTHP) that integrated practices and crosscutting concepts (Lead States, 2013). We worked with one science teacher and approximately 60 students over a period of 1 year to modify the instructional, pedagogical, curricular, and cultural norms to create new spaces where students could find meaningful ways to participate in the science classroom. This study, as one component of a larger study, answered two questions focused on students' interactions and engagement with supplementary and optional take home-projects (SOTHP). Data sources included student group interviews, students' artifacts, and field notes. Findings indicated a) students' identified the need to integrate design-based practices in their learning; and b) students transitioned their formal learning experiences into informal spaces (using SOTHP) seamlessly to engage in new learning opportunities. We will present opportunities (and challenges) that arise from interfacing the formal-informal learning experiences and their implications for student engagement.

Making Connections: Finding Success in the Gray Zone of a Collaborative, Cross-Cultural Making Project
Lauren Causey, Science Museum of Minnesota
Marjorie Bullitt Bequette, Science Museum of Minnesota
Gina N. Svarovsky, University of Notre Dame
ABSTRACT:
Museums present an array of informal learning options, but can be stymied by perceptions—or actual

practices—of elitism, monoculturalism, or disengagement with visitors' realities (Simon, 2010; Falk &

Dierking, 2012). Guided by theoretical frameworks which push on traditional versions of "culturally relevant" (Ladson-Billngs, 1995) work, toward efforts that are "culturally sustaining" (Paris, 2012), and therefore longer lasting, our research study holds promise in cultivating more inclusive Making practices among educators in both informal and formal learning spaces. We conducted an NSF-funded research study at the Science Museum of Minnesota in order to reconsider how to enact Making in the museum's overall scheme for engaging audiences, especially underrepresented audiences. The research study pondered whether a new paradigm for Making can be shaped, and our paper highlights ways in which the areas of greatest uncertainty, which we call the gray zone, caused us to learn the most about ways that culture was represented within new Making activities at the museum.

Exploring the Impact of Culturo-Techno-Contextual Approach, (CTCA) in Tackling Under-Achievement in Difficult Concepts in Biology

Khadijat Ige, Lagos State University, Lagos, Nigeria Peter A. Okebukola, Lagos State University, Nigeria Temitope Anuoluwapo, Lagos State University, Nigeria Rebecca Oyeyemi, Lagos State University, Nigeria Adetola Olusesi, Lagos State University, Nigeria Khadeejat Ige, Lagos State University, Nigeria Olatunde Owolabi, Lagos State University, Nigeria Foluso Okebukola, Lagos State University, Nigeria Sunday Banjoko, Lagos State University, Nigeria Grace O. Oshun, Lagos State University, Nigeria *ABSTRACT:*

The concern for culturally-relevant method of science teaching has continued to agitate researchers in Africa, reaching new heights at the beginning of this century. This study explored the impact of the Culturo-Techno-Contextual Approach (CTCA) on students' achievement and attitude towards perceived difficult concepts in biology. The study had a survey and a quasi-experimental phase. The survey phase involved 5,032 secondary biology students and their teachers (N=311) in Lagos State, Nigeria which yielded "Energy flow in an ecosystem" as the most difficult topic. The quasi-experimental phase (N= 132) employed quantitative and qualitative data-gathering techniques. CTCA was used for the experimental classes. MANCOVA showed that on the achievement measure, the experimental and control groups were significantly different (mean score for experimental= 23.08; control=16.51; F=19.24.05; p<.001). Similar trend was found for the attitude scores (mean score for experimental= 26.03.1; control=19.64; F=12.06; p<.001). Qualitative data analysis using NVivo software showed the emergence of three themes. The exploratory study provides a basis for the validation of CTCA and a confirmation of its potency. While the findings cannot be extrapolated beyond the study sample, it gives some initial basis for several important recommendations in the quest for culturally and contextually-relevant methods of effective delivery of science.

Rethinking Pedagogy in Urban Spaces: Implementing Hip-Hop Pedagogy in the Urban Science Classroom Edmund S. Adjapong, Teachers College, Columbia University Christopher Emdin, Teachers College Columbia University Ian P. Levy, Teachesrs College, Columbia University ABSTRACT: A significant amount of research regarding Hip-Hop Based Education (HHBE) fails to provide insight on how

A significant amount of research regarding Hip-Hop Based Education (HHBE) fails to provide insight on how to incorporate elements of Hip-Hop into daily teaching practices; rather educators focus mainly on incorporating Hip-Hop culture into curricula. This study explores the benefits of using two specific Hip-Hop pedagogical practices in an urban science classroom. Call-and-response and co-teaching, two different pedagogical approaches that are related to Hip-Hop culture were implemented and studied to understand their

benefits in an urban science classroom. This study provides insight on ways Hip-Hop can be incorporated into the art and science of teaching, extending current HHBE research, which mainly discusses how Hip-Hop can be used to design curricula based on music and rhymes.

Strand 14: Environmental Education

Symposium - International Symposium on Culture, Language, Practices, and Place in STEM Education: Indigenous and Place-Based Approaches

8:30am - 10:00am, Maryland Salon A

Presenters:

Pauline W. U. Chinn, University of Hawaii - Manoa Steven C. Semken, Arizona State University Huihui Kanahele-Mossman, University of Hawaii Hilo Geoffrey Bruce, Arizona State University Chiung-Fen Yen, Providence University, Taichung, Taiwan Hsuan-Fang Hung, Providence University, Taichung, Taiwan David Zandvliet, Simon Fraser University George Glasson, Virginia Tech Sharon Nelson-Barber, WestEd Rojjana Klechaya, Srinakharinwirot University, Bangkok, Thailand

ABSTRACT:

This symposium addresses the 2016 NARST theme "Toward Equity and Justice: Many Different Voices, Cultures, and Languages in Science Education Research for Quality Science Learning and Teaching" and Strand 14 in its focus on the ways Indigenous and local, place-based issues and perspectives influence curriculum development, pedagogy, teacher education, research and assessment. The U.S. NRC's A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas recommends that "learning...in the physical, life, earth, and space sciences and engineering be strongly linked with parallel learning in the social, behavioral, and economic sciences" (p.14) to achieve the vision of "educating all students in science and engineering and providing the foundational knowledge for those who will become the scientists, engineers, technologists, and technicians of the future" (NRC, 2012, p. 12). Papers address the role of Indigenous stories, cultural practices, and language as foundation for curriculum development; implementation of indigenous curricula; teacher education and professional development; culturally responsive assessment and evaluation and applications of technology. Increasing the access of Indigenous and underrepresented minorities to mainstream science communities contributes to educational equity and culturally responsive educational discourse that promotes systems-oriented understandings of our shared cultural, economic, and ecological world.

Concurrent Session #11 10:15am – 11:45am

Equity and Ethics Committee Administrative Sponsored Symposium - Jhumki Basu Scholars Symposium - Equity and Justice: **Perspectives From Emerging Scholars** 10:15am - 11:45am, Maryland Salon F **Presenters**: Nam-Hwa Kang, Korea National University of Education Deb Morrison, TREE Educational Services Senetta Bancroft, Grand Valley State University Joy Barnes-Johnson Thea Charles Geraldine Cochran Annabel D'Souza Khadija Fouad Maleka Gramling Sheron Mark Kirsten Mawyer Preetha Menon Karen Rose Kihyun (Kelly) Ryoo Somnath Sinha Sara Tolbert, University of Arizona Shari Watkins **ABSTRACT:**

The Equity and Ethics Committee sponsors this annual interactive poster session for the previous year's selection of Basu scholars. The fifteen 2015 recipients of the Basu Scholars Award have been invited to present exciting and compelling research that engages in the conference theme, Toward Equity and Justice: Many Different Voices, Cultures, and Languages in Science Education Research for Quality Science Learning and Teaching. The scholars bring diverse educational perspectives that will shape science education, and they present new approaches to help us understand challenges and successes of science teachers, students, and programs.

Strand 1: Science Learning, Understanding and Conceptual Change Instructional Trajectories and Learning Across Levels 10:15am - 11:45am, Homeland Presider: Shannon H. Sung, Spelman College

Comparing Elementary and Junior High School Students' Conceptual Understanding and Analogical Modeling Competence of Electricity

Jing-Wen Lin, Graduate Institute of Science Education, National Dong Hwa University Meng-Fei Cheng, Department of Physics, National Changhua University of Education Ruan-Ching Yu, Graduate Institute of Science Education, National Dong Hwa University Weishen Wu, Department of Information Management, Da-Yeh University *ABSTRACT:* The aim of this study was to compare elementary school and junior high school students' achievements on electricity and their performance in analogical modeling on electricity. The participants in this study were Grade 6 (n=274) and Grade 9 (n=251) students in middle Taiwan. Two instruments were adopted: (1) concepts of electricity and (2) analogical modeling items, which are classified into five stages (e.g., model selection/construction, model analysis, model validation, model application, and model deployment) and six levels (0-5, inability to represent associated factors to construct a theoretical model). The results showed that the students' conceptual understanding of electricity was acceptable, and there was no statistical difference in the total score between the sixth and ninth graders. In addition, both the sixth and ninth graders' analogical modeling competences of electricity were insufficient to make inferences of relationship between two objects (lower than Level 2). Students could not construct the key elements (i.e., bulb and battery) of a circuit model. However, the ninth graders received significantly higher scores in model deployment and larger proportion in modeling competence at higher levels and stages of model validation, model application, and model deployment than the sixth graders.

Distinguishing Emergent and Sequential Processes by Learning Emergent Second-Order Features

Dongchen Xu, Arizona State University Na Li, Arizona State University Joshua R. Adams, Arizona State University Michelene T.H. Chi, Arizona State University

ABSTRACT:

People have many robust misconceptions in explaining emergent process concepts such as natural selection and diffusion. This is because they lack a proper categorical representation of emergent processes and often misclassify these processes into the sequential processes category with which they are more familiar. The two kinds of processes can be distinguished by their second-order features that describe how interactions relate to one another. This study investigated if teaching emergent second-order features can help them correctly distinguish processes. It also compared different instructional methods in teaching emergent second-order features and received the correct features as feedback were better at distinguishing the two kinds of processes compared to participants who did not learn them. This "generate with feedback" condition was also better than the condition where participants attempted to generate emergent features first and then asking participants to explain the difference between emergent and sequential features resulted in an equivalent learning gain as the "generate with feedback" condition. These results proved that teaching emergent second-order features does help learners categorize processes and demonstrated an efficient way to teach them.

Elementary, Middle and High School Students' Scientific Reasoning Skills: A Content Analysis From 1980 to 2015

Yurdagul Bogar, University of Tennessee Jale Cakiroglu, Middle East Technical University *ABSTRACT:*

The primary objective of this study is to provide a review of research on elementary, middle and high school students' scientific reasoning skills in science education based on publications from 1980 to 2015. In fulfilling this goal, content analysis has employed in this study. After we identified the relevant articles, we defined the characteristics central to our content analysis study and analyzed the articles we selected on the basis of these characteristics. These are participant of the study, year of the study, publication source of the study and research design. As a result we collected forty-three studies that met all of the criteria and provided the requisite data for a content analysis were identified. The findings of this content analysis study showed that although number of scientific reasoning skill studies did not increase each year gradually, we can say that scientific reasoning is

developing area and has had popularity recently in science education field. Future studies can focus on college or undergraduate students, graduate students and teachers. Furthermore, they can include a variety of data sources including master thesis, dissertations and unpublished dissertations. Key words: Scientific reasoning, elementary school students, middle school students, high school students, content analysis

Following and Breaking Conventions for Scales on Graphs: From Middle School Students to University Professors

Cesar Delgado, University of Texas at Austin Margaret M. Lucero, Santa Clara University

ABSTRACT:

Scale construction is a little-studied component of graphing, which is an essential practice in science and mathematics. While specific conventions apply to the construction of standard scales, these conventions are often tacit. In order to compile a comprehensive list of conventions, scholarly literature and committee reports were analyzed, yielding nine conventions. For example, scales for quantitative data should use equal lengths for equal numbers of units (ELENU). Next, the scales constructed by 37 middle school, 84 high school, and 52 undergraduate students, and the 174 scales from graphs used by professors in the multimedia presentations of an interdisciplinary undergraduate course were analyzed for conformance with conventions. Compliance with the ELENU convention rose with increased level of schooling. Compliance at all levels. Common forms of high school students. Other conventions feature high rates of compliance at all levels. Implications for the teaching of graphing are suggested.

Strand 2: Science Learning: Contexts, Characteristics and Interactions Socio-Scientific Issues and Outdoor Learning

10:15am - 11:45am, Maryland Salon E **Presider:** Stephen C. Scogin, Hope College

Analysis of a Middle School, Problem-Based Outdoor Learning Science Program Stephen C. Scogin, Hope College Chris Kruger, Hope College Regan Jekkals, Hope College ABSTRACT:

STREAM School is a seventh-grade program provided through a partnership between a rural Midwestern school district and a non-profit outdoor education center. STREAM School takes a non-traditional approach by connecting students to the outdoors through project-based learning (PBL).In an effort to gain as much insight as possible into this complex program, researchers used a convergent-parallel mixed methods research design (Creswell & Plano-Clark, 2011) to analyze the program. Results provide evidence suggesting student gained appreciable non-cognitive outcomes while progressing acceptably on standardized tests. While the design of this study precludes researchers from making direct causal links, these results are highly suggestive of an effective program.

Exploring Students' Quality of Argumentation About Local Socio-Scientific Issues in Different Learning Contexts Esra Capkinogly, About Izzet Paysol University

Esra Capkinoglu, Abant Izzet Baysal University Serkan Yilmaz, Hacettepe University Gulsen Leblebicioglu, Abant Izzet Baysal University *ABSTRACT:* Abstract: This study investigated argumentation quality of seventh grade students who learn about five local socio-scientific issues in three different learning contexts. Three learning contexts were outdoor (learning at site), newspaper (learning from news), and presentation (information presented by the researcher) groups. Twelve students enrolled in each group. Five local socio-scientific issues were artificial lake, chicken factories, leather tanneries, base stations, and hydroelectric power plants in or around the city. The groups in three learning contexts involved in the same verbal argumentation practices within small groups at each local socio-scientific issue. Students' small group discussions were recorded and transcribed verbatim. Argumentation quality was determined by levels proposed by Erduran, Simon, & Osborne (2004). The results showed that while newspaper group generated highest number of sophisticated argumentations in four of five socio-scientific issues. Presentation group was between the two. It was concluded that it would be better if news on newspapers be used in teaching argumentation. Teachers should be careful in choosing the context for students' argumentation, since context affects quality of their argumentation.

Negotiations Among Students, Scientists, and Teachers in a School-Based Citizen Science Partnership Emily Harris, University of California, Davis Heidi Ballard, University of California Davis Cynthia Carter Ching, University of California Davis ABSTRACT:

This study explored how youth participants developed their own inquiries of a citizen science database in a high school marine biology class in the context of a student-scientist partnership (SSP). Specifically, the study explored how negotiations among students, scientists, and their teacher shaped the group inquiries as they collected data to contribute to a citizen science project, asked questions of the large database, analyzed data, and published findings in a blog. Drawing on student work in Google documents, observations, and interview data, this article analyzes four processes across three group inquiries and how negotiations or lack thereof afforded differential opportunities for students to develop an emergent sense of authenticity (Rahm, Miller, Hartley, & Moore, 2003). Findings indicated that 1) repeated in-person and virtual negotiations—among students, scientists and the teacher—led to productive inquiries because students had ownership of the project and developed inquiries the available data could answer, 2) foregrounding the project as a school assignment could undermine both student ownership and their sense of contribution to science, leading to a lack of authenticity, and 3) emergent interactions involving misinterpretations sometimes led to unexpected and successful inquiries. Potential problems and opportunities for citizen science-based SSPs are discussed.

Trouts and High-Rises: Exploring Student and Teacher Experiences with a STEM Integrated PBL

Marissa C. Owens, University of Nevada, Las Vegas

Abeera P. Rehmat, University of Nevada, Las Vegas

ABSTRACT:

The focus of this study was to investigate teacher and student experiences surrounding the implementation of a STEM integrated PBL. The study was guided by the following research questions: 1) What is the experience of implementing a STEM integrated PBL for a female science specialist teacher?; 2) What is the experience of participating in a STEM integrated PBL for fourth grade students enrolled in a science special class?; and 3) How does a teacher's experience in implementing a STEM integrated PBL compare to student opinion on the experience? A qualitative phenomenological research design was utilized for this study. This research design method was used because the teacher and students all shared and experienced a common phenomenon, a STEM integrated PBL enriched environment. A phenomenal data analysis revealed common themes that emerged from the data, from both the students and teacher experiences: increased interactions, focus on design and engineering, and collaboration. Findings from this study indicated that students enjoyed an increase in interactions, working in groups, and being provided with an opportunity to design and create solutions to

problems. The teacher appreciated the ability to facilitate learning and provide hands-on experiences that led to more interactions with students and real-world applications.

Strand 2: Science Learning: Contexts, Characteristics and Interactions

Symposium - Why Matter Matters in Science Education: Implications for Practice

10:15am - 11:45am, Maryland Salon B **Presenters**: Catherine E. Milne, New York University

Kathryn Scantlebury, University of Delaware

Anita Hussenius, Uppsala University, Centre for Gender Research

Anna T. Danielsson, Uppsala University

Annica Gullberg, University of Gvle

Katherin Otrel-Cass, Aalborg University, Denmark

Bronwen M. Cowie, University of Waikato/WMIER

David S. Heywood, Manchester Metropolitan University

Shirley A. Simon, University College London

Paul Davies, Institute of Education, University of London

ABSTRACT:

In education and science education there has been a tendency to ignore material culture and to focus on social practice through constructivist lenses with language used as the arbiter of such social practice. Often material practice, such as those in the forms of apparatuses, artifacts, scientific instruments, is ignored when scholars communicate new knowledge and/or realities based on socio-cultural examination of the world. While we do not ignore the role of language in the construction of science and science education, we agree with Karen Barad (2003) that perhaps language has too much power and with that power there seems a concomitant loss of interest in exploring how matter contributes to both ontology and epistemology in science and science education and its role in scientific practice across many levels of science education and explore implications for learning in science and related fields.

Strand 3: Science Teaching--Primary School, Grades preK-6): Characteristics and Strategies *Impacts of Teacher Knowledge on Elementary Science Classrooms* 10:15am - 11:45am, Watertable Salon A

Presider: Claudia P. Aguirre-Mendez, Emporia State University

Comparing the Preparedness and Instructional Quality of Traditional and Science Specialist Elementary Teachers

Joseph A. Brobst, Western Washington University Tammy Q. Tasker, Western Washington University Kimberly A. Markworth, Western Washington University *ABSTRACT:*

We describe comparisons between a sample of elementary science instructional specialists and a matched comparison group of traditional elementary teachers on self-reported preparedness to teach science as well as measures of content knowledge and instructional quality. Elementary science instructional specialists were more likely to have completed science content degrees, and reported feeling more prepared to teach both science and engineering content as well as being more familiar with the Next Generation Science Standards. Specialist teachers scored higher than their matched counterparts on measures of Astronomy/Space Science,

Earth Science, and Physical Science content knowledge while the two groups did not differ on a measure of Life Science content knowledge. Based on preliminary analyses of videotaped science lessons, specialists also more effectively engaged students in two key elements of effective science instruction: using evidence to make claims and sense-making (Banilower et al., 2010). Our findings suggest that elementary instructional specialist models may attract teachers with stronger science backgrounds and that teachers working in these models may be better equipped to engage their students in effective science instruction. The importance of past professional development in contextualizing our findings will be discussed along with implications for future professional development and research.

Developing and Testing a Method for Collecting and Synthesizing Pedagogical Content Knowledge Courtney Nelson Plumley, Horizon Research, Inc.

Patrick S. Smith, Horizon Research, Inc.

Keith Esch, Horizon Research Inc.

ABSTRACT:

Pedagogical content knowledge (PCK) has been suggested as a form of knowledge that sets teachers apart from other professionals. In their practice, teachers uniquely blend disciplinary content knowledge and pedagogical knowledge. Despite the appeal of PCK, its potential for transforming instruction and instructional materials has largely gone unrealized. Among the obstacles is a lack of agreement among researchers about nature of the construct. In addition, our field can point to few instances of codified PCK relative to the number of science topics. To address this second obstacle, we are developing and testing a method for gathering and synthesizing PCK from three sources: empirical literature, practitioner literature, and expert practitioner insights. We call the product "collective PCK," or "C-PCK." The work is taking place in the context of two elementary topics from the Next Generation Science Standards: Matter and Ecosystems. The overall goal of our study is to create an efficient, scalable method for collecting, synthesizing, and formalizing C-PCK that can be applied to a broad array of science topics. This paper will describe the method and our findings to date.

Influence of Pedagogical Content Knowledge (PCK) on Sustainable Implementation of an Argument-Based Inquiry Approach

Jee Kyung Suh, University of Iowa Soonhye Park, North Carolina State University

ABSTRACT:

This study aimed to examine the nature of Pedagogical Content Knowledge (PCK) that enables teachers to effectively implement and sustain pedagogical practices of an Argument-Based Inquiry (ABI). In particular, we explored common patterns of epistemological orientations and PCK of three exemplary teachers who had employed an ABI approach, the SWH approach for an extended period consistently at a high-level of implementation. The findings of this study expand the scholarship of nature of PCK integration and its role in sustaining changes in practice. Specifically, this research contributes to our understanding of how a teacher can sustain changes in their teaching methods by reconstructing their own knowledge and beliefs.

The Investigation of Effective Strategies for Developing Creative Science Thinking

Kuay-Keng Yang, National Sun Yat-Sen University Ling Lee, National Sun Yat-Sen University Zuway-R Hong, National Sun Yat-Sen University Huann-Shyang Lin, National Sun Yat-Sen University *ABSTRACT:*

The purpose of this study was to explore the effectiveness of the Creative Inquiry-based Science Teaching (CIST) on students' creative science thinking and science inquiry performance. A quasi-experiment design consisting one experimental group(N = 20) and one comparison group(N = 24)with pre- and posttests was

conducted. The framework of the intervention focused on potential strategies recommended by literature. Results reveal that the experiment group students outperform their counterparts on the performances of science inquiry and convergent thinking. Additional qualitative data analyses from classroom observations and case teacher interviews allow us identify supportive teaching strategies of developing student creative science thinking. Keywords: convergent thinking, divergent thinking, science inquiry

Using Elementary Teacher Life Science Subject Matter Knowledge to Inform Professional Development David E. McKinney, Johns Hopkins University School of Education Erica L. Smith, Johns Hopkins University Carolyn A. Parker, The John Hopkins University

ABSTRACT:

This paper describes the life science subject matter knowledge (SMK) of third grade science teachers as communicated during six ecology lessons. This study is situated in a National Science Foundation-funded Math Science Partnership (MSP) between a university and a large urban school district aimed at improving Science, Technology, Engineering, and Mathematics (STEM) education in grades three through five. As a part of the MSP, teachers receive a STEM curriculum, materials, and professional development (PD). A component of the PD are STEM Academies, content-focused courses for participating teachers. In this study, video-recorded observations of ecology lessons were analyzed for teacher communication of scientifically acceptable and alternative science conceptions. All teachers communicated acceptable and alternative conceptions of knowledge of ecology during the observations. Alternative conceptions were expressed when provided lesson plans lacked detail or recommended a resource that communicated alternative conceptions. These findings were used to inform the planning of a Life Science STEM Academy with teachers, including those observed in this study, participating in the MSP.

Strand 4: Science Teaching--Middle and High School, Grades 5-12): Characteristics and Strategies *Interdisciplinary Approaches*

10:15am - 11:45am, Kent **Presider:** Rhea L. G. Miles, East Carolina University

Engineering Integrated Science (EIS) for Reforming Technical High School Science Curriculum in South Korea Seoung-Hey Paik, Korea National University of Education Younkyeong Nam, the College at Brockport - State University of New York

ABSTRACT:

This study investigated how engineering integrated science (EIS) curricula affect first-year technology high school students' attitudes toward science and perceptions of engineering. The effect of the EIS participation period on students' attitudes toward science was also investigated by experimental study design. Two engineering integrated science curricula (10 and 18 weeks) were purposefully designed and implemented for the study. Two important results emerged: (1) The EIS curriculum participation period (10 or 18 weeks) mattered for changing students' attitudes toward science and (2) A majority (>61 %) of the students from both control and experimental groups who participated in the first EIS agreed that the curriculum positively affected their understanding of engineering practice. The results suggest that EIS is a potential pedagogical approach for reforming current science practice in technical high school programs to improve both students' interest in science and career readiness. Implications for implementing EIS in technical high school settings are addressed.

Lessons From Four Middle School Science Teachers' Implementation of Integrated STEM Units Nii A. Tackie, University of Minnesota Sousada Chidthachack, University of Minnesota

Gillian Roehrig, University of Minnesota Tamara J. Moore, Purdue University *ABSTRACT:*

In today's technological age the solutions to many problems we encounter demand the integration of Science, Technology, Engineering, and Mathematics (STEM) concepts (Bybee, 2010). Despite the push to integrate mathematics and engineering in science classrooms, science teachers continue to face challenges when teaching outside their content area and therefore, results in missed opportunities to support meaningful integration. The STEM Integration Project (SIP) is an NSF Mathematics and Science Partnership involving partners from higher education and grades 4-9 science teachers. In this paper, we focus on four middle school science teachers who taught physical science content. Through multiple case study and analyzing field notes and videos of implementation of integrated STEM units, this work aims to better understand the challenges that science teachers face as they work to integrate meaningful mathematics and engineering to their classrooms.

Urban Science Teachers' Implementation of Common Core State Standards for ELA within the Context of Interdisciplinary Science Inquiry

Michelle R. Eades-Baird, State University of New York at Buffalo, SUNY) Xiufeng Liu, State University of New York at Buffalo, SUNY)

ABSTRACT:

The purpose of this study was to explore science teacher beliefs, perceptions and practices surrounding the implementation of the Common Core State Standards (CCSS) for ELA within the context of their Interdisciplinary Science Inquiry (ISI) - based instruction. It was situated within a project called the Engineering and Interdisciplinary Science Partnership (EISP-pseudonym), an NSF-funded teacher professional development program between 12 public schools and 2 public universities in the North Eastern United States. This study utilized a mixed-methods research design to investigate the following research questions: (1) how do science teachers demonstrate knowledge and values of CCSS for ELA curricula when they conduct ISI? and (2) what relationship, if any, exists between teacher beliefs and perceptions of the CCSS for ELA and its implementation in the science classroom? The data sources from this study included three years of teacher interviews, classroom observations, teacher and student artifacts and survey data. The results from this multiple case study demonstrate that (1) science teachers' beliefs related to science teaching have the greatest influence on their implementation of the CCSS for ELA; (2) teachers who approach science teaching using constructivist and reform-based methodologies meet more of the CCSS for ELA student portraits and do so in different ways than their colleagues; and (3) addressing implementation support during professional development is critical to the successful implementation of the CCSS for ELA and ISI/inquiry-based teaching practices. The findings of this study have implications for all stakeholders involved in educational reforms and in-service science teacher professional development.

An Urban High School Biology Teacher's Initial Experience Implementing Scientific Argumentation Brent Gilles, Indiana University

Gayle A. Buck, Indiana University

ABSTRACT:

Secondary teachers are the most reluctant group of teachers to implement scientific argumentation in their classrooms (McNeill & Knight, 2013). This is most likely due to teachers' orientation and their understanding of this teaching strategy. The purpose of this study was to investigate a biology teacher's first attempts at implementing scientific argumentation in her classroom. We took an instrumental case study approach to this study in order to document a teacher's first attempt at incorporating argumentation into her classroom. Our findings suggest that teachers need help placing new concepts into their previous knowledge. We also found that our teacher needed help in placing argumentation into her existing curriculum for change to occur in the classroom. The evidence collected helps to inform professional development and methods course instructors in

designing appropriate scientific argumentation activities. A couple areas should be addressed. The first area is to ensure that teachers understand how to construct a scientific explanation and how the parts of that explanation fit with the teacher's previous understandings. The second aspect is to help teachers identify lessons they are already familiar with to implement argumentation.

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

Science Education for Social Change 10:15am - 11:45am, Watertable Salon C Presider: Loran C. Parker, Purdue University

Colleagues as Change Agents for Undergraduate Education Reform Tessa C. Andrews, University of Georgia Evan P. Conaway, University of California-Irvine Jun Zhao, University of Georgia Erin Dolan, University of Texas at Austin

ABSTRACT:

Relationships with colleagues could be a source of support for faculty to make meaningful change in how they teach. In particular, science departments are hiring discipline-based education researchers (DBERs), often with the goal of promoting reform, yet we know little about the impact of DBERs. We asked: what colleaguecolleague relationships provide teaching resources and influence instructional change, and how? Our investigation was informed by research on the diffusion of innovations within organizations and social network theory. We used surveys and interviews to examine colleague-colleague interactions about undergraduate teaching in four life sciences departments, each employing DBERs. We used linear regression models to investigate the characteristics of: faculty who share resources for undergraduate teaching and faculty who promote change in teaching. We used qualitative research methods to better understand who promotes education reform and how. Mid-career faculty, female faculty, and DBER faculty provided significantly more teaching resources for their colleagues. DBER faculty and faculty who had engaged in intensive teacher training most commonly influenced colleagues to change their teaching. DBER and other influential faculty promoted change by co-teaching, coordinating courses, providing easy access to education research, and providing teacher training and mentoring.

Making the World a Better Place by Educating the Public with Equity, Justice, and Respect Eva Erdosne Toth, West Virginia University Paula Witt-Enderby, Duguesne University Michelle Nowacki

ABSTRACT:

The need to examine the complex issue of scientific literacy for everyday living towards achieving an equitable and just society is the timely theme of the 2016 NARST conference. Experts in health professions have an important role in educating the public about the application of products of novel discoveries to achieve scientifically literate, healthful living. This presentation focuses on preparing experts in health professions to contribute to the ethical distribution of scientific advances for healthcare choices. A survey of 153 5th year pharmacy students revealed their experiences with patient education practices and their perspectives on the ethical complexity of these communications including focus on the (1) ethical treatment of humans, (2) conceptualizing medical advice, (3) finances and business related issues and (4) complex choices for practical action. The results highlighted participants' epistemological stance on the value of their classroom education and the role of expert mentors in learning norms for ethical behavior and patient interactions. The results

support the formulation of innovative classroom pedagogies thus promise to be of interest to NARST members, attuned to the theme of the 2016 International Conference.

Studying Organizational Change and Learning: Rigorous Attention to Complex Systems Via a Multi-theoretical Research Model

Jana L. Bouwma-Gearhart, Oregon State University Ann Sitomer, Oregon State University Kathleen M. Quardokus Fisher, Oregon State University John D. Ivanovitch, Oregon State university Christina Smith, Oregon State University Milo Koretsky, Oregon State University David Little, Oregon State University

ABSTRACT:

We detail the design of a multi-theoretical research model that remedies noted ontological, epistemological, and methodological limitations to studying change in postsecondary organizations. Our first research question is given the constraints of previous research associated with postsecondary STEM education improvement initiatives, how might we more rigorously and completely study change? We then detail our research model's application in exploring the first research phase associated with a STEM initiative, what is the current potential for organizational change at one research university regarding issues of teaching, specifically more commonly enacted and efficacious a) course evidence based instructional practices (EBIPS) and b) inter- and intra-disciplinary collaborations towards implementation of EBIPs? Data allowed us to ascertain relative prevalence and strength of certain factors indicative of potential for organizational learning, a key necessity for our initiative's success and for its continuous improvement. We reflect on our use of our research model towards informing and honing both our project's theory of action and its feasibility for other efforts to improve and study postsecondary STEM education.

Undergraduate Research Experience and Changes in Career Ambitions for Underrepresented Students in STEM

Anthony Carpi, John Jay College

Darcy M. Ronan, Research Foundation, City University of New York

ABSTRACT:

In this study, we explore changes in the career intentions of students in an undergraduate research experience (URE) program at a large public minority-serving college, using the lens of Social Cognitive Career Theory. Using a pre/post questionnaire model, we explore changes in career intentions as students complete their science major program, with those students not completed a URE providing a control. Graduates participating in mentored research are increasingly focused on professional and academic STEM career tracks involving postgraduate study. In addition to providing an important credential and building students' skills, participation in undergraduate research is seen to have a transformative effect on career ambitions for many students at MSIs.

Strand 6: Science Learning in Informal Contexts Informal Science Online and Games 10:15am - 11:45am, Gibson Presider: Lucy R. McClain, Penn State University

High School Students and Critical Reading of Inaccurate Science Claims on the Internet Anita S. Tseng, Stanford University ABSTRACT: This paper examines the types of background knowledge used by students when reading science texts with inaccurate claims. Today's media landscape has made more science information available to the public. However, there is also more misinformation that is self-published or widely distributed, as exemplified by the popularity of non-expert opinions on vaccination safety. Using Think-Aloud reading activities and semi-structured interviews, I collected data on types of background knowledge utilized by high school students and scientists while reading a blog article with inaccurate claims about vaccination. Results of data analysis indicated that similar to scientists, some high school students could evaluate the article critically, using their knowledge of scientific epistemology and of literacy skills. Other students who validated the author's claims attempted to evaluate the article with their background knowledge on vaccination by drawing from their background knowledge of scientific thinking and general literate skills, but others struggle to do so when relying on non-expert levels of content knowledge. Findings from this research may have implications for an increased emphasis on scientific epistemology and literacy in science education to help students reason with invalid scientific information.

Building Systems From Scratch: An Exploratory Study of Student Learning About Climate Change Gillian Puttick, TERC Eli Tucker-Raymond, TERC

ABSTRACT:

Computing has been a foundational tool in the development of scientific understanding of current and future impacts of climate change, the most important socio-scientific issue facing society today. Science practices, such as modeling and abstraction, are critical to understanding complex systems dynamics integral to understanding climate science. Given the demonstrated affordances of game design in supporting computational thinking, many aspects of which are akin to systems thinking, we implemented a free four-day intensive game design and climate change workshop for middle school girls that focused on game design to teach about climate change. In the workshop, five girls used the object-oriented programming environment, Scratch, to create games based on a systems perspective on climate change. We present findings related to the experience of Lori, a girl with no prior experience with Scratch. Findings are organized into three broader categories: a) analogies to science content in the games, b) game design experience, and c) evidence of systems thinking, including socio-ecological connections.

Social Media Messaging and Engagement with Paleontology in an Online Community of Practice Lisa M. Lundgren, University of Florida Kent J. Crippen, University of Florida Bruce J. MacFadden, Florida Museum of Natural History University of Florida Shari Ellis, Florida Museum of Natural History University of Florida Betty A. Dunckel, Florida Museum of Natural History University of Florida Eleanor E. Gardner, Florida Museum of Natural History ABSTRACT:

ABSTRACT:

Social learning via social media offers a tremendous yet unrealized potential for supporting the collaborative practice of science that spans its formal and informal practices, including amateur and professional participants. To fully enact such a form of social learning would be to unleash some of the lost potential due to lack of communication and collaboration. This study explores the relationship between forms of social media messaging and subsequent interactions (i.e. discourse) among members of a paleontology community of practice (CoP) on the Project's Facebook page. This longitudinal study examined the ways in which CoP members engaged with content and focused on describing which types of posts generated the most conversations about scientific topics. Using descriptive statistics to quantify engagement, levels varied based on post type. Content analysis of the comments reveals that basic conversations about science (those without much

scientific merit) do occur. The thrust of the research reported here involves using our work building a community of practice for paleontology to better understand how social media can be used to support collaboration among amateurs and professionals in order to more fully realize the potential of such collaboration for science.

Science in the Media: Analyzing Depictions of Science Content in ESPN's Sportscience? Joel R. Drake, Utah State University Victor Lee, Utah State University ABSTRACT:

Although television is an important source of popular awareness of science, television programs have been minimally examined as artifacts in learning science content. In this paper, we perform a semiotic analysis of SportScience, a popular segment aired on ESPN and ESPN.com which purports to explain the science behind athletic feats across many sports and athletes. We seek to understand the range of visual techniques used in television media in communicating science content, with the goal of understanding the proper contexts and strategies for appropriating them into other science teaching materials. In analyzing a sample of 30 SportScience vignettes, we found that the program seems prioritize the quantification of athletic performance while demonstrating and using physics terminology. Knowing the nature of such biases of inherent in media can help educators discern whether and how the media may be made useful.

Strand 8: In-service Science Teacher Education

Support and Collaboration Among Teachers and Stakeholders

10:15am - 11:45am, Maryland Salon A **Presider:** Jonathan Francis Osborne, Stanford University

Practitioner Inquiry into Professional Development Centered on STEM, Access and Equity, and Distributed Leadership

Liesl Chatman, Science Museum of Minnesota Amy Grack Nelson, Science Museum of Minnesota

ABSTRACT:

Our museum-based professional development team has engaged in practitioner inquiry to evaluate the impact of our teaching on inservice teachers and school and district leaders. This empirical study looks at how we worked with researchers to collaboratively develop and validate a survey and used it to improve our professional development practice, communicate with district leaders, and strengthen the claims we can make to stakeholders about our professional development. We wanted to know: how do we use the development, validation, and analysis of a pre-post survey of professional development practice to increase our participants' knowledge base, sense of preparedness, and application of practices that integrate access and equity, STEM education, and distributed leadership? We created our own instrument because none of our colleagues were aware of an instrument that could assess this integration. With researchers we carried out validation studies of our survey including descriptive analysis, item think-alouds, and three iterations of exploratory factor analysis. The implications for the field are that PD providers can do this kind of rigorous inquiry with the right supports, and that practitioner inquiry can help us to become better teachers ourselves, which after all, is what we ask our participants to do.

A Foundational Study of the District Science Coordinators Role in Supporting Science Instruction Brooke A. Whitworth, Northern Arizona University Jennifer Maeng, University of Virginia Lindsay B. Wheeler, University of Virginia

Jennifer Chiu, University of Virginia *ABSTRACT:*

This mixed-methods study explored the professional responsibilities of district science coordinators, their professional development, and the relationship between their role, responsibilities, district context, and background. Surveys (n=122) were administered to a national sample of science education leaders. Participants' responses were analyzed using descriptive and correlational statistics. Open-ended responses were analyzed using a constant-comparative approach. Following analysis of survey data, 15 participants (12.3%) were purposefully selected for follow-up interviews. Results indicated the majority of respondents identified themselves as Caucasian, female, and had served in their position for less than 10 years. Most coordinators had a science degree, were former science teachers, and wanted coordinator-focused professional development. Respondents without science degrees had positions at smaller, remote rural school districts and were responsible for multiple content areas including science. Respondents working in larger, urban school districts tended to have science backgrounds, had more professional responsibilities, and less content areas. In interviews, science coordinators further reported on the variety of barriers they encountered and difficulties experienced in their positions. The results further define the professional responsibilities of coordinators, provide insight into the role of a science coordinator, and specify the prevalent types and focus of professional development desired by science coordinators.

Collaboration Among Science Teachers in Qatar Saed Sabah, Qatar University, Qatar ABSTRACT:

This study aimed at exploring the levels of collaboration among science teachers in Qatar. The data of 193 teachers who participated in TIMSS 2011 were analyzed to answer the research questions. Teachers' responses to collaboration items of TIMSS 2011 Teacher Questionnaire were summarized and plotted. The collaboration levels for most of the items were relatively high. Also, Rasch model measurement was utilized to estimate the "difficulty" of each item and to convert the ordinal data to interval data. Visiting another classroom to learn more about teaching was the "most difficult" item , least likely occur while discussing to teach a particular topic was the least difficult item . The collaboration level among female teachers in Qatar is significantly higher than the level of collaboration among male science teachers. Science educators in Qatar need to support teachers' peer observation practices . By considering the societal and cultural context , more in depth studies are in need to understand the factors that affect collaboration among science teachers in Qatar.

Developing Elementary Teachers' Capability to Support Reading for Learning in Science Jonathan Francis Osborne, Stanford University Brian M. Donovan, Stanford University Michelle Friend, Stanford University Alexis Patterson, Stanford University Diego X. Roman, Southern Methodist University ABSTRACT:

Reading matters and the reading of expository text has been given new emphasis in the US Common Core Standards for literacy. In this paper, we report on the outcomes of a professional development program to improve elementary teachers' knowledge of how to support the teaching of reading in science. 16 elementary teachers participated in a program consisting of 23 days of professional development spread over three years. The program was based on theoretical ideas drawn from systemic functional linguistics, the teaching of reading, the multi-modal nature of text, and the importance of dialectal discussion of texts. Videos of teachers enacting their practice were obtained at three points of the study and were coded using a mixture of theoretically derived and emergent codes. The data were then analyzed using principal components analysis and various models fitted to the data. The major finding was the increase in the use of an interactive approach to teaching. Emerging from our work too is a deeper understanding of the nature of the pedagogical content knowledge needed to support the teaching of reading in science.

What Influences Science Teachers' Ability to Lead Within and Beyond the Classroom? Rachel Ruggirello, Washington University in St. Louis ABSTRACT:

This research seeks to uncover the hindrances and affordances to science teacher leadership practice in order to better understand how to retain science teachers by supporting them to lead from the classroom. Using qualitative analysis through coding of multiple sources of data I highlight structures that hinder and afford science teacher leadership practice (agency). Findings highlight specific examples of structures - both schema and resources - that contribute to the ability of teachers to enact agency in their own field. Findings suggest that professional development programs and school context influence the ability of science teacher leaders to carry out leadership practice within their schools. Specific structures of the professional development programs afforded and constrained leadership practice. Additionally, school factors such as seniority, time, recognition, money, and administrator support impacted teachers' ability to transpose the resources from the program to their own context and act as leaders. These findings provide implications for the ways that schools are designed to support and nurture science teacher leadership in order to build a space for happier and healthier professionals. Additionally, programs for science teacher leaders should consider the school context of teachers as they develop strategies for supporting science teacher leadership.

Strand 10: Curriculum, Evaluation, and Assessment

Teachers and Students

10:15am - 11:45am, Watertable Salon B **Presider:** Dan Carpenter, TX Tech Education College

The Teacher's Voice in Education Policy: Responses to National Curriculum and Assessment Reforms in Sweden

Jim Ryder, University of Leeds Malena Lidar, Uppsala Uuniversity Eva Lundqvist, Department of education Leif Ostman, Uppsala University *ABSTRACT:*

Curriculum and assessment reforms have a major impact on the working lives of teachers. However, teachers' voices are often unheard in the development of educational reforms and in the planning for their introduction. This study examines the process of policy enactment in schools using teachers' reflections on their experiences of reforms in Sweden. We focus on three distinct, but linked, education policy reforms: national curriculum reform for all subjects; and, within science at Y6, national tests and local grading. This paper reports on findings following three interviews with each of 13 teachers over a two year period. Our analysis deploys the concept of teacher professionalism, emphasising the themes of accountability and autonomy. In many cases teachers identified elements of the reform as an enablement that aligned with their personal professional goals. However, teachers also referred to significant constraints associated with enactment, challenging their local autonomy. Our findings suggest that reforms need to take account of other planned/existing reforms and policies that the teacher is responding to; seeking policy coherence. Furthermore, to incorporate the teacher's voice reforms need to provide sufficient flexibility for teachers to adapt reform to local contexts, whilst retaining common reform elements.

STEAM-ESL Professional Development for Elementary Teachers: Mediation Through the Language and

Inquiry Science Tool

Irasema Ortega, University of Alaska-Anchorage Sissy S. Wong, University of Houston *ABSTRACT:*

This proposal explores the analysis of two years of data from two courses offered as part of a culturally sustaining science, technology, engineering, arts, and mathematics (STEAM) and English as second language graduate professional development program for inservice elementary teachers. In particular, we share how the teachers used the Language and Inquiry Science Tool (LIST) to redesign curriculum in ways that address the academic and language proficiency needs of English language learners (ELLs). This instrument was developed and calibrated in 2012 by Author. The corpus of data for this proposal consists of curriculum maps, lesson plans, and teacher reflections related to curriculum evaluation and design. The analysis of data indicates that through the use of the LIST as a framework for curriculum evaluation and lesson design most of the participants were able to gain a new understanding of culturally sustaining curriculum and pedagogy to address the academic and language needs of their ELLs. Furthermore, using the LIST as the teachers were able to modify prescribed curriculum in ways that address the needs of their students. The finding shared in this paper merit consideration because of the implications for the professional development of teachers in urban and rural settings

Data Literacy: Assessing Student Understanding of Variability in Data

Bill Zoellick, Schoodic Institute

Molly Schauffler, University of Maine

Marcella Flubacher, Schoodic Institute at Acadia National Park

Ryan Weatherbee, University of Maine

Hannah Webber, Schoodic Institute at Acadia National Park

ABSTRACT:

The ability to analyze and interpret data is central to scientific inquiry. Interpreting data, in turn, requires understanding that a collection of data is not just a group of data points, but is instead an aggregation with properties of its own. These properties include, importantly, the variability of the data within the aggregation. A variety of studies have shown that it takes time for students to develop the ability to think in terms of data aggregations and variability. Knowing where students are at in this learning process is important not only to helping them improve their data skills, but also to designing scientific investigations that are well-matched to their ability to use data as evidence. This paper presents and describes an instrument that measures students' progress in learning to think about data aggregations and variability. Through use of a Rasch model to iteratively refine the instrument, we have developed a measurement tool that correlates well with results from an open-response assessment that asks students to justify reasoning about data and variability. We present both the instrument and data about its performance as a contribution to a broader conversation about measuring students' ability to analyze and interpret data.

Investigating Formative Assessment Classroom Practices in Science

Hye-Eun Chu, Macquarie University

Kok Siang Tan, National Institute of Education Singapore

Rachel Ong, National Institute of Education Singapore

Eugene Lim, National Institute of Education, NTU Singapore

ABSTRACT:

This research involved developing a video-analysis-coding scheme and investigating formative assessment practices in Secondary 3 science classrooms where students learn thermal physics concepts. Six teachers participated in this research and six videos were chosen as part of the development of a video analysis-coding scheme for formative assessment practices. The coding consisted of three main areas: 1) teacher-elicited

questions and students' responses, 2) student-elicited questions and students'/teacher's responses and, 3) types of tasks supportive of formative assessment and feedback. Findings show that although teachers begun by using open/guided/closed questions, they always ended up with guided/closed questions. Most of the time, the types of accepted students' explanations/responses varied. These include well elaborated answers, responses by multiple representation or short responses depending on what resources the teacher used and how the questions were shaped. Most teachers provided direct feedbacks on students' responses instead of encouraging students to construct their own explanations. No peer assessment and student self-assessment were observed. Further quantitative analysis on the video-based information will be done by using the Videograph-software to investigate teachers' formative assessment practices in science classroom.

Strand 11: Cultural, Social, and Gender Issues

Related Paper Set - Queering Perspectives on the Production and Regulation of Difference in STEM Education

10:15am - 11:45am, Federal Hill

Presider: Will Letts, Charles Sturt University

Discussants:

Steve Fifield, the Franklin Institute Science Museum

ABSTRACT:

The theme of this paper set is using queer theories and related perspectives to examine the production and regulation of difference in STEM education. In the fading light of science for all, difference is treated as an ordered domain of mediating factors that complicate progress toward standardized learning outcomes and national policy mandates for a STEM-literate citizenry and internationally competitive STEM workforce. The dominant imaginary for STEM education research, policy, and practice is to name, order, and treat salient differences using evidence-based practices intended to move diverse learners along predetermined pathways to standardized outcomes. The queering analyses in this paper set abrade dominant cultural and disciplinary discourses around difference (Hall, 2003), and leaven skeptical critiques with wonder, improvisation, hope, and renewal (Sedgwick, 2003). These authors subvert simple formulations of STEM inclusion/exclusion by turning to the vast confluence of discursive structures and agencies. The papers explore from diverse perspectives how STEM education produces and refuses subjectivities, even as it incites resistance, improvisation, and creativity in being(s). The session reflects how queering attends to entangled differences of sexed, gendered, and desirous being(s) in ways that do not necessarily locate sexuality at the center of analysis.

Grit, Gumption, and Virtuous Bodies: Constructions of Promise in American Engineering Students Amy Slaton, Drexel University Will Letts, Charles Sturt University Steve Fifield, the Franklin Institute Science Museum

Wonder as a Pathway to Emotion, Inspiration and Possibility in Science Classrooms Andrew Gilbert, George Mason University Emily Gray, RMIT

What Does Queer Theory Have to do with Teaching Science in Elementary Schools? Kristin L. Gunckel, University of Arizona

Children, Nomads, Queers: Desire and Surprises in a Wiggly World Sheri Leafgren, Miami University Scott Sander, Miami University

Strand 11: Cultural, Social, and Gender Issues

Administrative Sponsored Symposium - A Critical Examination of Social, Cultural, and Gender Research in Science Education

10:15am - 11:45am, Fells Point

Presenters:

Angela Chapman, University of Texas Rio Grande Valley Michelle A. Fleming, Wright State University Leon Walls, University of Vermont Ariana Garza, University of Texas Rio Grande Valley Laura Hinojosa, University of Texas Rio Grande Valley Mayra Hernandez, University of Texas Rio Grande Valley Edgar Palomino, University of Texas Rio Grande Valley Felicia Rodriguez, University of Texas Rio Grande Valley Carolina Zarinana, University of Texas Rio Grande Valley Eva Rojas, University of Texas Rio Grande Valley *ABSTRACT:*

We will present findings from two studies focusing on social, cultural, and gender perspectives in science learning in informal and formal settings. This will be followed by an interactive, critical discussion of the how our perspectives frame our research and contribute to science education literature as well as the impact on preservice and inservice teachers practice. Study #1: The Role of Gender Dynamics in Informal STEM Learning Environments This study presents findings from an investigation of how social behaviors, culture, and gender intersect with participation and engagement in an informal STEM setting for predominately Latino/a children. Study #2: Mingling Cultures: Mutual Learning of Science This study examines the "mingling" of cultures as they connect or disconnect to each other, particular activities, and/or scientific practices. How do social, gender, and cultural perspectives manifest from field-based experiences in an early childhood (EC) science methods course? Behaviors, language and interactions among preservice and inservice teachers were examined using ethnographic methods. Emerging themes will be presented.

Strand 12: Educational Technology

Argumentation, Literacy, and Dialogue 10:15am - 11:45am, Baltimore Salon A **Presider:** Shirly Avargil, Bar Ilan University

Utilizing Mixed Methods to Better Understand Knowledge Organization with Multiple Representations for Socioscientific Argumentation

Bahadir Namdar, Recep Tayyip Erdogan University *ABSTRACT:*

One of the fundamental goals of using mixed methods research is to better understand the phenomenon of interest (Greene, 2007). Despite the increasing number of empirical studies that employ mixed methods research in science education (Schram, 2014); in what specific ways mixed methods allow researchers to gain better understanding of the phenomenon of interest, and thus empirical research explicitly pointing at this aim in the field remain scarce. Hence, to address this gap in the field, a mixed methods research was designed to understand learners' knowledge organized with multiple representations for socioscientific issues in the context of a computer supported collaborative learning environment. Three aspects of this phenomenon were identified
as knowledge organization, argumentation, and the intersection of argumentation and knowledge organization. Utilizing social network analysis, argumentation analysis, conversation analysis along with content analysis this paper illustrates how mixed methods research can be an useful tool for researchers to have better understanding of the phenomenon of their interest.

Using Social Media to Make Computer Modeling Accessible and Improve Dialogue in an Online Course Morgan B. Yarker, Yarker Consulting

Michel d.S. Mesquita, Uni Research Climate Bjerknes Centre for Climate Research *ABSTRACT:*

An area of science education that has been steadily increasing is the research and development of educationally robust online courses. It is particularly important in the field of weather and climate, where understanding of complex computer forecast models is imperative in order to use data to understand, adapt to, and mitigate a changing climate. One effective strategy for teaching is utilizing argument-based inquiry, which involves a significant focus on peer dialogue and can be very difficult to utilize in an online setting. This project looks at two identical online courses about running and educational version of a regional climate model, one where students interacted with the instructor and peers using traditional online course forums and the second where they used a Facebook group. Results indicate that not only did the number of student posts significantly increase for the Facebook group from the forum group, but there were also a broader range of topics covered as well as statistically significant increase in components of effective dialogue. We conclude that social media is one method to improve dialogue between students over forums for online classes.

Using an Interactive Simulation to Promote High School Students' Scientific Argumention

Tugba Keser Solak, Trakya University

ABSTRACT:

This case study focused on the role of an interactive simulation supporting the development of scientific argumentation. Forty-seven 11th grade students from four classes first worked in pairs and then, all the pairs returned the classroom for discussion. One pair was selected as a focal group by their chemistry teachers within each class resulting in a total of four focal groups. The chemistry teachers posed the driving question of Part I to familiarize students with scientific argumentation while they challenged the students with the driving question of Part II to help students construct and defend more elaborate scientific arguments. The results depicted that in pair discussions, argumentation was a way of participants' collectively supporting a scientific claim based on evidence from the interactive simulation and trying to agree on conclusions drawn from this evidence. On the other hand, in classroom discussions focal groups tried to win their opponents over to their points of view and to weaken opposing views with making their evidence visible on the interactive simulation.

AgLIT, Agricultural Literacy Through Innovative Technology): A STEM Integrated, Project-Based, Upper-Elementary Agricultural Literacy Curriculum Module

Farah L. Vallera, Lehigh University

Alec M. Bodzin, Lehigh University

ABSTRACT:

As myriad initiatives address the need for increased STEM and agricultural literacy nationwide, agriculture can unify STEM subjects through knowledge, skills, and attitudes/beliefs (KSABs) shared between the subjects and provide authentic material for increasing STEM interest and literacy, while enhancing 21st century skills. This study tested the efficacy of an iPad-based, standards-aligned, project-based, and STEM integrated agricultural literacy curriculum module and assessment materials in fourth grade classrooms from a large urban district in northeastern U.S. Four teachers and 95 students were a part of the study that sought to 1) create a STEM integrated agricultural literacy, 2) add to the existing knowledge about the nature of upper-elementary urban students'

STEM and agricultural literacy, and 3) test the efficacy of the module. The module included pre- and posttest knowledge and attitudes instruments and eight project-based performance tasks centered around the driving question, "How will you help Farmer Kathy prepare for the farmers' market?" Findings revealed that treatment group students gained knowledge and had more positive attitudes/beliefs following the curriculum's 10-day implementation. Implications for designing technology-driven integrated STEM curricula will also be discussed.

Strand 15: Policy

Policy, District-Level Professional Development, and Leadership

10:15am - 11:45am, Baltimore Salon B **Presider:** Gavin W. Fulmer, National Institute of Education

Are We So Different? a Study of Teacher and Administrator Perceptions of Science Education Ashley Chiu, Museum of Science and Industry, Chicago Aaron Price, Museum of Science and Industry, Chicago Elsie Ovrahim, Museum of Science and Industry ABSTRACT:

Supporting science education and effectively leading science initiatives and program enhancements requires a structured process. Science education reform cannot happen solely in the classroom; rather, it must happen in the whole school environment, including not just teachers, but also administrators and other school staff. Science teachers are trained to teach science, but this is not necessarily the case for school administrators. Differences may arise between these groups in their thoughts about teaching science. School administrators and teachers are heavily studied populations in education research and the literature suggests some reasons for differences in belief between teachers and school leaders; however, the attitudes toward science of these two groups are seldom compared. The results from a survey study, a case study, and future work that highlight similar opinions and attitudes about STEM education between teachers and school administrators suggest that teachers and administrators may be more similar than they believe and can work together towards improving science education through whole-school change.

Examining the Relationship Between Generic and Subject-Specific Observational Measures of Secondary Science Teaching Effectiveness

Jamie N. Mikeska, ETS Tamara Shattuck, Michigan State University Leslie Stickler, ETS Yi Qi, ETS Steven Holtzman, ETS *ABSTRACT:*

Across the nation, states and school districts have been tasked with creating valid and reliable teacher evaluation systems that can be used for two key purposes: (1) to provide critical feedback for improving teachers' instructional practice and (2) to make personnel decisions about teacher retention, promotion, and placement. Observational measures have been used widely within these systems, with the majority of districts opting to use generic observational tools for assessing teachers' practice. Yet recently researchers and teacher educators have argued persuasively for the importance of attending to the discipline-specific aspects of teachers' instructional practice. However, it is unclear to what extent generic and subject-specific observational instruments measure distinct aspects of teachers' instructional practices. To address this gap, this study examines the relationship between generic and subject-specific observational measures of secondary science teachers' instructional practice. Findings contribute to policy discussions concerning the potential benefits and limitations of using generic and subject-specific observational measures within teacher evaluation systems.

The Impact of a High School Science Professional Development Program on Achievement: A Retrospective Quasi-Experiment Jody Bintz, BSCS Molly Stuhlsatz, BSCS Joseph A. Taylor, ABT Associates ABSTRACT:

This retrospective, quasi-experimental study tests the effect of an intensive, 3-year PD intervention for district science education leaders in Washington State on students' science achievement. This study was designed with two components: 1) a test of the effect of the program on student achievement in participating districts as compared to matched non-participating districts and 2) a test to identify mediating variables predictive of student achievement among the participating districts. Results showed an initial dip in student achievement in participating districts compared to matched districts followed by steady improvement with an overall effect size (Hedge's g) of 0.126 of the intervention. Preliminary analyses indicate mediating variables predictive of student learning outcomes among participating districts include district-level organizational support and the application of findings from How People Learn.

NGSS and Scientific Argumentation: District Leaders' Beliefs and PCK

Rebecca Katsh-Singer, Boston College

Katherine L. Mcneill, Boston College

ABSTRACT:

Recent research has addressed the challenges and opportunities NGSS offers to students and teachers (e.g. Osborne, 2014). While district-level science leaders are called on to design and implement professional development to enable teachers to shift their instruction (NRC, 2015), we currently lack research about these leaders' beliefs and knowledge about NGSS. Therefore, in this study we explore the beliefs and pedagogical content knowledge (PCK) of such leaders about NGSS and specifically the science practice of argumentation. Utilizing a sense-making theoretical framework (Weick, 1995; Spillane, 2004), we surveyed 53 and interviewed 10 district science leaders in states that have adopted NGSS to better understand their beliefs about scientific argumentation and measure their PCK for argumentation. Our findings suggest that district science leaders believe argumentation is important for students and offers key benefits such as improving literacy skills. However, our results also indicate that some leaders may not be "letting go" of their beliefs about typical science instruction, instead combining these ideas with newfound beliefs about NGSS. In addition, some possess low levels of PCK for argumentation. Therefore, district science leaders may need support so that the learning experiences they design for teachers accurately reflect the goals of NGSS.

Concurrent Session #12 1:00pm – 2:30pm

Workshop - Publications Advisory Committee *The "Guest Doctoral Student Reviewers" Initiative: Realizing the Professional Development Potential of the Journal of Research in Science Teaching* 1:00pm - 2:30pm, Baltimore Salon A **Presenters:** Fouad Abd-El-Khalick, University of Illinois, Urbana-Champaign Dana Zeidler, University of South Florida

ABSTRACT:

JRST has provided doctoral students with opportunities to review submitted manuscripts in the past. While very useful, these opportunities hardly serve to realize the potential of JRST as an effective instrument in the professional development of doctoral students in science education, especially in terms of publishing their research. We will present a new initiative to help realize this potential. We propose that faculty members from the broader science education community request that a small number (e.g., 2 to 5) of their doctoral advisees and students serve as JRST Guest Reviewers. The students will be invited a write a review for a manuscript submitted to JRST. More importantly, while these reviews will not count toward the final decision on the submitted manuscript, the Guest Doctoral Student Reviewers will get to examine, and compare their own reviews with, the 'official' reviews of the manuscript and resultant editorial decision letter. The faculty member will-as a required part of the process-lead a student discussion about the reviews, decision, and ways to respond to recommendations for revision and improvement of the manuscript. Once the student group submits a synthesis report-which is endorsed by the sponsoring science education faculty member-about the latter discussions to the JRST editorial office, students will be issued a formal letter acknowledging their role as Guest Reviewers. The students also will be formally acknowledged as Guest Reviewers in the corresponding end of year JRST issue. This symposium aims to introduce the initiative, elicit feedback from participant students and faculty members, and engage participants with a discussion about writing an effective and informative review of manuscripts submitted to JRST.

Strand 1: Science Learning, Understanding and Conceptual Change Supporting Growth in Student Understanding of Science Content 1:00pm - 2:30pm, Baltimore Salon B

Presider: Mandy M. Smith, Capital University

College Students' Ideas About Antibiotics as an Application of Evolution

Lisa A. Borgerding, Kent State University Vanessa A. Klein, Montclair State University Lucy Kulbago, Kent State University

ABSTRACT:

Evolution is the cornerstone of modern biology, but students may not be motivated to learn about evolution because they perceive evolutionary knowledge as irrelevant or useless in their daily lives. Antibiotic resistance is poorly understood and yet holds potential as a means by which to make evolution and natural selection instruction relevant to biology learners. The purpose of this study was to investigate college biology students' understandings of antibiotics, antibiotic resistance, and connection between antibiotic resistance and evolution by natural selection. A sequential explanatory mixed methods approach was employed in which an author-designed quantitative survey first explored 208 college biology students' ideas about antibiotics usage and resistance, and then a subset of 13 of these students was interviewed to explore participants' ideas in greater depth. The major findings include widespread understanding of the existence and specificity of antibiotics and less understanding that only bacteria can be killed by antibiotics. Participants showed less robust understandings about the development of antibiotic resistance and its connection to natural selection. The main contributions of this study are its illumination of common misconceptions about antibiotic resistance and its relationship to natural selection, and implications for science education are provided.

Middle School Students' Materialistic Views of Sound Concept

Eshach Haim, Ben Gurion University of the Negev, Israel Tzu-Chiang Lin, National Taiwan University of Science and Technology Chin-Chung Tsai, National Taiwan University of Science and Technology

Guo-Li Chiou, National Taiwan University of Science and Technology *ABSTRACT:*

It is well documented in the literature that materialistic thinking poses a significant barrier in the conceptual change process. Materialistic thinking is usually treated as a general idea. This study makes "zoom-in", and not only examines whether materialistic thinking exists, but rather, which material properties are associated with sound. To this end, the SCII (Eshach, 2014) was used. 732 Taiwanese 8 and 9 grade students, which were special because their scores in international academic comparisons (TIMSS/PISA) are among the highest, participated. Results show that although the subject of sound was taught extensively in grade 8, students associated sound with all of the materialistic properties. Using the framework theory, it is suggested that the different materialistic properties may be considered as a kind of a materialistic sound framework, which students use when confronting with sound related phenomena. The results also indicated that in grade 9, in which the sound was not part of the curriculum, there was a kind of a regression to more materialistic thinking. It seems that the shift from the materialistic category to the scientific category is slow and that reiterations are needed in the teaching process. Some practical methodological suggestions are further discussed.

Student Ideas in Middle School Science: Attending to Partial Understandings Regarding Science Phenomena

Christine S. Lee, California State University East Bay Kathryn N. Hayes, California State University, East Bay Dawn O'Connor, California State University, East Bay Anna M. Newman, University of Texas Brownsville Jeff Seitz, California State University, East Bay Rachelle DiStefano, Cal State University East Bay

ABSTRACT:

Students enter science classrooms with idiosyncratic notions and beliefs that influence how they develop science understanding. While it is critical for educators to explore the nature of students' ideas, science education policy and practice has depended heavily on narrow summative assessments that prioritize abilities to memorize and recall facts. This study draws upon theoretical frameworks of constructivism and conceptual change, as well as empirical research on learning progressions, to focus on students' partial understandings in both declarative knowledge and conceptual model categories. Written scientific explanations from formative assessment probes and student focus group interviews were collected from five middle school classrooms (1 earth; river erosion, 1 life; natural selection; and 3 physical science; forces and motion, liquid density, phase change). Results from deductive coding of student data showed that the majority of students' ideas fell in the partial declarative and partial conceptual understanding (compared to the full understanding and misunderstanding categories). Results from inductive coding highlighted the nature students' discipline-specific understanding (e.g., ideas regarding balanced and unbalanced forces). Implications of findings for supporting an approach to viewing all learners as holders of meaningful ideas, that have the potential to be developed towards deeper understanding, are discussed.

Teaching Complex Systems Components with an Agent-Based Participatory Simulation

Christopher Rates, University of Virginia Bridget K. Mulvey, Kent State University Jennifer Chiu, University of Virginia *ABSTRACT:*

Components of complex systems apply across multiple subject areas and teaching these components may help students build unifying conceptual links. Complex systems are often complicated and counter-intuitive and instruction may benefit from a combination of agent-based participatory simulation and scaffolding. This study of 96 college students tested both whether such a simulation improved student understanding, and whether different types of scaffolding might help. Students made small significant improvements in two components due

to the intervention, but only after receiving ontological scaffolding. These results support the use of agent-based participatory simulations and the need for ontological scaffolding in teaching complex systems.

Strand 2: Science Learning: Contexts, Characteristics and Interactions

Related Paper Set - How Spatial Factors Relate to Earth-Space Conceptual Learning and Understanding 1:00pm - 2:30pm, Maryland Salon A

ABSTRACT:

This related paper-set focuses on how spatial factors (spatial perspective, mental rotation, patterns, scale, etc.) relate to Earth-Space conceptual learning and understanding (Strand 2). The four reported studies concern: a) in-service middle level teachers' spatial-scientific understandings regarding the cause of lunar phases, b) how daily moon journaling showed teachers geometric spatial visualization and pattern development, c) how preservice teachers spatial ability correlated to their Earth-Science achievement, and d) the role spatial perspective taking plays on elementary students' understandings of celestial motion phenomena (Sun's apparent motion, stars' apparent motion, and seasonal constellations). Underlying themes of all papers illustrate the educational importance and critical need of creating integrated spatial-scientific experiences for students (K-20) and their math-science teachers. Findings showed possible ways to support students and their teachers towards constructing spatially sophisticated explanations about Earth-Space phenomena in ways that move beyond factual recall and use the kind of spatial reasoning indicative of model-based reasoning. 0 0 1 177 1009 JennyThings.com 8 2 1184 14.0 Normal 0 false false false EN-US JA X-NONE /* Style Definitions */ table.MsoNormalTable {mso-style-name:"Table Normal"; mso-tstyle-rowband-size:0; mso-tstyle-colbandsize:0; mso-style-noshow:yes; mso-style-priority:99; mso-style-parent:""; mso-padding-alt:0in 5.4pt 0in 5.4pt; mso-para-margin:0in; mso-para-margin-bottom:.0001pt; mso-pagination:widow-orphan; font-size:12.0pt; fontfamily:Cambria; mso-ascii-font-family:Cambria; mso-ascii-theme-font:minor-latin; mso-hansi-fontfamily:Cambria; mso-hansi-theme-font:minor-latin; }

Teachers Conceptions and Spatial Sense About the Earth, Moon, Sun System Jennifer A. Wilhelm, University of Kentucky Merryn Cole, University of Kentucky Ronald Wilhelm, University of Kentucky

Journaling to Show In-Service Teachers' Spatial Reasoning of Lunar Phases Merryn Cole, University of Kentucky Jennifer A. Wilhelm, University of Kentucky

The Relationship of Spatial Ability, Earth Science Conceptual Understanding, Content Exam Success, and Completion of University Science Content Courses Jill, Alice A.) Black, Southwest Missouri State University

The Role of Spatial Perspective-Taking in Understanding Celestial Motion Corinne Bower, The Pennsylvania State University

Strand 2: Science Learning: Contexts, Characteristics and Interactions The Construction and Use of Modeling Within Science

1:00pm - 2:30pm, Maryland Salon F **Presider:** Noemi Waight, University at Buffalo Bridging Students' Views on Models and the Use of Representations in Science: An Empirical Study Kyungwoon Seo, University of Iowa Brian M. Hand, University of Iowa Brian M. Hand, University of Iowa

ABSTRACT:

The purpose of this study is to examine the relationships between students' views on the models and the use of representation in science. Built on the theoretical framework of semiotics, a field of signs and its use in relation to meaning-making process, the study is grounded in the notion that using models and representations in science classroom can be used as valuable cognitive and epistemological tools for promoting students' science learning. The study involves the development and validation of two measures: Model Survey and Representation Survey. The instrument of Students' Understanding of Models in Science (SUMS) by Treagust, Chittleborough and Mamiala (2002) was revised to include recent advances in the model research, generating a 27-item Likert-type Model Survey with a 5-point scale. A 29-item Likert-type Representation Survey was developed through semi-structured interview and content/construct validity establishment. Data from 703 middle school students were collected and the results of factor analysis showed that the two measures were both reliable and valid. Five and two distinctive factors were identified for Model Survey and Representation Survey, respectively. Also, results of correlation analyses demonstrated that there is a high correlation between students' views of models and the use of multiple methods of representation.

Investigating the "Collabrified" Use of an App to Engage 6th Grade Students in Co-Constructing Models Carrie-Anne Sherwood, University of Michigan

ABSTRACT:

Students are increasingly expected to learn science through engagement in science practices (NGSS Lead States, 2013; NRC, 2012). Because collaboration and the use of technology are fundamental parts of the work of science, participating in authentic science in schools, as described in current reform documents, requires that students also engage in technology-integrated collaboration. Though calls for the integration of technologies in schools are ubiquitous, and more technology-based instructional tools are introduced into classrooms every day, the question arises whether digital mobile technologies and apps can enable students to engage in collaborative knowledge building. This paper addresses calls for research to better understand the role of collaboration in technology-rich classrooms by reporting the findings of a pilot classroom study of pairs of sixth-grade students' synchronous and face-to-face collaboration as they engaged in constructing models within the context of a tablet-based science app. Our study articulates how students interact collaboratively within a technological science-as-practice environment. We hypothesize the impact the of the environment design on students' collaborative engagement in science practices through the app. Lastly, we discuss the implications of this work for the future design and research of similar educational technologies.

Shift in Students' Epistemological Framing and Network of Epistemological Resources During Small Group Modeling

Soo-Yean Shim, University of Washington Heui-Baik Kim, Seoul National University *ABSTRACT:*

This study aimed to explore (1) contexts in which Korean middle school students shifted their epistemological framing during small group modeling, and (2) networks of the students' epistemological resources that were triggered behind such shifts. 34 eighth grade male students conducted six modeling tasks on 'Excretion', and two small groups of 4 students were selected as focus groups. The students' epistemological framing, epistemological resources, and modeling processes in each context were qualitatively analyzed based on their discourse and behaviors in the collaborative modeling practices. According to the results, students from Small Group 1 mostly showed unproductive epistemological framing in scientific modeling. They recognized

knowledge as being transmitted from the highest achieving student. However, sometimes the epistemological framing of the students shifted to productive framing, especially when the highest achieving student tried to function as a facilitator or when he did not know the answer. Meanwhile, students from Small Group 2 mostly showed productive epistemological framing. They evaluated claims based on evidence and tried to persuade one another through justification. However, sometimes the students' epistemological framing shifted to unproductive framing, especially when there was a continuous cognitive conflict or when the students recognized the whole-class discussion as a competition.

Labs Versus Models: Physical and Computational Experiences in Learning About Complex Systems in Chemistry

Sharona T. Levy, University of Haifa Sigal Samon, University of Haifa

ABSTRACT:

The contributions of physical experiences with laboratories and computational experiences with models to learning science are explored. Computational experiences are framed within a complex-systems approach. The study compares junior-high school students' learning of the gaseous phase in chemistry in three modes: with computer models using a complexity approach (M), with a normative disciplinary approach that includes laboratories (L), and with computer models using a complexity approach that includes laboratories (ML). Learning is tracked for science concepts, such as pressure, and systems ideas, such as emergence and randomness. 124 seventh grade students participated in a non-randomized three-group comparison quasi-experimental pre-test-intervention-post-test design, with identical pre- and post-tests, spaced 2-3 weeks apart. The learning activities for all modes were 12 45-minute lessons. Students' scores rose in all three groups, but to a different extent, showing a distinct advantage of combining models and labs (ML) and no differences between the models (M) condition and the laboratories (L) condition. Similar patterns were found for some but not all science concepts and systems components. Diffusion was learned similarly by using models, with and without laboratories. Pressure was learned similarly in all conditions. With models (M), students learned more about the micro-level than with laboratories (L).

Examining the Relationship Between Physical Models and Students' Science Practices Alison R. Miller, Bowdoin College

ABSTRACT:

Scientists engage with practices like model development and use, data analysis and interpretation, explanation construction, and argumentation in order to expand the frontiers of science, so it can be inferred that students' engagement with science practices may help them deepen their own science understanding. One of three dimensions of the Next Generation Science Standards, science practices are recognized as an important component of science instruction. However, research on science practices among students tends to focus on one or two practices in isolation when, in reality, students and scientists tend to engage with multiple overlapping practices. This study focused on identifying and characterizing multiple science practices as eighth and ninth-grade Earth Science students participated in a small group collaborative problem solving activity both with and without the use of a physical model. This study found a relationship between the frequency of science practices and the accuracy of the groups' outcomes. Based on this relationship, groups were assigned to one of three categories. Further analysis revealed that model use varied among the three categories of groups. Comparisons across these three categories suggest that there may be a relationship between students' engagement with science practices and the development of their content understanding.

Strand 3: Science Teaching--Primary School, Grades preK-6): Characteristics and Strategies *Instructional Strategies in Elementary Science*

1:00pm - 2:30pm, Pride of Baltimore **Presider:** Cory T. Forbes, University of Nebraska-Lincoln

Examining Student Thinking Through Leaner-Generated Drawings Dongsheng Dong, University of Washington Min Li, University of Washington Xiaoming Zhai, BNU Siwei Chen, University of Washington ABSTRACT:

Although learner-generated drawing has been widely used to enhance student thinking and promote scientific modeling, how to interpret and maximize the value of students' visual representations are still under investigation. This paper examines students' use of drawings to communicate their understanding and how students with varying performance levels and linguistic proficiency present their drawings differently. Data were gathered from responses of 417 students at grades 5 to 6 in a science test around the topic of landforms, of which 249 included some forms of visuals in their responses. This study presents a two-level coding system to capture student understanding of content knowledge and characterize different drawing patterns of four groups of students. Some of the preliminary findings indicate: (1) students tended to use drawings to answer questions involving higher-level thinking. (2) High- and low-performing students differed in the number of main objects they drew and the former group was more capable of presenting changes in objects' relative scales than the latter group. (3) Students spoke only English at home tended to use compound images to express their thinking, whereas students whose home languages were not or not only English tended to communicate their understanding by including more relational symbols.

Learning to Support Students' Model-Based Learning About the Water Cycle: A Three-Year Longitudinal Case Study of Two 3Rd-Grade Teachers

Tina Vo, University of Nebraska-Lincoln Cory T. Forbes, University of Nebraska-Lincoln Laura Zangori, University of Missouri-Columbia Christina V. Schwarz, Michigan State University *ABSTRACT:*

Scientific models can help students reason about and engage with natural phenomena, particularly complex systems, and the scientific practice of modeling is emphasized in the Next Generation Science Standards. The water cycle is a complex natural system for which models and modeling can help elementary students develop more robust understanding. In order to support students' engagement in scientific modeling, however, teachers must possess a sophisticated understanding of modeling and its component parts, an area of research that has largely gone under explored at the elementary level. To better understand teachers' learning to engage in model-centered science instruction about the water cycle, we conducted a 3-year longitudinal case study of two, 3rd-grade teachers. Through classroom observations, interviews, and other artifacts, we examine how each teacher conceptualized scientific modeling that the teachers emphasized, the instructional strategies and approaches they utilized in their classrooms, and how both evolved over the course of the study. Study findings contribute to the field's understanding of the instructional dimensions of scientific modeling and have important implications for professional development, curriculum development, and science teacher education.

STEM Integration Using a Problem-Based Learning Approach: Measuring Students' Content Knowledge and Critical Thinking Skills

Abeera P. Rehmat, University of Nevada, Las Vegas *ABSTRACT:*

As we progress into the 21st century, higher-order thinking skills and achievement in science and math are essential to meet the educational requirement of STEM careers. Educators need to think of innovative ways to engage and prepare students for current and future challenges while cultivating an interest among students in STEM disciplines. An instructional pedagogy that can capture students' attention, support interdisciplinary STEM practices, and foster higher-order thinking skills is problem-based learning. Problem-based learning embedded in the social constructivist view of teaching and learning promotes self-regulated learning that is enhanced through exploration, cooperative social activity, and discourse. This quantitative, quasi-experimental repeated measures study was conducted with 98 fourth grade students. The study utilized STEM content assessments and a standardized critical thinking skills in the problem-based learning group as compared to the traditional learning group. The quantitative results revealed that over time both groups showed an increase in their content knowledge assessments and critical thinking skills. However, there was a significant difference found between groups in regards to their content knowledge and critical thinking skills.

Student Notebooks as a Tool for Identifying Evidence of Engineering Learning in Elementary Classrooms

Kristina Maruyama Tank, Iowa State University

Tamara J. Moore, Purdue University

Bhaskar Upadhyay, University of Minnesota

ABSTRACT:

As an increasing numbers of schools and teachers are including engineering as part of their science instruction, it is important to gain a better understanding of what counts as evidence of student learning in engineering lessons and how student artifacts, like notebooks, can be used to help document this learning. This paper examines the use of student notebooks in two elementary classrooms during the implementation of an engineering unit to gain a better understanding of the amount and types of evidence of student learning of engineering content, skills, and processes that are present in the student's notebooks. Evidence of students' process of design and engineering design thinking, including reasoning about design, use of background knowledge in their design decisions, and key engineering habits of mind were found throughout the notebooks. The results from the analysis of the elementary students' notebooks suggest that engineering notebooks can be a rich source of data that can be used by teachers to identify evidence of engineering learning from their students

Teaching the Water Cycle with a Systems Thinking Approach

Tammy D. Lee, East Carolina University M. Gail Jones, North Carolina State University Katherine Chesnutt, North Carolina State University Bonnie B. Glass, East Carolina University *ABSTRACT:*

National elementary science standards have included the teaching of systems for decades, however little is known about teachers' understanding of complex systems. This study focuses on how elementary pre- and inservice teachers understand and apply "systems thinking" to the water cycle. Teachers completed the Water Cycle Diagnosis Test and the Systems Thinking Assessment. Results showed that more in-service teachers (54.1%) used high-level systems thinking explanations than pre-service teachers (33.3%). Although none of the teachers scored at the intermediate level (highest level) of systems thinking. Common barriers were identified with both teacher groups, which included identifying components and processes, recognizing multiple

interactions and relationships between subsystems and hidden dimensions, and finally, difficulty understanding the human impact on the water cycle system.

Strand 4: Science Teaching--Middle and High School, Grades 5-12): Characteristics and Strategies *Pedagogical Implications on Student Learning*

1:00pm - 2:30pm, Maryland Salon E **Presider:** David F. Jackson, The University ofGeorgia

Exploring Middle School Students' Embodied Conceptions of thermal Conduction and Its Implications for Instruction

Nitasha Mathayas, University of Illinois Urbana Champaign Robb Lindgren, University of Illinois Urbana-Champaign David E. Brown, University of Illinois

ABSTRACT:

Conceptions research about heat shows that students' everyday experiences conflict with the scientific understanding of heat. While many middle school curricula and intervention studies have targeted students' ontological conceptions of heat, few have focused on the mechanism of heat transfer. In this study, we investigated students' use of gestures while they applied the particle model of matter to develop explanatory models of thermal conduction. We developed a semi-structured interview consisting of three phases – an initial conceptions phase, an intervention phase exploring simulations depicting conduction at the molecular level, and a final conceptions phase. We interviewed 24 middle school students and examined the data for interactions between gestures and explanations. We found several different ways that gestures contributed to students' mechanistic explanation of conduction. We discuss these cases and their implications concluding that having students specifically enact the causal mechanism of a scientific phenomenon may be a fruitful way of grounding their understanding in physical intuitions.

Students' Ideas About Ecosystems and their Implications for Teaching

Hayat Hokayem, Texas Christian University

ABSTRACT:

Systems and system models are recognized as a crosscutting concept in the newly released framework for K-12 science education (NRC [National Research Council], 2012). In previous work, I developed a learning progression for systemic reasoning in ecology at the elementary level. The learning progression captures five levels of students' reasoning patterns across four progress variables—dimensions of ecological systemic reasoning. In this study, I used the rank correlation and qualitative examples to investigate the extent to which students using the same level of reasoning across the various progress variables. The results showed a wide range of students' reasoning patterns and kinds, some of which used the same level consistently across the four progress variables, while others did not. The results have practical implications for curriculum and instruction. I recommend using specific strategies to teach each progress variable, and providing students with opportunities to reason within and across the progress variables.

Developing Explanatory Gestures for the Seasons: Two Students' Approaches

Nathan Kimball, Concord Consortium

Robb Lindgren, University of Illinois Urbana-Champaign

ABSTRACT:

Our project investigates how body movement--gestures of the hands, in particular--supports reasoning of critical science concepts that have unseen structures and unobservable mechanisms, such as conduction by molecular motion. We conducted one-on-one clinical interviews with a diverse set of middle school students to

uncover students' ability to grow their understanding of key science concepts through questioning and through interaction with a sequence of physical and computer-based models. These video-recorded interviews captured the development of their ideas through multiple requests for explanation and also their spontaneous and prompted body movements made in support of their explanations. This paper reports on two interviews, and describes the way the students developed different, but consistent embodied expressions that aided in their understanding of the causes of the seasons. This paper will consider the nature of the differences in these expressions and their potential usefulness for understanding the phenomena.

Episodic Memories and the Longitudinal Impact of High School Physics on Female Students' Physics Identity Jianlan Wang, Florida International University Zahra Hazari, Florida International University Cheryl Cass, North Carolina State University Robynne M. Lock, Texas A&M University

ABSTRACT:

Most students will never take more than one course dedicated primarily to physics. In addition, students enter physics classes with depressed attitudes towards physics compared to the other sciences, particularly in the case of female students. Female students are also more likely to opt out of a second higher-level physics course. Thus, the broad goal of this work is to better understand how to have the most lasting positive impact on female students' attitudes and motivations towards learning physics after a single physics course in high school. Through longitudinal case studies of six female students using frameworks of episodic memory and physics identity, we explore the most impactful features of students' high school physics experiences. The data is drawn from one student survey and three years of student interviews. Our results suggest that high arousal (exciting) and negative valence (unpleasant) experiences are remembered in detail with longevity. Low arousal (non-exciting) and non-neutral valence (pleasant or unpleasant) experiences are remembered about context with longevity. Positive valence (pleasant) experiences have positive impacts on female students' physics identity construction. Discussing counterintuitive physics concepts is found to have the most-lasting positive impact on the students' physics identity.

Strand 5: College Science Teaching and Learning, Grades 13-20) Visual & Spatial Reasoning in Understanding Science 1:00pm - 2:30pm, James Presider: Stanley M. Lo, University of California, San Diego

Fostering Spatial Skills in Chemistry Deborah L. Carlisle, UMass Amherst

ABSTRACT:

The study of chemistry requires the understanding and use of spatial relationships, which can be challenging for many students. The purpose of this study was to engage undergraduate chemistry students in chemistry-specific guided activities designed to strengthen their spatial reasoning skills. General chemistry plays a central role in the undergraduate curriculum, making it an appropriate place to provide training with spatial skills that have been identified as beneficial for chemistry learning. In this study, qualitative data in the form of field notes, semi-structured interviews and artifacts, were used to analyze the ways in which the activities supported students' acquisition of spatial reasoning skills. The findings show that the use of activities which require students to sketch molecular models from different perspectives, locate a plane of symmetry on a 3D model and on a 2D sketch of the same molecule, as well as position physical models to match 2D sketches containing dash/ wedge cues is an effective approach to assist students with the learning of spatial skills. This study informs pedagogy in general chemistry, with the aim of improving a broader range of student understanding among a

diverse group of learners. Normal.dotm 0 0 1 180 1027 Phillips Academy 8 2 1261 12.256 0 false 18 pt 18 pt 0 0 false false /* Style Definitions */ table.MsoNormalTable {mso-style-name: "Table Normal"; mso-tstylerowband-size:0; mso-tstyle-colband-size:0; mso-style-noshow:yes; mso-style-parent:""; mso-padding-alt:0in 5.4pt 0in 5.4pt; mso-para-margin:0in; mso-para-margin-bottom:.0001pt; mso-pagination:widow-orphan; fontsize:12.0pt; font-family: "Times New Roman"; mso-ascii-font-family: Cambria; mso-ascii-theme-font: minorlatin; mso-fareast-font-family:"Times New Roman"; mso-fareast-theme-font:minor-fareast; mso-hansi-fontfamily:Cambria; mso-hansi-theme-font:minor-latin; }

The Value of Multiple Visual Representations for Student Learning of Quantum Concepts in General Chemistry Emily C. Allen, Boston University Peter S. Garik, Boston University Binyomin Abrams, Boston University

Dan Dill, Boston University

ABSTRACT:

This study contributes to research on how students develop models for abstract scientific concepts. While the study focuses on modeling by students in chemistry, the results suggest the more general importance of teaching students visual modeling skills. Fifteen students in a college general chemistry course completed pre- and postinterviews with the researcher that focused on atomic and molecular structure. The results of this study are that as students developed greater command of their understanding of abstract quantum concepts, and were introduced to multiple visual representations, when asked the same questions during the post-interviews they spontaneously selected more appropriate representations to describe their more sophisticated models of atomic and molecular structure and did so with fewer mistakes. This suggests that when visual modeling with multiple representations is taught, along with the limitations of the representations, it can assist students in the development of models for reasoning about abstract topics such as atomic and molecular structure. The results of these interviews were used to design a workbook which targeted misconceptions evidenced by student misuse of visual representations. In a subsequent rendering of the same course, students' content gains were found to improve as a function of the usage of the workbook.

"Seeing Data": Eye Tracking Students' and Scientists' Practices in Reading and Interpreting Graphs Joseph A. Harsh, James Madison University

Christina Myers, James Madison University

Caylin Murray, James Madison University

Molly Campillo, Harrisonburg High School/Massanutten Regional Governor's School

ABSTRACT:

Given the centrality of graphs to the communication of scientific information, increasing emphasis has been placed on the development of students' graph literacy – one's ability to generate and interpret data representations - to foster understanding of domain-specific knowledge and the successful navigation of everyday life. Despite the merit of prior research in identifying student difficulties and methods to improve graphing competencies, there is little understanding to how learners develop these skills. To gain a better resolution to the cognitive basis by which individuals "see" graphs, this study uses eye tracking and cognitive interviewing to compare how individuals along a continuum of scientific expertise make sense of and use visual data. Results of the study highlight variation in how individuals (n=36) direct their attention (i.e. fixation duration and visual search patterns) in completing a graph-based assessment as a function of science expertise and response correctness. As research on the transition from novice to expert is crucially important in designing curricula that help novices move toward more expert-like performance, we feel this study has implications for the advancement of new strategies to aid the teaching and learning of data analysis skills.

Design by Introductory Engineering Students and the Role of Spatial Knowledge and Functional Creativity Jaclyn K. Murray, University of Georgia Barbara A. Crawford, University of Georgia

ABSTRACT:

The aim of this exploratory investigation was to comprehend the design process involved in the creation of a novel and useful package from the perspective of introductory engineering students. Aspects of participants' spatial knowledge were examined in addition to the creative process and product originality and functionality. What type of spatial abilities do incoming college engineering majors possess before spatial skills are introduced? How does spatial ability influence aspects of the product or design process? In what ways does the design process and product incorporate elements of functional creativity? Findings may contribute to crafting appropriate spatial and creative instruction to enhance student learning in engineering design education.

Strand 7: Pre-service Science Teacher Education

Cultural and Equity Perspectives to Teacher Preparation, 1)

1:00pm - 2:30pm, Watertable Salon C **Presider:** Felicia Moore Mensah, Teachers College, Columbia University

Student Diversity in the Science Classroom:, Re)-Introducing a Dimension of Topic-Specific Science Pedagogical Contest Knowledge

Saiqa Azam, Memorial University of Newfoundland

Bonnie L. Shapiro, University of Calgary

ABSTRACT:

As a result of human migration around the world, student diversity has become a global phenomenon. A wide range of differences within student populations are found in today's schools. They vary according to race, ethnicity, culture, language, religious beliefs, sexual orientation, and socio-economic status, gender, age, and ability. The student diversity in today's schools raises a number of questions: Are teachers prepared to embrace student diversity in their science classrooms? What knowledge is required for teachers to address student diversity in their teaching? What are effective strategies to address student diversity in a science classroom? Are these strategies content-specific? The present study takes the issue of student diversity seriously by researching the knowledge of teaching a specific science topic area. This research is an effort to explore teachers' knowledge base of science teaching related to addressing students' diverse backgrounds in science classrooms, and hence achieving the goals of equity and social justice in science education.

Teacher Candidates' Perceptions About Student Diversity and Teaching Science on Equity

Eun Young Lee, University of North Texas Karthigeyan Subramaniam, University of North Texas Dina Castro, University of North Texas Pamela Harrell, University of North Texas *ABSTRACT:*

This proposal presents a study that identified the various awareness patterns about cultural diversity among preservice teachers enrolled in elementary science methods courses. The proposal also presents the effects of science methods courses on preservice teachers' awareness and beliefs about equitable science teaching practices. Using the Cultural Diversity Awareness Inventory and short-answer questions, a pretest and a posttest were administered to 58 preservice teachers. Results indicate that preservice teachers' awareness did not change over the semester in the methods courses, but bilingual non-white preservice teachers were more likely to have high levels of cultural awareness than others. Furthermore, misconceptions about equitable teaching for science

were evident. Most preservice teachers recognized language as a sole matter impacting their instructional practices other than race/ethnicity, socioeconomic status, and culture. Also, they did not have a clear understanding of equity because they interchangeably used it with equality.

Teaching Science in Inclusive Classrooms: Preservice Science Teachers' Knowledge and Views About Inclusive Education

Nurcan Cansiz, Artvin Coruh University Mustafa Cansiz, Artvin Coruh University *ABSTRACT:*

The current study embraced the idea of teaching science to all students rather than ignoring a particular group of students. Students with disabilities are now included in general education classrooms and try to learn science, mathematics, and other disciplines. However there exists a problem which is whether teachers are knowledgeable or trained to teach science to those students effectively. Based on this, this study aimed to explore preservice science teachers' (PSTs) knowledge, views, and practices in inclusive classrooms. Analysis of interviews with ten PSTs revealed six themes which were knowledge about inclusive education, experience, views about inclusion of students with disabilities, training about inclusive education, practice, support for implementation, proposed model for educating students with disabilities.

Why Science Teacher Education Needs Disability Studies: A Comprehensive Research Analysis Phillip A. Boda, Columbia University: Teacher's College ABSTRACT:

The intention of inquiry in science education is to facilitate learning for all students, as seen in its reform documents over the past 50 years in the United States. Through this push for inquiry learning, science education presented itself as both a means and an end to civic goals, which could be seen more broadly in human rights initiatives focused on 'inclusion' of all citizens in civil society and its projects. Through framing inclusion as a civic goal for all citizens including those with disabilities, inclusion for people with disabilities in education is a human rights issue. This project is far from its climax and deserves a more thorough research base from which new research in science teacher education is produced that serves to meet the goal for a comprehensive 'science for all'. This proposal will present the science teacher education community with a research agenda focused on a truly reformative 'science for all' perspective. Grounded in critical realist tradition, the analysis of existent research involving students with disability is provided within the larger context of inquiry-based pedagogy. Implications for adopting a disability studies in education perspective toward research in science teacher education are also described to further this proposal.

Strand 7: Pre-service Science Teacher Education *Preservice Science Teachers' Pedagogical Content Knowledge* 1:00pm - 2:30pm, Kent **Presider:** Nidaa Makki, The University of Akron

Teachers' Understandings and Perceptions in an Engineering Design Course for Educators Nidaa Makki, The University of Akron Karen Plaster, The University of Akron Edward Evans, The University of Akron ABSTRACT:

The Next Generation Science Standards emphasize the incorporation of engineering practices in the science curriculum. However, most teachers are not prepared to incorporate engineering in the classroom. This study explores the experiences of novice math and science teachers in an engineering workshop, taught by an

engineering faculty and an educator with an engineering background. The workshop engaged the teachers in relevant engineering problems as learners, so they practiced what engineers do. Findings indicate that teachers benefited from participating in solving engineering problems related to issues in their local community. The teachers had positive perceptions of the fit of engineering activities in the curriculum as it was presented through a problem based learning. Furthermore, participants emphasized the importance of building a learning community that can approach the task of implementing engineering activity as a design challenge. Implications for professional development and pre-service teacher education are discussed.

Topic Specific Pedagogical Content Knowledge from the Perspective of Chemistry Pre-Service Teachers Elizabeth Mavhunga, Wits University

Marissa S. Rollnick, Wits University

ABSTRACT:

The paper reports on an investigation that determines how chemistry pre-service teachers who were exposed to an intervention that aims to develop their Pedagogical Content Knowledge(PCK) in specific topics, recognize their developing knowledge of the construct in their own planning and classroom practice. The development of PCK in electrochemistry in a pre-service programme, was targeted through the use of five knowledge components of a construct termed Topic Specific PCK. The construct is a version of PCK located specifically in topics which has knowledge components we regard as knowledge for teaching science. The study employed mixed methods in a methodology class with 16 fourth year chemistry pre-service teachers. Pre-service teachers were placed in schools where they taught various chemistry topics. Their teaching was video recorded and they analysed their own teaching for episodes of teaching. Preliminary findings indicate that the pre-service teachers had a developing level of Topic Specific PCK in electrochemistry and were able to analyse their classroom practice from displayed TSPCK Episodes. It is also observed that they placed value more on the quantity of TSPCK Episodes rather than nature or extent of component interactions. Their analysis is compared to that of an experienced science education teacher educator. Recommendations about knowledge for teaching science and aspects to be emphasized when teaching it to prospective teachers are made.

Using Explicit Approach to Develop Pre-Service Teachers' Knowledge Base for Teaching Chemical Bonding Mpunki E. Nakedi, University of Witwatersrand

Elaosi Vhurumuku, UNiversity of Witwatersrand

ABSTRACT:

It is well documented that sound science content knowledge remains a challenge not only to learners but also to practicing teachers as well as pre-service teachers. PCK has become a popular research construct that addresses issues around integration of teacher subject matter knowledge and pedagogy. Loughran, Berry, & Mulhall (2006) argue that much of research done on PCK so far, reflects that interest in this construct did not necessarily aim to find ways to help teachers improve their practice. This paper reports the results of a study that investigated how pre-service Physical Science teachers (n=60) developed their subject matter and pedagogical strategies (as components of pedagogal content knowledge (PCK) (Shulman, 1986) during learning to teach about chemical bonding. The topic of focus was chemical bonding because of its complexity as a central and foundational topic in chemistry. The data which informed this paper was drawn from the students' assignments and their exam equivalents. The results show that the programme greatly enhanced the pre-service teachers' content knowledge and pedagogical strategies for teaching chemical bonding. The study shows how the strategies for learning to teach a topic within a methodology course were made explicit in order to enrich their content knowledge by drawing from both their content and methodology courses. Implications for Chemistry teacher education curriculum development and training are raised.

The Encyclopedia and the Newborn Deer: Monitoring Student Teachers' PCK Development Addressing Separate PCK Elements and Psychological Filters and Amplifiers

Erik Barendsen, Radboud University & Open University of the Netherlands

Ineke Henze-Rietveld, Delft University of Technology

ABSTRACT:

In this study, we explored the mechanisms behind science teachers' development of pedagogical content knowledge (PCK). Through analysis of student chemistry teachers' authentic products (lesson, plans, lesson evaluations and reflections) we were able to describe pathways of PCK development in terms of separate knowledge elements and combinations of these elements. Moreover, we found specific psychological factors that influenced this development. The teachers' metaphoric descriptions of their self-image as a teacher were helpful to explain the positive or negative impact of these psychological factors on the teachers' PCK development.

Analysis of Pre-Service Science Teachers' TPACK in their Creation of an Adventure Learning Environment Joshua A. Ellis, Michigan Technological University

Emily A. Dare, Michigan Technological University

Gillian H. Roehrig, University of Minnesota

ABSTRACT:

Technology Tools for Teachers: Science (T3-S) is a course designed to engage pre-service secondary science teachers in a subject-specific, content-based technology pedagogy as described by Hughes (2005) so that they are capable of engaging in technology-integrated instruction. Three teams of pre-service teachers in T3-S each created an online Adventure Learning (AL) module for Chasing Aurora, a nascent AL project on astronomy education. This study utilizes an explanatory embedded case study methodology (Yin, 2014) to observe the effect of this AL experience on pre-service science teachers' understanding of TPACK. We did not find noticeable differences between the three teams in either the Pre- or Post-Questionnaire. Teachers from all three teams showed gains in their ability to create technological affordances for student communication and collaboration. Teachers also showed a marked increase in their interest to ground their science instruction in a culturally relevant global context. These results indicate an increase in pre-service teachers' ability to identify and create pedagogically-grounded TPACK strategies for their future science instruction as a result of participation in the AL experience. This presentation will provide science teacher educators with specific, applicable practices regarding content-based technology integration.

Strand 8: In-service Science Teacher Education

Symposium - Models, Strategies, and Research on PD for Science Educators: Responding to the Framework and NGSS 1:00pm - 2:30pm, Maryland Salon B **Presenters**: Sarah Michaels, Clark University Brian J. Reiser, Northwestern University Jean Moon, Tidemark Institute Deanna E. Bailey, Vermont Science Initiative Renee Affolter, UMass Amherst William R. Penuel, University of Colorado Samuel Severance, University of Colorado Boulder Eve Manz, University of Colorado Boulder

Heather Leary, Brigham Young University-Idaho Suzanne M. Wilson, University of Connecticut *ABSTRACT:*

At the conceptual level the National Research Council's Framework for K-12 Science Education (2012) and the Next Generation Science Standards (2013) have transformed science education. At the implementation level, however, in realizing this vision in science classrooms, challenges remain. State leaders express concern that PD providers utilizing traditional models of PD ("content delivery" in short-term workshops) are ill-matched to the kind of long-term PD now needed. In response some states and districts want to invest in local and regional Teacher Leaders to become professional development facilitators, investing in scaling strategies supported by local school-based expertise. Likewise districts are forming Research and Practice Partnerships to build a knowledge base grounded in local realities. Similarly, work on how best to support teachers in instantiating high-leverage epistemic practices such as argumentation, modeling, and explanation — through talk and discussions — is underway. During this symposium we will explore these lines of work through four presentations using the lens of an emergent model of professional development for science educators – the Next Generation Science Exemplar (NGSX) learning system. We will examine issues and research responses associated with these inter-related lines of work so the field can consider them in future work.

Strand 10: Curriculum, Evaluation, and Assessment

Related Paper Set - Supporting Student and Teacher Learning of Genetics Across Grade Levels Through a Technology Based Curriculum

1:00pm - 2:30pm, Watertable Salon A **Presiders**: Kevin W. McElhaney, SRI International Michelle Williams

ABSTRACT:

Given the complex nature of genetics and the extent of persistent non-normative ideas, technology-enhanced instruction has tremendous potential for promoting student learning around complex and abstract science topics such as genetics. There is a need for examining cumulative learning for genetics and student conceptions so that observable patterns of learning at the different grade spans (including non-normative understandings and learning goals) can be identified. The papers in this set report on how innovative technology inquiry based instructional curricula with embedded assessments and in person learning opportunities enhance students' conceptual understanding of genetics across grade levels (upper-elementary, middle and high school). In addition, these papers also examine how teacher professional development supports practitioners in making instructional decisions that helps their professional learning as well as in deepening their students' understanding of heredity topics. Last, these papers provide insights into the important role of teachers in the co-design process of curriculum materials and how research-teacher collaborations can benefit students in light of multiple constraints teachers must balance at the state, district, and classroom levels.

Learning About Genetics in an Elementary Classroom Amal Ibourk, Michigan State University Michelle Williams

Analysis of Middle School Students' Knowledge Integration About Trait Expression During a Technology-Based Science Inquiry Investigation Erika D. Tate, bluknowledge LLC Mingyu Feng, Center for Technology in Learning SRI International Kevin W. McElhaney, SRI International Designing Inquiry-Based Investigations for High School Genetics: Insights From Researcher-Practitioner Collaborations Stefanie Marshall, Michigan State University Christina Restrepo Nazar, Michigan State University Kevin W. McElhaney, SRI International

3-D PD for 3-D Science Learning: Designing Professional Learning Opportunities for Middle School Science Teachers Tamara J. Smolek, Michigan State University Erika D. Tate, Bluknowledge LLC

Strand 10: Curriculum, Evaluation, and Assessment *Teaching and Assessing Science and Engineering Practices* 1:00pm - 2:30pm, Fells Point **Presider:** Jamie N. Mikeska, ETS

Diagnosing Students' Understanding of Models and Modeling Sarah Gogolin, Freie Universitaet Berlin Dirk Krueger, Freie Universitaet Berlin ABSTRACT:

From an educational point of view, the process of thinking in and about models as a form of scientific practice can be seen as one of the learning goals for science students seeking to understand the nature of science and develop scientific literacy (e. g., Germany: KMK, 2005; USA: NGSS Lead States, 2013). When implementing model competence, teachers require professional teaching competencies to diagnose and foster their students (Justi & Van Driel, 2005). In order to help teachers master this challenge, we are presenting an efficient and sensible diagnostic tool that detects a student's individual understanding of the nature and purpose of models. Interviews (nature of models: Nstudent responses = 211; purpose of models: Nstudent responses = 720) give evidence that the diagnostic tasks are suitable to investigate students' understandings of models and modeling. Quantitative assessment with students from grades 9-12 (N = 382) using the diagnostic tasks reveals that the students mainly see models as idealized representations of an original. Furthermore, the students see the purpose of models primarily in their descriptive function. The comparison of students from different grades indicates that there are significant differences, both for the aspects 'nature of models' and 'purpose of models'.

Assessing Experimental Skills in the Large-Scale: A Simulation-Based Test Instrument

Knut Neumann, Leibniz Institute for Science Education, IPN Kiel Martin Dickmann, University of Duisburg-Essen Bodo Eickhorst, University of Bremen Horst Schecker, University of Bremen Heike Theyssen, University of Duisburg-Essen *ABSTRACT:*

It is a main aim of science education to help students develop the skills needed to successfully plan and perform experiments as well as to analyze and interpret the collected data. Assessments for accountability purposes have traditionally favored paper-and-pencil tests that are known for failing to validly assess the skills required to actually perform experiments. Valid assessments of the outcomes of 21st century science education should, however, address a broad range of experimental abilities, including the area of performing experiments. In our paper we will present an instrument that can reliably and validly assess students' skills in all three areas:

planning, performing, and analyzing experiments. We will present the process of developing the test instrument and the steps we undertook to ensure reliability and validity. Findings from administering the instrument to N =1262 middle school students confirm that the instrument can indeed reliably and validly assess students' experimental skills. We will discuss our findings with respect to how reliability and validity were achieved and to the impact of our findings for performance-based assessments in science education.

Towards Engagement with the Science and Engineering Practices for All Students

Joan D. Pasley, Horizon Research, Inc. Peggy J. Trygstad, Horizon Research, Inc. Eric R. Banilower, Horizon Research, Inc.

ABSTRACT:

The eight science and engineering practices outlined in the Next Generation Science Standards (NGSS) are critical components of scientific literacy. However, there is limited guidance for teachers on what these practices "look like" when they are operationalized in instruction across different grade ranges and topic areas. Further, there is little existing guidance for teachers on how to make the practices in the NGSS accessible to all students. This paper describes the efforts of the [PROJECT NAME] project to operationalize the practices at different grade levels and content areas, and codify this knowledge in a primer. This work is part of a larger study aimed at developing survey items to measure teachers' use of the science and engineering practices.

Secondary Teachers Current Use of Four Science Practices While Teaching Genetics and Biological Evolution Dina Drits-Esser, University of Utah

Nicola C Barber, University of Utah Louisa A. Stark, University of Utah

ABSTRACT:

This study examined secondary biology teachers' self reports on their use of four Science and Engineering Practices (SEPs) (analyzing and interpreting data; using mathematics and computational thinking; constructing explanations; engaging in argument from evidence) during instruction in genetics and biological evolution. Specifically, the study explored: (a) the frequency with which teachers provide opportunities for their students to engage in the SEPs, (b) how these frequencies differ between genetics and evolution units, and (c) teachers' reported comfort level with guiding students through the SEPs. Data were collected from 834 teachers via a web-based survey. Results indicated that teachers engage students in analyzing provided data more often than data students collect themselves; students use basic math and graphing (such as bar graphs) more often than advanced math (algebra or basic statistics) or graphing (such as scatterplots); and teachers use data analysis in their genetics units more often than in evolution units. In addition, teachers reported that they more often have students write arguments than present them orally. Comparing across practices, the data suggest that teachers engage students in math and data analysis during class more often than constructing evidence-based explanations or arguments. Implications for NGSS-aligned curriculum and professional developers are provided.

Strand 11: Cultural, Social, and Gender Issues *Cultural Competence and Science Curricula*1:00pm - 2:30pm, Watertable Salon B
Presider: Jacqueline Theresa Mcdonnough, Virginia Commonwealth University

Biology Teachers, the Teaching of Biological Evolution and Secularism in Three Latin American Countries Heslley M. Silva, University Center of Formiga

Eduardo F. Mortimer, Universidade Federal de Minas Gerais *ABSTRACT:*

Considering that context may influence biology teachers' conceptions of biological evolution, three countries, Argentina, which has an official religion in its constitution, Brazil, a self-proclaimed secular country, and Uruguay, a consolidated secular country, were investigated. It was investigated through teachers' answers to a questionnaire and an interview and school curriculum content. Argentinean and Uruguayan teachers pointed to Barbour's category of independence between science and religion, while Brazilians ranged between conflict, dialogue and integration. The teachers' religion apparently influenced their answers. In Brazil, religion was an obstacle to the teaching of biological evolution; while the answers varied in Argentina and Uruguay. Conflict in class was reported in Brazil and less frequent in Argentina and Uruguay. Together with poor teacher training, teachers' personal internal conflict towards biological evolution explains the Brazilian teachers' answers. Argentinean and Uruguayan teachers reported biological evolution as part of the curricula without inference from religion, in contrast to half of the Brazilian teachers. The Uruguayan curriculum is more assertive of biological evolution, while Argentina's and Brazil's core curricula leave detailing to regional administrations and room to distortions. In conclusion, conversely to Argentinean and Uruguayan teachers, Brazilian teachers face difficulties in teaching biological evolution that are related to religion.

Opportunities to Learn Science: A Case Study of Science Classrooms in Successful-Diverse Texas High Schools Jennifer K. LeBlanc, Texas A&M University

Carol L Stuessy, Texas A&M University Kaitlin K. Stone

ABSTRACT:

Science education is not inclusive and this becomes obvious in the science career pipeline. Gross underrepresentation in the field of science and opportunities to learn science are intricately linked together (National Academies of Sciences, 2011). In this mixed method multiple case study we observe, interview, and survey a total of nine biology teachers in three Texas urban high schools identified as Highly Successful and Highly Diverse (HSHD). Using the How People Learn framework (Bransford, Brown, & Cocking, 2000) our goal is to understand how these science teachers orchestrate their classroom learning environments. Based on our findings we see that on average across the school cases teachers are not necessarily implementing reform based teaching practices which would lead students to engaging in higher levels of cognitive complexity. Furthermore, we note that teachers need support in providing opportunities for students to transfer information and spend time with metacognition in their science classrooms.

The Educational Debt: Biology Textbooks Can Increase Prejudice and Misunderstandings of Biological Variation Amongst Adolescents

Brian M. Donovan, Stanford University

ABSTRACT:

Little is known about the impact of the biology curriculum on the development of racial thinking amongst adolescents although much has been written on this topic. This longitudinal study presents findings from a double-blind field experiment carried out in biology classrooms in California. Individual students (N=135, 7-9th graders) were randomly assigned to complete a California approved textbook curriculum that associated race with genetic disease or to an identical curriculum that lacked references to race. Students in the racial condition (as compared to the nonracial condition) exhibited significantly: (i) greater growth in genetically deterministic beliefs about racial difference; (ii) greater growth in incorrect perceptions of human biological variation; (iii) greater growth in opposition to ameliorative racial policies in education; (iv) reduced interest in cross-racial social contact. In sum, the results suggest that biology education can undermine equity and justice when it ignores the subtle ways students learn about race in the biology classroom.

The Travelling Story of Traditional Ecological Knowledge: Its Origin and Current Conceptualizations in Science Education

Eun-Ji A. Kim, McGill University *ABSTRACT:*

What is Traditional Ecological Knowledge (TEK)? This is an easy or difficult question depending on who is answering. In many disciplines, including science education, anthropology, and resource management, TEK has been conflated with Indigenous Knowledges (IK), which has contributed to a lack of understanding about the nature of TEK. This paper explores the history and origin of TEK through a nuanced literature review and examines current pedagogical conceptualization of TEK in science education. This research reveals that TEK and IK should not be treated as one and the same. TEK is a form of cultural and intellectual appropriation that awkwardly modifies IK in order to better fit a conventional Western Modern Science (WMS) framework. This paper elucidates how contemporary understandings of TEK, as inseparable but different from IK, have had untold ramifications on the development of science education curricula.

Human Bodies in Primary Education: Difference in Fo-cus

Carolina R. Souza, Federal University of Sao Carlos Mauricio Pietrocola, University of Sao Paulo

ABSTRACT:

These work approaches the conception of body by a theoretical bias. The construction of this conception is connected with the establishment of differences and with historical and cultural commitments. At school, body is normally presented in a biological perspective. It is important for a more plural pedagogical work at school to be aware about the discussion surrounding the notion of bodies and its difference. The paper aim to present and analyze elementary teachers' conceptions about body after being exposed to images. The images serve as a trigger to start a discussion where body's differences are at the center. The reflection in this case can overcome aspects of the bodies' differences and be extended to the way teachers become aware of their judgments and practices. In the case study presented herein, teachers were able to notice the reductionist way that the bodies were treated at school, and they were also able to go beyond the self-awareness.

Strand 13: History, Philosophy, and Sociology of Science Classroom Teachers' Perspectives on Nature of Science and Scientific Inquiry 1:00pm - 2:30pm, Federal Hill Presider: Hasan Deniz, University of Nevada

Developing Knowledge and Pedagogical Practices for the Nature of Scientific Inquiry: Results From a 13-Month Preservice Program

Renee S. Schwartz, Georgia State University

ABSTRACT:

Experiencing Research for Teaching Science [ExpeRTS] is a 13-month program for preservice teachers to engage in authentic scientific research and a community of peers and support structures to develop knowledge and pedagogical abilities that bring authenticity to the science classroom. Our aim is to develop future teachers as confident scientists who are able to translate their experiences into effective inquiry-based science instruction that also addresses nature of science [NOS] and the nature of scientific inquiry [NOSI]. The purpose of the present study was to explore changes in participants' views of NOSI and examine the extent to which they included NOSI aspects within their initial teaching practices. Participants were undergraduates in elementary education, secondary education, and science majors considering a career in science teaching. Data sources included pre/mid/post survey and interviews, as well as lesson plans and teaching observations. Participants

demonstrated improvements in all targeted NOSI aspects. Lesson plans tended to emphasize scientific practices initially, but with feedback and modeling, participants were able to include learning objectives for most NOSI aspects. Even though explicit instruction was planned, only some of the participants included explicit instruction in practice. While several cases were quite successful in explicitly including NOSI in most planned as well as taught lessons, much pedagogical attention remained focused on scientific practices with implicit NOSI. Implications for teacher preparation are discussed.

Hong Kong In-Service Science Teachers' Views on the Values of Teaching Nature of Science

Zhi Hong Wan, the Hong Kong Institute of Education Siu Ling Wong, The University of Hong Kong

ABSTRACT:

Although the goal of developing school students' understanding of nature of science (NOS) has long been advocated, little is known about how science teachers, a kind of major stakeholder in NOS instruction, perceive the values of teaching NOS. Through semi-structured interviews, this study investigated the views of 15 Hong Kong in-service teachers toward the values of teaching NOS. The values of teaching NOS as perceived by the teachers fall into two types. The first type is related to students' learning of science in the classroom and involves (i) facilitating the study of subject knowledge, (ii) increasing the interest in learning science, (iii) aiding the conduct of scientific inquiry, (iv)meeting the needs of public examination, and (v) fulfilling the inherent requirement of scientific learning. The second type goes beyond learning science and includes (i) developing thinking abilities, (ii) cultivating scientific ethos, and (iii) supporting the participation in public decisions on socioscientific issues. Although rich relationships were perceived by these teachers between NOS instruction and students' learning of science, few values were stated from broad social and cultural perspectives. Suggestions are made on designing programs to prepare teachers for teaching NOS.

The Link Between Continuing Professional Development Program and Teachers' Nature of Science Views

Nihal Dogan, Abant Izzet Baysal University Eda Erdas, Kastamonu University Serhat Irez, Marmara University William W. Cobern, Western Michigan University Yalcin Yalaki, Hacettepe University Gultekin Cakmakci, Hacettepe University Zekai Berk Altiner, Marmara University *ABSTRACT:*

This study is about a large-scale teacher professional development project aimed at supporting middle school in-service science teachers' professional competence about nature of science (NOS). The purpose of this study is to investigate the changes of teachers' NOS views in a continuing professional development (CPD) program. Characteristics of the effective CPD programs' and strategies or structures to be included for teachers have also been investigated and a model that is effective and suitable for teacher training has been suggested. In this study, a CPD program was implemented for a year with voluntary attendance of 18 middle school science teachers. The intervention process with the science teachers consisted of ten monthly meetings over two semesters. Participant's NOS views were assessed through face-to-face interview using VNOS-C at the beginning and end of the second stage. Data were analyzed with content analysis. Teachers' views were classified into three categories as 'naive', 'eclectic' and 'informed' for each theme. In the light of the analyses of the interviews conducted at the beginning and end of the CPD program, an improvement was observed in all participant teachers' NOS views.

Visualizing Change of Teacher's Accurate Understanding and Misconceptions Regarding Scientific Inquiry and Nature of Science

Yue Li, Miami University Sarah B. Woodruff, Miami University

ABSTRACT:

This paper seeks to develop an alternative way to visualize the change of in-service teachers' understanding and misconceptions regarding scientific inquiry (SI) and nature of science (NOS) before and after participating in a professional development program funded by a National Science Foundation Mathematics Science Partnership project. This study reported findings from 14 teachers' responses to a Likert-type scale questionnaire prior to beginning the program and three years after involvement in the program. Instead of simply reverse coding the misconception items and included them in the same factors, teachers' pre- and post-scores for accurate understandings (y-axis) and naïve understandings (x-axis) were plotted to determine both the relationship between accurate and naïve conceptions and the change in teachers' understandings. With two-dimensional demonstration of teachers' changes in both accurate and naïve understandings, evaluators and researchers can further study how teachers' progressive acquisition of understanding of the SI and NOS interacts with their misconceptions, as components of the teachers' belief system regarding science teaching and learning.

Strand 14: Environmental Education

Climate Change 1:00pm - 2:30pm, Homeland **Presider:** Keith R. Langenhoven, University of the Western Cape

Examining Teacher Candidates' Moral and Ethical Perspectives on Climate Change

Emily Hestness, University of Maryland J. R. McGinnis, University of Maryland Wayne Breslyn, Montgomery County Public Schools *ABSTRACT:*

We investigated prospective science educators' perspectives on climate change as a socioscientific issue. Using drawings as evidence, we focused on morality and ethics as dimensions of prospective teachers' environmental identity development. Participants (N=59) were undergraduate teacher candidates enrolled in a university-based Elementary Science Methods course. We present self-generated drawings reflecting teacher candidates' ideas about climate change causes and effects. We discuss our interpretations of the drawings, including the dimensions of climate change that appeared salient to participants, the ways in which participants appeared to represent emotions and behaviors, and the potential insights these aspects could provide into participants' moral reasoning about global climate change. In addition, we include data from two focal participants who engaged in follow-up interviews using their drawings as a referent. We found that despite the challenges of interpretation, drawings served as a fruitful tool for research on teacher candidates' perspectives related to climate change, as well as for teacher candidates' own self-reflection on a socioscientific issue with moral and ethical dimensions.

Elementary Teachers and Climate Change: Examining Teacher Knowledge in a Science Professional Development Program

Andrew J. Keck, George Mason University Kristofer Pachla, George Mason University Amanda Luh, George Mason University David E. Long, George Mason University *ABSTRACT:*

In this quantitative study, a sample of 140 teachers from a large, federally funded Elementary Science Professional Development were surveyed regarding content knowledge about climate change. These survey results are compared to two nationally sampled surveys adapted for this study, and indicate that compared to the national samples, these teachers are more knowledgeable about the different scientific concepts of climate change. Correlations between knowledge of climate change and confidence in that knowledge reveal important trends regarding the science education and background of elementary teachers, as well as the professional practices of elementary teachers regarding climate change. The results of this study suggest that although these elementary teachers are more knowledgeable in climate change than the national sample, their confidence in that knowledge is less.

Student Argumentation About Climate Change Barry Golden, University of Tennessee **ABSTRACT:**

This paper describes a qualitative study in which sixth grade students' understandings about anthropogenic climate change were analyzed before, during, and after an argumentation-based unit in which students were asked to analyze historical climate data, develop evidence-based explanations, and communicate those explanations to peers. Five students were purposefully selected to provide a diversity of responses in the data. The data were comprised of written artifacts produced during the argumentation sessions, plus transcriptions of interviews conducted with the students before, during, and after the unit, plus a delayed post interview. Three salient findings emerged from the analysis: One, that immersion in such a climate change unit can in fact lead students to understandings which move them towards the consensus in climate change; Two, that students underwent epistemic scaffolding as a result of their argumentation efforts, in that they shifted their justifications towards data versus anecdote; Three, that students did not have an appropriate ontological category for climate change with which to distinguish it from any other environmental problem. This research fills a need established by Shepardson, et al (2012) in regards to the development of K-12 GCC curricula and for building models of student comprehension for anthropogenic climate change.

Teaching Climate Change Through Pbl: Successes and Failures at a Multi-Site Professional Development Institute

Danielle M. Kittrell, George Mason University Susan Poland, George Mason University Amanda Luh, George Mason University David E. Long, George Mason University

ABSTRACT:

Elementary teachers participated with an intense science education reform professional development program over the course of four weeks. The overarching topic of the academy was global climate change with an emphasis on problem-based learning. The objective of the study was to investigate teachers' confidence levels as well as their basic understanding of climate change. A pre and post survey was administered at the beginning and end of the professional development academy. Pre-survey results indicated that elementary teachers had minimal understanding of basic climate change concepts. Initial results of the post-survey also indicated that teachers' understanding of climate change was marginal once the professional development academy was over.

Who Is Learning About Climate Change in Us Schools? Not Many!

Barry Golden, University of Tennessee

ABSTRACT:

The poster paper describes research into the extent of global climate change (GCC) coverage in the state science frameworks, as well as the Next Generation Science Standards (NGSS). We searched each framework for relevant content by conducting word searches for key terms/concepts such as the greenhouse effect, climate,

and so forth. We describe three major findings: 1) The extent of GCC content is very poor, with only five states scoring the highest possible score; 2) GCC is often addressed in a very cursory way, as a subset of other curricula, and 3) GCC in general is not focused upon anthropogenic causal mechanisms or the evidence for such. We discuss the implications of this research for the needed professional development for the current shifts towards the NGSS.

Concurrent Session #13 2:45pm – 4:15pm

Strand 1: Science Learning, Understanding and Conceptual Change *Reasoning and Cognitive Development in Upper Secondary Students* 2:45pm - 4:15pm, Maryland Salon B

Presider: Abigail C. Perkins, Texas A&M University

Classifying Grade Ten Students' Positions Regarding the Existence of Sodium Chloride Crystal Sulaiman M. Al-Balushi, Sultan Qaboos University

ABSTRACT:

One important voice in science education that should be heard is that of learners. Thus, this study investigated students' justifications of their positions regarding the existence of sodium chloride crystal. The sample included 62 students at grade ten in the Sultanate of Oman. Participants were asked to justify, in writing, their positions on the existence of sodium chloride crystal. The analysis of their responses produced five main categories: Acknowledgment, experimentation, imagination, social influence and structural orientation. The reliability of the coding process was carried out by two researchers. The reliability coefficient was 0.75. The results show that the types of justification brought up most by participants were 'experimentation' and 'imagination'. The results of the study also indicated that the superficial understanding of submicroscopic entities could be one of the main reasons behind students' disbelief in these entities. Thus special care is needed when teaching and explaining theoretical and unobservable scientific models to young learners. Further research is needed to decide on appropriate approaches to deal with this epistemological phenomenon.

Eliciting Students' Discipline-Specific Epistemic Knowledge: A Value-Focused Approach Hiroki Oura, University of Tokyo

ABSTRACT:

A major goal of science education is to develop students' scientific knowledge and skills through engagement in disciplinary practices. Scientific disciplines are organized around specific sets of epistemic aims, tools, and norms, and there are common characteristics shared by all or most disciplines such as knowledge development and argumentation. In contrast, there are also distinctive characteristics that differ or dissent between disciplines. Students without such awareness more likely conflate one discipline with another from their naïve assumptions or prior learning. I call such situations epistemological conflation and conflicts (ECCs), and suspect that analogous issues would emerge in authentic-practice-based curricula associated with the current reforms (NRC, 2012). Working from this perspective, important research questions arise regarding the theoretical specification and methodological strategies of one's disciplinary understanding. How can we elicit students' discipline-specific epistemic (DSE) understanding, and on what account can we determine that students have developed DSE knowledge for a focal practice/discipline? In this background, the present study proposes a value-focused approach as a way to elicit students' DSE knowledge with a set of open-ended questions, followed by a case study demonstrating that the approach helped identify revision points of instructional materials in an authentic-practice-based curriculum unit.

Emergent Student Conceptions of Geologic Time and their Implications for Embodied Learning Jason Morphew, University of Illinois

Robb Lindgren, University of Illinois Urbana-Champaign

David E. Brown, University of Illinois

ABSTRACT:

An understanding of large numbers within the context of geologic time is critical for students in understanding many concepts within geology, evolution, and climate change. One perspective of student ideas in STEM views student conceptions as both wrong ideas that are common and robust and as ideas that arise out of more elemental intuitions. This study employed task-based interviews to assess the individual's way of making sense of geologic time as well as their ability to construct an accurate geologic timeline. Thirteen undergraduate students were asked to think about how they made sense of different units of time, and then construct a geologic timeline. Their data was analyzed using a framework which views student conceptions through four different lenses -- verbal-symbolic knowledge, conscious models, implicit models, and core intuitions. One visual model that emerged reflected the viewing of time from a position situated within time. Participants used visual differences between their conscious models of past time periods and the present, as well as the number of events they could recall, to measure time. Some of these models were less availing to developing or eliciting verbal-symbolic knowledge. Educational implications of these interactions of knowledge sources are discussed.

What Matters? Exploring the Development of Inquiry and Scientific Reasoning Skills in High School Chemistry Raghda M. Daftedar, Teacher's College, Columbia University

ABSTRACT:

Reasoning in multivariable contexts is recognized as the bread and butter of science, yet little research how those skills may be fostered in the high school chemistry classroom. The proposed study thus aims to explore how causal reasoning skills may be fostered in two high school chemistry classrooms (n=47), namely: (1) controlling variables to identify covariation within a multivariable context, and (2) predicting the level of an outcome variable by coordinating the effects of multiple variables. A curriculum intervention was designed asking collaborative groups of chemistry students to identify the causal relation of various element attributes on the level of activation energy within a hypothetical chemical reaction scenario. An embedded mixed methods approach was used with pretest-posttest results indicating significant gains from pretest to posttests (P<.001) in their ability to control variables within a multivariable context in chemistry. Qualitative process data captured mechanisms of developing causal reasoning skills as well as the metacognitive and strategic competencies involved through a process of theory evidence coordination. Implications for policy and curriculum development are discussed.

Strand 2: Science Learning: Contexts, Characteristics and Interactions *Diverse Strategies for Studying and Improving STEM Learning*2:45pm - 4:15pm, Baltimore Salon A Presider: Hillary Z. Lauren, University of Illinois at Urbana-Champaign

Converging Learning Performance and Neuroimaging Measures to Examine Team Function During Collaborative Problem Solving Pavlo D. Antonenko, University of Florida Robert Davis, University of Florida Mehmet Celepkolu, University of Florida Jiahui Wang, University of Florida Christine Davis, University of Florida

Nancy Ruzycki, University of Florida *ABSTRACT:*

Simple placement of learners in groups does not ensure effective collaboration. A useful approach to scaffolding collaborative learning is using collaboration scripts. This study compared the influence of an epistemic collaboration script and a social collaboration script on problem-solving performance, collaborative reasoning, individual knowledge acquisition, and team neurosynchrony. Our results confirm that social scripts can improve individual knowledge acquisition. However, data from collaborative learning performance measures demonstrate that epistemic script dyads outperformed social script dyads on three of the four problem-solving rubric criteria, focused mostly on relevant resources, and exhibited enhanced team neurosynchrony. Epistemic scripts appear more effective in collaborative learning situations where the goal is to define and solve a specific problem, rather than understand the concepts around a topic of study. Future research should test the effects of different designs of social and epistemic scripts, as well as the effects of integrated social and epistemic scripting on collaborative problem solving. More conceptual and empirical research is also needed to investigate the potential of team neurodynamics measures and models to inform our understanding of team organization during complex problem-solving tasks.

Using the Eye Tracking Method to Reveal Students' Cognitive Conflicts

Chia Hui Cheng, National Taiwan Normal University Fang-Ying Yang, National Taiwan Normal University *ABSTRACT:*

In the study, we used the eye tracking method to detect students' cognitive conflicts. Participants were 20 lifescience freshmen from a national university in Taiwan. They were randomly assigned to two groups. Students took the misconception test first, and then proceeded to read a short expositive text. Before reading the expositive text, students of group 1 were asked to read the misconception test again with an answer on each item, while the other group (group 2) went directly to read the expositive text without knowing the correct answers. Students' eye movements were recorded all the time during the experiment. The eye movement measures analyzed in the study were the changes in pupil size and first-pass fixation duration time. It was found that group-1 students showed larger pupil expansion rates and first-pass fixation durations when their misconceptions were revealed. When students read the expositive text, group-1 students, compared to group-2 who were not given answers, displayed shorter first-pass reading time, indicating less cognitive loads. Moreover, by cross analyzing students' answers and the correct answers for the misconception test, it was confirmed that those who encountered cognitive conflicts were indeed more efficient in making sense of the expositive text.

The Impact of the Design and Use of Multiple Models on Seventh Graders' Spatial Abilities. William J. McConnell, Old Dominion University Daniel L. Dickerson, East Carolina University Stephen R. Burgin, University of Arkansas ABSTRACT:

Current science education reform calls for the integration of engineering practices within science classrooms. Thus, design-based instruction is receiving much attention in science education literature. The purpose of this study was to better understand how design-based instruction with an emphasis on scientific modeling might impact students' spatial abilities. In the following mixed-method multiple case study, seven middle grade students underwent an instructional intervention. Students created and used multiple forms of expressed models to explore the interrelatedness of the environment and an organism's form and function. Pre/post data were collected through the use of The Purdue Spatial Visualization Test: Rotation, the Mental Rotation Test and interviews and video recordings and various student artifacts were also collected. Spatial abilities tests were analyzed using descriptive statistics while models were analyzed using content analysis. The remaining data were coded and analyzed for emergent themes. Findings included increases in spatial abilities for six out of seven participants, and an immense difference in the spatial challenges students encountered when using 3D printing technologies instead of paper drawings to create models. Participants also navigated spatial challenges differently depending on the model type. Limitations and recommendations for further research are also presented.

School Leadership and STEM Enactment in a High Needs Secondary School in Belize Noemi Waight, University at Buffalo Stephen Jacobson, University at Buffalo Lorenda Chisolm, University at Buffalo

ABSTRACT:

This case study examined how the work of school leaders informed the curricular trajectory and enactment of STEM in a high needs secondary school in Belize. More specifically, the study examined the role of school leaders, how school leaders informed the design and development of STEM curriculum, how STEM curriculum was enacted in practice, and, students' experiences in STEM courses. Findings revealed that school leaders emphasized four main themes: opportunities for access to school and community-based experiences, student preparation to contribute to the economics of their community (e.g., tourism), provide professional development for teachers, and, address administrative and logistical issues. For school leaders expectations for science and technology curriculum reflected the global urgency of preparing youth for STEM careers. While science and technology resources were limited in the context of schooling (e.g., lack of science lab and equipment), science inquiry experiences were provided through field-based investigations and school-community project-based experiences related to integrated science and ecology. This study contributed to our understanding of the role of leadership and STEM in developing nations specifically Latin/Central American countries. 0 0 1 191 1091 University at Buffalo 9 2 1280 14.0 Normal 0 false false false EN-US JA X-NONE /* Style Definitions */ table.MsoNormalTable {mso-style-name:"Table Normal"; mso-tstyle-rowband-size:0; mso-tstyle-colbandsize:0; mso-style-noshow:yes; mso-style-priority:99; mso-style-parent:""; mso-padding-alt:0in 5.4pt 0in 5.4pt; mso-para-margin:0in; mso-para-margin-bottom:.0001pt; mso-pagination:widow-orphan; font-size:12.0pt; fontfamily:Cambria; mso-ascii-font-family:Cambria; mso-ascii-theme-font:minor-latin; mso-hansi-fontfamily:Cambria; mso-hansi-theme-font:minor-latin; }

Literature Review of Students' Metacognition and Metacognitive Strategies in Science Education

Rea Lavi, Technion - Israel Institute of Technology

Shirly Avargil, Bar Ilan University

Yehudit Judy Dori, MIT; Technion - Israel Institute of Technology

ABSTRACT:

Many educators and policy makers regard metacognition as imperative for teaching and learning science, from elementary through secondary school to higher education level. We conducted a literature search and analysis to identify how metacognition has been studied in the present century, focusing on science education. Our review included about 300 published chapters and papers concerning metacognition, assessment, and science education, as documented by the National Research Council and archived in three leading journals. Our analysis identified three categories of empirical papers: (a) research on assessment tools for metacognition, (b) research on metacognitive learning processes, and (c) research on metacognition-based pedagogical intervention. We identified the widest gap between needs and current state of the art in category (a). We further analyzed papers concerning pedagogical metacognitive intervention and surveyed the tools described for assessment of students' metacognitive skills, based on criteria from the literature. Finally, we provide suggestions for researchers and educators concerning metacognition in science education. This review can help teachers improve the performance of their low and high achieving students. It can also provide researchers with knowledge on how

metacognition and assessment in science education have been implemented and investigated, and what research directions should be pursued.

Strand 4: Science Teaching--Middle and High School, Grades 5-12): Characteristics and Strategies *Exploring Novel Instructional Approaches*

2:45pm - 4:15pm, Homeland **Presider:** Daniel M. Alston, Clemson University

A Comparison of Three Teacher-Created Project-Based Investigations on Local Watersheds: Successes and Limitations

Rebecca McNall Krall, University of Kentucky Justin M LeVaughn, University of Kentucky Bharath Kumar, University of Kentucky

ABSTRACT:

Project-based learning (PBL) environments can promote application of scientific knowledge and skills in solving real world problems in authentic contexts. Developing teachers' abilities to design student-centered instruction embraced by models such as PBL is essential in implementing NGSS. This exploratory case study compares watershed units designed by three teachers that had completed a PBL professional development program on watersheds. The research design included pre and post assessments of the entire cohort of seven middle school science teachers participating in the watershed PD. Instruments were designed to measure changes in teachers' knowledge of watersheds and PBL environments. In addition, instructional units, field notes, and interviews were used to provide rich descriptions of units, their adherence to the PD PBL model, and to identify challenges and limitations in designing and implementing units. The three models appeared to fall along a continuum. At one end was a unit that most closely aligned with the PD model of the three units, and at the other end was a unit that demonstrated little change from the teacher's original ecosystems unit. Time, adherence to district-wide standards, and teachers' views of PBL were limitations affecting unit design. Issues arising in designing units also will be discussed.

Exploring Science Teachers' Practices About Formative Assessment

Dante Cisterna, Pontifical Catholic University of Chile Amelia Wenk Gotwals, Michigan State University

ABSTRACT:

The implementation of quality formative assessment is promising for science instruction and student learning. However, current research has not agreed and clearly specified what constitutes formative assessment practices in science classrooms. This study explores classroom practices of in-service science teachers, in the context of professional development focused on promoting this practice, and problematizes the extent to these formative assessment practices help students learn about science. Using a mixed-methods approach, this multiple-case study provides insights about what teachers (can) do with enacting formative assessment with specific content.

Productive Framing for Making Effective Transitions on Learning Progressions: A Video Study

Hui Jin, Educational Testing Service

Michele Johnson, University of California, Santa Barbara

Charles W. Anderson, Michigan State University

ABSTRACT:

This study uses framing as theoretical lens to examine the dynamic relations between students' interpretation of science learning in class and teachers' instructional moves. We analyzed 21 lesson videos collected from an intervention study where four participating teachers used learning progression-based curriculum materials to

teach a unit on plants gaining weight. We analyzed 78 whole-class discussion episodes, where the teacher pressed students to explain the "how" and "why" of their answers. Based on data analysis, we identified five frames of students: mechanism, inquiry, covering law, knowledge matching, and heuristic. We define the first two frames as productive frames because they guide students to reason about causal mechanisms and scientific methods that we expect students to use in order to achieve the upper anchor of the learning progressions. The results suggest that the teachers in general focused on learning the scientific knowledge but not learning the process of "doing science". We also found that teachers used different instructional moves in respond to students' different frames. General pedagogical moves include repeating students' responses as a question, repeating the question, and asking for alternative answers. Specific instructional moves include asking "reflective toss" questions and asking students to provide specific examples for their answers.

Classroom Patterns That Characterize the Different Levels of Inquiry-Based Instruction

Daniel M. Alston, Clemson University Jeff C. Marshall, Clemson University Julie B Smart, Clemson University

ABSTRACT:

In the United States, reform movements have been a part of the science education community for decades. Inquiry-based instruction has a long history in reform documents and while it is not explicitly used in the Next Generation Science Standards (NGSS), the underlying tenants of this instructional strategy are still evident. Thus, inquiry-based instruction remains a strategy that science teachers can use to address the expectations set forth in the NGSS. Therefore, it is crucial that researchers provide science teachers with information concerning the characteristics their inquiry-based lessons should exhibit. This study utilized 5 years of data collected on inquiry-based lessons to search for distinctive patterns between at least proficient and below proficient lessons. Specifically, we were seeking to describe these patterns in terms of the amount of time spent in the different components of inquiry and levels of student cognitive engagement. We ran MANOVAs to determine if distinct patterns existed. Results showed that at least proficient inquiry lessons spent more time allowing students to explore scientific concepts and getting students to display higher-order thinking skills. Implications of these findings speak to at least proficient inquiry instruction being a viable instructional strategy to accomplish the goals set forth in the NGSS.

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

Teacher Preparation and Science Education

2:45pm - 4:15pm, Pride of Baltimore

Presider: David Osmond, University of North Georgia

Pre-Service Science Teachers' Misconceptions About Density and Buoyancy Sinem Demirci, Middle East Technical University Mehmet Sen, Middle East Technical University

ABSTRACT:

Determining students' difficulties has been one of the major concerns in science education. Educators in the late 1970s realized that students have some misconceptions. Correspondingly, researchers conducted studies to detect them. Similar to other disciplines, individuals have misconceptions about physical systems. Misconception studies generally focused on light, sound, electricity, force, and motion. However, limited studies were found about density and buoyancy. Since these physical concepts are important for meaningful learning and teachers are one of the misconception resources, the study aimed to detect pre-service teachers' misconceptions. Case study was chosen since the researchers seek in-depth information for the understandings about the concepts. 6 pre-service elementary science teachers were participated and semi-structured interview

were conducted. The interview questions were constructed by the researchers and two experts examined and provide feedbacks. The interview has two parts aiming to detect misconceptions reported in literature. The interviews were transcribed and analyzed. The results indicated that similar misconceptions were observed among the pre-service teachers. Moreover, they had some difficulties defining these physical concepts and lack of explaining the scientific phenomena related to those concepts. This study may give some insights for further studies in a way that it may highlight formation and elimination of misconceptions.

Written Argumentation in an Undergraduate Physics Class for Future Elementary Teachers Carina M. Rebello, Purdue University

ABSTRACT:

Scientific argumentation is a key science and engineering practice identified in the Next Generation Science Standards. Although argumentation has been widely researched in science education, there is relatively little research on argumentation in the context of physics problem solving. We investigate the integration of argumentation in a physics course for future elementary teachers. Participants were trained to either construct or evaluate arguments in conceptual physics problems. After training in small teams, participants received tasks that required them to transfer their argumentation skills to new problems requiring a different form of argumentation. Results indicate that either forms of training were equally effective at preparing students to transfer their learning to conceptual problems requiring a different form of argumentation.

On the Relation Between Pre-Service Teachers' Physics and Mathematics Content Knowledge

Irene Neumann, Leibniz-Institute, IPN), Kiel Anke M Lindmeier, Leibniz-Institute, IPN), Kiel Knut Neumann, Leibniz-Institute, IPN), Kiel Aiso Heinze, Leibniz-Institute, IPN), Kiel

ABSTRACT:

Physics and mathematics are closely tied together. Physics concepts are expressed by means of mathematical symbols and mathematical modeling helps to describe natural phenomena. Consequently, it seems obvious, that also the learning of physics and mathematics are closely connected. In fact, there are studies, which identified students' problems, e.g. with physics formula. These studies provide a very detailed and in-depth understanding of mathematics-related challenges occurring in physics problems, and therefore typically are based on only small samples and items. The present study adds to this research as we report about exploring the relationship between mathematics and physics knowledge of German pre-service physics and mathematics teachers. This group is of particular interest, since German pre-service teachers study two (sometimes even three) subjects as a major, which allows for investigating the relation between mathematics and physics knowledge from a broader perspective. Our study involved N = 104 pre-service teachers who were administered two tests, addressing higher mathematics and physics. Our results indicate a significant relationship between physics and mathematics and physics howledge at the college level.

Interaction Between Science Teaching Orientation and PCK Components

Betul Demirdogen, Bulent Ecevit University

ABSTRACT:

The purpose of this case study is to delve into the complexities of how preservice science teachers' science teaching orientations as an interrelated set of beliefs interact with their other components of pedagogical content knowledge (PCK). Eight preservice science teachers participated in the study. Qualitative data were collected in the form of Content Representation (CoRe), responses to an open-ended instrument, and semi-structured interviews. Preservice teachers' orientation and PCK were analyzed deductively. Constant comparison analysis of how their orientation interacts with other PCK components revealed three major themes: (1) Type of

purposes of teaching science influences the PCK component it interacts, (2) Beliefs about nature of science do not interact with other PCK components until it relates to goals and purposes of science teaching, and (3) Beliefs about science teaching and learning mostly interact with knowledge of instructional strategies. Implications for science teacher education and research are discussed.

Strand 6: Science Learning in Informal Contexts Interests and Attitudes in Out of School Time Science 2:45pm - 4:15pm, James

Presider: Jennifer Wyld, Oregon State University

Middle School Girls' Science Motivation and Performance: Cognitive Effects of an Out-of-School-Time Program

Jennifer A. Gatz, Stony Brook University Angela M. Kelly, Stony Brook University *ABSTRACT:*

Innovative strategies are needed for middle schools girls to improve their science identity, motivation, and achievement. Self-regulation serves as a measure of control over behavior and environmental contexts play a pivotal role in the causal structure of social cognitive theory, which asserts that cognitive processes exert a determinative influence on goal-directed pursuits. In science, students' attitudes and motivations towards different science courses and activities affect their effort, perseverance when encountering difficulties, and academic achievement. We applied this model to an Out of School Time (OST) program and measured its impact on students' cognition, science motivation and achievement. A 20-week informal science and triathlon training program served as the intervention for female middle school students (n=29). The comparison group of females (n=30) was randomly drawn from middle school students of a similar demographic. ANCOVA was used to determine the effect of the intervention contributed to a statistically significant improvement in cognition, science motivation and achievement. These results suggest that an out-of-school-time program with a nutrition and fitness component may produce increases in cognitive processes and motivations involved in science learning.

Impacts of Students' Interaction with Indigenous Craftsmen on their Attitude and Interest in Physics Related Careers

Irene U. Osisioma, California State University, Dominguez Hills Peter A. Okebukola, Lagos State University, Lagos-Nigeria Hakeem Akintoye, Lagos State University, Lagos-Nigeria Solomon O. Aregbede, Lagos State University, Lagos-Nigeria Yinka Orulebaja, Lagos State University, Lagos-Nigeria Grace Njoku, Lagos State University, Lagos-Nigeria

ABSTRACT:

The current study explored how students' interaction with indigenous craftsmen at their local workshops impacted students' attitude towards Physics and interest in pursuing Physics related careers. It was based on the theory that support the presumption that students' willingness to change their attitude towards Physics and to develop positive disposition towards Physics related careers depended on their perception of how beneficial and rewarding the visit to the mechanic workshop was to them. A mixed methods approach, quasi-experimental non-randomized pre-test, post-test, non-equivalent control group and descriptive survey designs was used to collect experimental and control data from 70 students from two experimental and 90 students from two control schools. Physics Students' Attitude Questionnaire and Physics Students' Interest Questionnaire were used for

data collection. Results showed that the interaction had positive impacts on experimental students' attitude and choice of Physics related careers as opposed to the control group students. Experimental groups students developed more positive attitude towards Physics and tended to choose mostly Physics related careers while control groups students did not have much affinity for Physics related careers. It was recommended that science teachers should use place-based outdoor instructional strategies to increase students' attitudes and improve their interest in Physics.

"Anchor Points" to Define Youth Scientific Literacy for Informal Education Programs

Martin H. Smith, University of California, Davis Steven Worker, University of California Emily Schoenfelder, University of California Kelly Brian, University of California Andrea Ambrose, University of California Lynn Schmitt-McQuitty, University of California ABSTRACT:

Scientific literacy is an important educational and societal goal. Measuring scientific literacy, however, has been problematic because there is no consensus regarding the meaning of the construct. Most definitions focus on content and processes of major science disciplines, ignoring social factors and citizens' needs. These "within science" definitions represent a Vision I perspective of scientific literacy. A definition of scientific literacy for California 4-H, an informal youth education program, was developed from the citizen's viewpoint, a Vision II perspective, concentrating on authentic science-related situations. The definition includes four anchor points: science content; scientific reasoning skills; interest and attitude; and contribution through applied participation. The definition, adaptable for use by other informal science programs, provides California 4-H with a consistent framework for future science curriculum and program development and implementation, educator professional development, and evaluation.

Characteristics, Influencing Factors, and Development of Members of Ten STEM Hobby Groups: A Comparison Study

Elysa N. Corin, North Carolina State University M. Gail Jones, North Carolina State University Thomas andre, Iowa State University Gina M. Childers, North Carolina State University *ABSTRACT:*

Adults continue to learn about STEM topics long after their compulsory schooling has ended by engaging in free-choice activities in their leisure time. Comparing 2,838 adults who filled out an online questionnaire about their participation in one of ten STEM hobbies (astronomy, beekeeping, birding, electronics/robotics, environmental monitoring, falconry, gardening/horticulture, home brewing, model building, and rock/fossil collecting), this study allows comparisons to be made amongst members of different hobby groups. Results show that nearly half of the hobbyists in the sample became first interested in their hobby during childhood, and that diverse factors (i.e. friends, family, significant events, teachers, other educators) were reported as first getting participants interested in their lifelong hobby in different proportions, by hobby group. "Significant events" were reported most often as influencing astronomy and electronics/robotics hobbyists to begin their hobby, "family" was reported by gardening, birding, rock/fossil collecting and beekeeping hobbyists, and "friends" was most often reported by home brewing, model building and falconry hobbyists. The influence of "teachers" was not reported as the highest influence for any hobby group, but environmental monitors rated the influence of "other educators" as the highest influence on their interest development.

Strand 7: Pre-service Science Teacher Education

Preservice Teachers? Learning About Pedagogical Routines and Assessments 2:45pm - 4:15pm, Fells Point Presider: Grant Williams, St. Thomas University

Influencing Pre-Service Science Teachers' Beliefs About Model-Based Whole-Class Discussions

Grant Williams, St. Thomas University John J. Clement, University of Massachusetts

ABSTRACT:

If science teachers are encouraged to employ explanatory model construction as a means of fostering students' understanding of abstract concepts, they must first develop their own familiarity with the processes and products of modeling. Our work identifying and categorizing the model-based teaching strategies of experienced science teachers led to the development and piloting of an eight-week instructional unit on modelbased teaching strategies for pre-service science educators. The purpose of the present study was to determine the impact of the instructional unit on the developing teachers' beliefs about and understanding of how to engage science students in the construction of explanatory models. Through the analysis of pre and postinstruction surveys we noted that the pre-service science teachers in this study appear to have gained an increased appreciation for the importance of 1) whole class discussion, 2) centering science instruction on the learner, 3) starting from students' prior knowledge, and 4) engaging them in an evolutionary process of generating, evaluating, and modifying explanatory models to help them better understand abstract science concepts and phenomena. Our results provide an initial existence demonstration that a course that takes discussion strategies seriously can influence the beliefs of pre-service teachers about important aspects of pedagogy.

Longitudinal Study of Preservice Teachers' Use of Learning Processes in an Integrated Course Peter Cormas, California University of Pennsylvania

Samantha Middlemiss, California University of Pennsylvania

ABSTRACT:

Mathematics and science have similar learning processes and it has been proposed that integrated courses focused on these and other similarities can enrich learning. However, it is not known how the degree and type of processes in lessons taught to children change throughout a preservice teacher education course. Three hundred and ninety lesson plans written by 113 preservice teachers from 10 sections of a methodological, process, and sequenced integrated science and mathematics education course were analyzed. The findings show that preservice teachers need to write and teach at least four lesson plans in science to significantly increase the number of processes used in lessons. Preservice teachers also need to teach three mathematics lessons, after four science lessons, to reach the same degree of processes used by the end of the fourth science lesson. Lastly, results show that some similar processes in mathematics and science are highly correlated and seemly transfer from science to mathematics, while others are more difficult to incorporate in lessons from each discipline despite similarities.

Pre-Service Teacher Planning for Academic Language During Elementary Science Instruction

Karl G. Jung, University of Minnesota Julie C. Brown, University of Minnesota

ABSTRACT:

The NRC (2012) sees the important role that language plays in learning science, noting that every science and engineering lesson should be in part a language lesson to support students in developing the language skills necessary to participate in science. The language used in science differs greatly from the language students use in everyday conversation and is often challenging for students to access (Gee, 2008). Unfortunately, many

teacher struggle to identify the language demands associated with their lessons and fail to make those demands clear to their students (Schleppegrell, 2004). This case study investigates the ways in which an academic language planning organizer supported pre-service teachers (PSTs) in identifying language demands and planning supports for those demands. Results show that while the PSTs were able to identify a clear language function, their identification of associated demands varied. All PSTs were able to plan at least one clear support for the identified language function and demands, however the translation of those supports to the lesson plan varied across the PSTs. This study looks to build on the current research related to academic language in science and is of interest to science teacher educators, methods course instructors, and PST mentors.

Tracking the Development of Assessment Literacy: Preservice Science Teacher Trajectories Frances Edwards, University of Waikato

ABSTRACT:

Science teachers need to be skilled assessors in order to assess the wide range of knowledge and skills that students develop in science classes. Preservice science teachers develop assessment literacy through their teacher education program, but research indicates that teachers enter the profession with only an emergent understanding of the complexities and technical skills involved in assessing students' learning. This paper describes a longitudinal study which tracked eight science teachers' assessment literacy development. Qualitative data was gathered and a 10-dimensional rubric was developed which describes aspects of assessment literacy. Teachers were scored at four significant stages of their program, leading to the construction of graphical displays of individual teacher's progress. These illustrate their assessment learning trajectory. Key elements contributing to the teachers' learning about assessment were identified. This paper makes the case for designing a customised rubric to track preservice teachers' assessment literacy development.

Strand 8: In-service Science Teacher Education

Science Teachers' Use of Inquiry Strategy and their Beliefs About Scientific Inquiry 2:45pm - 4:15pm, Maryland Salon F Presider: Franz X. Bogner, University of Bayreuth

European-Wide Large-Scale Study of Inquiry-Based Professional Development in Science Education Franz X. Bogner, University of Bayreuth

Sofoklis Sotiriou, R&D Department Ellinogermaniki Agogi, Pallini/Athens

Rodger W. Bybee, Biological Science Curriculum Study

ABSTRACT:

In an evolutionary context, we present a bottom-up initiative, called "PATHWAY to Inquiry Based Science Education", to setting the grassroots for new science learning innovations. Consequently, the objectives were to reach the right balance with top-down planning, thus, meeting the challenges for emerging paradigms concerning access to learning, the sharing of knowledge and the building of competences in learning communities. Unlike pilot experimental situations where most educational innovations are typically assessed, school reality would go beyond such frames due to constraints, such as, for instance, curricular misalignment, laboratory infrastructure, teachers' resistance to change, poor educational governance, political and social obstacles which may mediate or dilute the impact of educational top-down innovations. The PATHWAY initiative was designed to mobilize practitioner communities and educational authorities to work jointly for a standardized framework for teaching science as inquiry. PATHWAY brought together 10.053 science teachers from 15 European countries to a lively community and conveyed a mechanism sustaining the innovation process in numerous schools. Within this initiative, about half the sample contributed to our data basis (n= 5060) extracting providing empirical support regarding its innovative potential in science classrooms through effective community building and support for teachers' professional development.
Science Teachers' Cultural Beliefs and Views of Scientists and Scientific Inquiry: A Call for Scientist-Science Teacher Partnerships to Promote Inquiry-Based Learning

Nasser Mansour, University of Exeter

ABSTRACT:

Despite a growing consensus regarding the value of Inquiry-Based Learning (IBL) on students' learning and engagement in the science classroom, the implementation of such practices continues to be a challenge. If science teachers are to use IBL to develop students' inquiry practices and encourage them to think and act as scientists, a better understanding of factors that influence their attitudes towards scientific research and scientists' practices is very much needed. Within this context there is a need to re-examine the science teachers' views of scientists and the cultural factors that might have an impact on teachers' views and pedagogical practices. A diverse group of Egyptian science teachers took part in a quantitative-qualitative study using a questionnaire and in-depth interviews to explore their views of scientists and scientific research, and to understand how they negotiated their views of scientists and scientific research in the classroom, and how these views informed their practices of using inquiry in the classroom. The findings explored in depth teachers' underpinning epistemological-ontological cultural beliefs and views of scientists and scientific research that explain their views and practices of using IBL in the science classroom. The study argued for teacher professional development based on partnerships with scientists.

Teacher Professional Development Using Iterative Inquiry-Based Chemistry Activities

Mitchell Bruce, University of Maine Clint Eaton, University of Maine Somnath Sinha, University of Maine Laura Millay, University of Maine Alice Bruce, University of Maine *ABSTRACT:*

Maine Physical Sciences Partnership (Maine PSP) is a NSF project led by the RiSE (Research in STEM Education) Center at the University of Maine to reform and vertically align science education in rural school districts. The partnership caters to the needs of the science teaching community by providing professional development (PD) on topics of interest/need to teachers to foster teacher ownership in their development as leaders and professional educators. To enhance teacher understanding in chemistry, a week-long chemistry workshop for 20 middle-school teachers and graduate students was conducted involving content knowledge, scientific inquiry, and discussions about instructional practices. A unique aspect of the PD model was the iteration of small-group, inquiry-based lab activities involving data gathering, analysis and construction of posters. The evidence, analysis, and claims presented in posters was discussed to gain insight into inquiry by teachers and the implications for instructional practices with students. Research was conducted to understand teacher's understanding of chemistry inquiry and views of instructional practices. An analysis of pre- post-surveys, posters, and post-interviews conducted within 45 days the PD will be presented. Findings show increased levels of understanding of inquiry over the iterative cycles. Implications and further research directions will also be discussed.

Examining Science Teachers' Changes in Implementing an Argument-Based Inquiry Approach: Year 1 Results Soonhye Park, North Carolina State University Jee Kyung Suh, University of Iowa Ye Jun Bae, University of Iowa Brian M. Hand, University of Iowa ABSTRACT: This study reports the first year results of a 3-year research project that aims to 1) document and illustrate changes that teachers make as they become successively more able to implement an argument-based inquiry approach in the science classroom, and 2) link teachers' changes to student learning. The project has completed its first year and this current proposal describes teacher changes in orientations and practices emerging during the first year. This study employed a mix-methods research design involving eighteen middle school science teachers in US. Data sources include three teacher surveys, classroom observations, and teacher interviews. Teachers' responses to the surveys and teacher observations were scored using scoring rubrics. Teacher interviews were analyzed using constant comparative methods. Results indicate that even though teacher changes in epistemic orientations occurred slowly, at the end of the first year, some teachers made substantial changes. Those changes mainly stemmed from their shift toward student-centered view away from teacher-centered view. Although thirteen teachers out of 18 started implementing more student-centered instructional approaches, most had stayed at the low SWH implementation level throughout the first year. They found most challenging to implement 1) focusing on big ideas in science and 2) creating dialogical interactions.

Strand 8: In-service Science Teacher Education *Teachers' Understandings of and Responses to NGSS* 2:45pm - 4:15pm, Federal Hill **Presider:** Loran C. Parker, Purdue University

Developing Rubrics That Support Teachers' Understanding of NGSS Practices: An Approach Grounded in Improvement Science

Rachelle DiStefano, California State University, East Bay Corinne H. Lardy, California State University, East Bay Christine Lee, California State University, East Bay Michele Korb, California State University, East Bay Danika LeDuc, California State University, East Bay Michelle Sinapuelas, California State University, East Bay *ABSTRACT:*

With the advent of the Next Generation Science Standards (NGSS), a core aspect of current science education is a significant shift in pedagogy away from students memorizing discrete facts to actually doing science in the classroom. Unfortunately, there is a lack of NGSS-aligned tools that have been systematically field-tested in real education contexts that support these shifts. Anchored in Improvement Science theory in the context of a Networked Improvement Community (NIC), this presentation provides a rich, descriptive account of the complex nature of designing standards-aligned tools that are effective in real education contexts, what Improvement Science and authentic practitioner participation looks like in practice, and the organizing role of a NIC in accelerating and widely scaling these improvements.

Documenting, Characterizing, and Understanding Science Teacher Growth and Learning in the Context of NGSS

Arash Jamshidi, University of California, Davis Laura Schafer, University of California, Davis Cynthia Passmore, University of California-Davis *ABSTRACT:*

Affording teachers the opportunity to develop their own understanding of curricular reform shows sensitivity to both the cognitive and situated nature of knowledge construction. Through a co-constructive approach, teachers developed a contextualized understanding of the Next Generation Science Standards (NGSS) scientific practices, as they designed and enacted practice-aligned instruction. Applying Coenders & Terlouw's (2015)

Extended Interconnected Model for Teacher Professional Growth (EIMTPG) to analyze teacher reflections and descriptions of lesson enactments, grants researchers insight into how one group of science teachers understands and enacts pedagogical reform focused on the NGSS scientific practices. The resultant "storylines", or network of interactional learning pathways, for two science teachers in this project not only reinforce the value of this model for characterizing teacher growth in the context of science curricular reform, but they also yield potential mechanisms contributing to the different pedagogical "shifts" realized in both teachers' thinking and subsequent design of practice-aligned instruction. Studying these mechanisms helps identify possible leverage points impacting teacher learning as they seek to enact curricular change in future professional learning opportunities.

Examining Knowledge Pathways Teachers Leverage: Designing and Facilitating Professional Development Around NGSS Practice-Based Instruction

Laura a Shafer, University of California Davis Arash Jamshidi, University of California, Davis Cynthia Passmore, University of California-Davis *ABSTRACT:*

Professional development is seen as an important resource for expanding teachers' knowledge and beliefs around education reform efforts. Teacher knowledge gains are primarily situated in participation in professional development not in the design or facilitation of professional development programs. This study is unique in that we study teacher leaders who are positioned as professional development designers and facilitators. Our purpose here is to observe and analyze teacher leaders' professional goals and practices when designing and facilitating professional development around science education reform. The extended interconnected model of teacher professional growth[(Clarke & Hollingsworth, 2002) & (Coenders & Terlouw (2015)] is used as an analytic tool to illustrate teachers' negotiations of the knowledge domains that they draw from as PD developers. Empirical evidence of negotiations between knowledge domains are presented to guide our understanding of the commitments, ideas, and understandings teachers perceive as most salient for professional development around science education reform.

Perceptions of Expertise of Urban Elementary Teachers in Response to the Next Generation of Science Erica L. Smith, Johns Hopkins University

Carolyn A. Parker, The John Hopkins University David E. McKinney, Johns Hopkins University School of Education Charlie Mitchell, the Johns Hopkins University *ABSTRACT:*

The study was situated in a five year NSF-funded Math Science Partnership between a university and an urban school district in the eastern United States and includes an in-school STEM education curriculum, enrichment opportunities for students in grades 3 through 5, and teacher professional development (PD) opportunities. The focus of this study was to develop understanding of the extent to which in-service elementary teachers' perceptions change over the course of their involvement in PD opportunities and what aspects of the PD model influenced their perceptions towards their ability to teach science. This research study utilized a mixed-methods, exploratory research design. Results indicated that after one year of involvement, the teachers were less inclined to perceive themselves as a master science teacher. The self-efficacy of the teachers appeared to be impacted when they were asked to change how they had taught science prior to the project and their evolving understanding of what it means to be a master science teacher. The findings of this study have implications in continuing to better understand the impact of elementary teachers' self-efficacy in teaching science through inquiry and planning for its development through PD opportunities.

Strand 10: Curriculum, Evaluation, and Assessment

Issues of Diversity, Equity, and Access in Curriculum and Assessment

2:45pm - 4:15pm, Baltimore Salon B

Presider: Michael S. Tutwiler, Harvard Graduate School of Education

Equity in Science Education for Students with Significant Cognitive Disabilities Through Alternate Content Standards

Lori andersen, University of Kansas Sue Bechard, University of Kansas Katherine Anne Merriweather, University of Kansas

ABSTRACT:

Historically, students with significant cognitive disabilities (SWSCD) have received little science instruction (Karvonen et al., 2011), even though alternate content standards and assessments that are linked to the gradelevel standards are allowed (U.S. Department of Education, 2004). In response to the needs of SWSCD and new general education science standards, a group of four Midwestern U.S. states developed a set of 34 alternate content standards using principles of Universal Design and three levels of cognitive complexity to make science accessible to SWSCD. Assessments based on these standards were then developed following a process of Evidence Centered Design (ECD). This paper focuses on two of the ECD layers - domain analysis and domain modeling, which involve determining the specific content that will be included in the assessment and creating descriptions of the focal knowledge, skills, and abilities, as well as potential work products. Assessment items were created through a rigorous development process that included internal and external reviews. Accessibility of the alternate standards was evaluated through assessment results from a sample of 1,606 students from four states. Preliminary results support that the alternate standards are accessible and that SWSCD can learn academic science content.

Opportunities-To-Learn at School: Profiles of Students Reaching High Timss Science Benchmark Melinda Whitford, SUNY - Buffalo

ABSTRACT:

This study examines the relationship between opportunity-to-learn (OTL) variables related to teaching practices and teacher attitudes and students' attainment of science literacy. The data set used was the 2011 TIMSS science US sample. Data mining was used to create patterns of association between OTL variables. Students who failed to reach a high benchmark science level used computers in their classroom never, were assigned homework never, and spent less than 15 minutes on science in their classrooms. Their teachers report high levels of parental support, a lot of discussions with principals and observations with internal staff. Conversely, students who reached a high benchmark level conducted experiments almost every lesson, had lessons that related to student lives, and spent more than 15 minutes on science in their classrooms. Their teachers also report high levels of parental support, some or no time discussions with the principal and are not observed by external observers. These findings have important implications developing comprehensive science achievement improvement measures.

Differential Performance of English Learners on Science Assessments: The Role of Cognitive Complexity George E. De Boer, American Association for the Advancement of Science - Project 2061 Cari F. Herrmann Abell, AAAS/Project 2061 Sarah Glassman, AAAS/Project 2061

ABSTRACT:

This paper reports on the development and validation of a measure to score the cognifive complexity of test items used in a study of factors related to the differential performance of English Learners (ELs) on science assessments compared to native English speakers. This measure of cognitive complexity will then be used along

with measures of linguistic complexity to investigate the relationship between cognitive and linguistiv complexity and their ability to explain performance differences between EL and non-EL students.

Research-Based Transformation From Teaching to KNOW - to Learning to THINK for Equity and Justice Uri Zoller, Haifa University - Oranim

ABSTRACT:

Equity, justice, education and SCIENCE EDUCATION are conceptualised differently by people, sectors, societies, nations and educational systems. Consequently, the 'sustainability'-related sociocultural, moral, environmental, economical and policy components, are expected to transform differently in different contexts. The related paradigms shift in science, technology, environment, society, economy and policies (STESEP) interfaces contexts of SCIENCE, STES/STEM/STESEP EDUCATION is unavoidable.'Sustainability literacy' towards Equity and Justice (E&J) is contingent on research-based transformation of the conventional/traditional teaching to "Know" - to learning to "Think". This would require the development of students' higher-order cognitive skills (HOCS) such as question asking (QA), system thinking (ST, decision making (DM), Problems (not algorithmic exercises) Solving (PS) and moral thinking (MT). Selected results of pre-post designed research of the ST and MT capabilities of 10 grade students and the DM capability of undergraduate science students, compared with that of graduate (MA) students in Israel are presented; the "HOCS teaching" applied resulted in post-pre advancement in both levels. Yet, the disciplinary teaching of biology, chemistry, physics, as well as of technology and engineering courses. The LOCS-to-HOCS paradigm shift constitutes a major issue of concern, with respect to transdisciplinary 'STESEP learning to "THINK" – for equity and justice.

Reinserting Play and Playfulness into Formal Science Learning

Harouna Ba, SciPlay, New York Hall of Science

Amanda P. Jaksha, SciPlay, New York Hall of Science

ABSTRACT:

Play and playfulness are natural and essential components of learning because they are compelling frames and strategies through which young children explore and notice the world around them. However, the concepts of play, playfulness, and learning are often clearly separated in the formal academic lives of growing learners. Formal classrooms, especially science classes, are perceived as serious learning environments where learning and play do not mix. This separation becomes stark as children progress from early childhood learning to formal education settings and might be one of the key factors responsible for the high levels of students' disengagement in science classrooms. The authors of this paper will share the results of a study designed to reinsert play and playfulness into the learning of complex physics concepts in middle school classrooms by leveraging the affordances of students' physical play, a student-centric approach, and technology. The study will share how 22 teachers serving 1350 middle school students implemented the Playground Physics app, curriculum, and professional development activities in their classrooms; demonstrate students' levels of engagement in science classrooms and increased understanding of the concepts of motion, force, and energy; and discuss implications of the study results for science learning and teaching.

Strand 11: Cultural, Social, and Gender Issues

Language and Culture in Science Education: National and International Contexts 2:45pm - 4:15pm, Watertable Salon C

Presider: Shakhnoza Kayumova, University of Massachusetts-Dartmouth

"Do You Know Hwangsa?" an Examination of Korean-English Bilinguals' Translanguaging in an Afterschool Science Program

Minjung Ryu, Purdue University **ABSTRACT:**

Many students from immigrant backgrounds have to navigate bi/multilingual spaces in formal and informal science learning contexts. Such translanguaging is naturally occurring and facilitates emergent bilingual students' learning of science and language. Given the benefits, science education researchers highlight the importance of support of students' scientific sense-making in students' home languages. However, little is known about what is discursively occurring when students engage in multiple languages and in what ways it facilitates their learning. To fill this gap, this study examines how Korean-English bilingual students engage in translanguaging in an afterschool science program and what the translanguaging practices afford for their scientific sense-making and language development. Findings of the study indicate five forms of translanguaging-translation, insertion of lexical elements, speaking of a sentence/clause in their home language, explicit negotiation of language use, and repeating same/similar ideas in a second language. The identified functions of translanguaging include, for instance, drawing on knowledge constructed in their home language in home country contexts, clarifying meanings of key terms, and including monolingual students in the conversation. Moving away from the deficit perspective of non-native English speakers, this study provides implications for curriculum development and instructional strategies for bilinguals in multilingual science learning contexts.

Teaching NOS Within a Cross-Cultural Learning Community with Karen Elementary Students Susan G. Harper, University of Georgia

ABSTRACT:

Research on how elementary students understand the nature of science (NOS) has recently broadened to include an equity agenda. In this learning paradigm, culturally-marginalized students can leverage their ways of knowing to gain greater access to scientific knowledge. This qualitative research study explored an instructional strategy that paired explicit reflection on students' cultures with instruction and reflection on NOS within the context of a cross-cultural learning community. Karen (refugees from Burma) and non-Karen elementary students participated in an afterschool program in which Karen language lessons, Photovoice exercises, and inquiry-based science lessons prompted students to construct cultural and scientific knowledge. Narrative analysis of class activities, semi-structured interviews, and focus group discussions from Photovoice revealed a pattern of emerging agency in the scientific practice of argumentation by Karen students. However, closing interviews with students suggested that Karen students were not able to articulate the views of NOS as well as the non-Karen students. Whereas all of the students articulated their cultural knowledge in relation to science learning, the Karen students after four months needed more scaffolding to shift from the periphery of science learning to the center.

Explicating the Ubuntu Worldview into Science Education: A Project Experience Meshach Mobolaji Ogunniyi, University of the Western Cape **ABSTRACT:**

Abstract: This study is part of a larger project concerned with engendering equity and justice among students in multicultural African science classrooms using an ubuntu-driven dialogical argumentation instructional model (DAIM). Specifically, the study exposed a cohort of 23 science teachers and science educators (henceforth, participants) to DAIM for a period of two years. This was to enhance their awareness about the educational and cultural value of indigenous knowledge (IK) and to equip them with instructional strategies to implement a new indigenized science curriculum in a classroom context. An analysis of the data derived from video-audiorecordings and interviews shows that DAIM: enhanced the participants' ability to implement the new curriculum; increased their awareness about the educational and cultural value of IK and fostered their selfimage and sense of social identity.

English as Default Language of Instruction in Primary Grades: Repercussions in Indian Science Classroom Vanashri J. Nargund-Joshi, New Jersey City University

Nazan Bautista, Miami University

ABSTRACT:

Over two-thirds of countries in Asia, Africa, and Europe have developed policies on the use of the mother tongue for teaching science in the lower levels of their education system. In spite of this policy thrust, the educational system of many of these countries has not responded to the demands of such a policy. Because studies, analyzing the effects of using English language in teaching science at early stages with non-native English students, are scant, we remain in the dark as to how address this complex issue. This case study was conducted in a public, primary school in the urban setting of Western India. Qualitative data were collected from primary science classrooms where the mother tongue is expected to be used as a medium of instruction. Mismatch between policy and practice was found in these two teachers' science classrooms. It was also found that teachers' believed English as "language of knowledge" and best opportunities can be presented to the students through teaching science in English. During classroom observations, it was observed that teachers' preferred activities such as small classroom demonstrations, textbook reading and giving notes to the students to overcome their struggled with explaining science concepts in English language.

Strand 11: Cultural, Social, and Gender Issues

Symposium - Critical Perspectives on Science Education: Examples From Practice

2:45pm - 4:15pm, Kent **Presider:** Deb Morrison, TREE Educational Services Presenters:

Deb Morrison, TREE Educational Services Enrique Lopez, University of Colorado, Boulder Jean R. Aguilar-Valdez, Portland State University Alexandra Schindel Dimick, University at Buffalo Sara E. Tolbert, University of Arizona Daniel Morales-Doyle, University of Illinois at Chicago Deb Morrison, TREE Educational Services

ABSTRACT:

This symposium is a compilation of different voices representing critical perspectives on engaging in science research for the increased participation and success of students marginalized in science learning settings. As critical scholars, the authors are concerned with understanding the distribution of power in their particular setting and examining ways of redistributing power more equitably. In other words we are concerned with both structures of participation which may limit opportunities (Opportunity Gap), measures of achievement which may act as gatekeepers for success (Achievement Gap) for students, as well as curricula that disrupt broader inequities in society. This session will be organized as a structured poster symposium. We chose this format to facilitate rich discussion between authors and session participants as well as between authors. White men aren't the only scientists: Middle school students' critical investigations into science. Papers presented include: Ciencia Sin Fronteras: Latin@ Critical Race Theory and Chican@ Feminism in Science Education Research; Collective and Community Power in Defense of Academic Opportunity and Achievement in Secondary Chemistry; Altering the Ideology of Consumerism: Caring for Land and People Through Science Curricula; and Examining Latinas Strategic Uses of Academic and Social Resources to Thrive in Undergraduate Science: A Case Study Approach.

Strand 12: Educational Technology

Online and Mobile Tools 2:45pm - 4:15pm, Maryland Salon A **Presider:** Frackson Mumba, university of Virginia

Connecting Complex Human Body Systems During Model-Based Investigations

Barbara C. Buckley, WestEd Daniel Brenner, WestEd Andrew A. Grillo-Hill, WestEd George Deboer, AAAS Kim Luttgen, WestEd *ABSTRACT:*

The NSF-funded SimScientists Human Body Systems (HBS) project is testing simulation-based instructional modules with embedded formative assessments and a summative benchmark assessment for high school biology. Our theoretical framework integrates model-based learning (Buckley, 2012; Gobert & Buckley, 2000) with complex systems (Goldstone & Wilensky, 2008) in an evidence-centered design process (Behrens, et al, 2004). After pilot-testing the modules in classrooms and making revisions, we conducted a randomized controlled trial in the classrooms of 40 teachers. Preliminary analyses indicate that despite a significantly lower mean pretest score than the control group, the treatment group posted significantly higher gains on the posttest. While pretest scores were the major predictor of gain on the benchmark test, there was also a significant dosage effect.

Results of a Randomized Trial to Test the Effectiveness of Online Units to Teach Science Fatima Terrazas Arellanes, University of Oregon Lisa a Strycker, University of Oregon Emily Walden, University of Oregon Alejandro J. Gallard, Georgia Southern University ABSTRACT: English language learners (ELs) and students with learning disabilities (SWL De) have the

English language learners (ELs) and students with learning disabilities (SWLDs) have the potential to offer valuable insights into solving the world's scientific problems, but as a whole they continue to experience a science literacy gap and are marginalized in science, technology, engineering, and mathematics (STEM) careers. Project ESCOLAR addressed this inequity by creating online middle school science units to meet the special needs of ELs and SWLDs while providing an engaging web-based learning experience for all students. Two online science units were tested in the first year of a 3-year randomized controlled trial with 20 sixth-grade teachers and 1,174 students. Results showed significant improvement in science knowledge for students in the treatment condition, relative to the control group: general education students (p < .001), ELs (p = .04), and SWLDs (p = .015). ELs' gains in particular indicated a reduction in the knowledge gap compared to general education students. The study suggests that all students, including ELs and SWLDs, can learn with quality science education and learning supports. Science education practices should focus on incorporating quality science curriculum with effective technology practices to prepare students having many different voices, cultures, and languages for STEM careers and future global scientific challenges.

Impact of Mobile Technology Based Physics Curriculum on Preservice Elementary Teachers' Technology Self-Efficacy

Meera Chandrasekhar, University of Missouri, Columbia MO Deepika Menon, Towson University, Towson, MD Troy Sadler, University of Missouri, Columbia Mo

Dorina Kosztin, University of Missouri, Columbia MO *ABSTRACT:*

The purpose of this study is to investigate how affordances of mobile-technology-based physics curriculum support preservice elementary teachers' confidence in using mobile technologies in their own teaching. This quasi-experimental research study was conducted in two sections of a specialized elementary physics content course with 67 preservice elementary teachers. The experimental group (N = 33) used the Exploring Physics curriculum on an iPad and the comparison group (N = 33) used a traditional workbook. The Exploring Physics curriculum is available as a hybrid online-offline application running on multiple platforms (iOS, Andriod, PC/Mac) and provides a range of affordances to support teaching and learning of science. Data sources included two surveys, which assess self-efficacy for teaching science with technology and demographic information, focus-group and individual interviews, weekly observations of the classes and artifacts. Data analyses included repeated measures ANOVA and posthoc t-tests with Bonferroni adjustments, and grounded theory techniques. The results showed significant positive changes in confidence to teach using mobile technologies for the experimental group. In contrast, there was a significant decrease in the traditional group participants' confidence to teach science using mobile technologies at the end of the course. Findings have implications for preservice teacher preparation for technology integration.

Not Just Kittens: Design Guidelines for Youtube Science Videos for the General Public

David L. Fortus, Weizmann Institute of Science Yossi Elran, Davidson Institute of Science Education Avi Saig, Davidson Institute of Science Education Shulamit K, Davidson Institute of Science Education Hanna Edelman, Davidson Institute of Science Education

ABSTRACT:

This study investigates three questions which are central in the design of web-based informational science videos: How can one captivate the audience and what are the factors that motivate the viewers to continue watching the video until its end rather than leave in the middle? How is the interest in science-based videos distributed over various characteristics such as age, gender, language, educational background, and geographic location? Can one define a design-formula that leads to a balanced interest among varied audiences while maintaining scientific accuracy? The study looks at 25 existing YouTube videos and from them identifies potential design criteria. Additional videos based on these criteria are produced and then tested, leading to final design criteria and the production of additional videos (altogether 102).

Strand 13: History, Philosophy, and Sociology of Science

Perspectives on Socioscientific Issues and Instruction

2:45pm - 4:15pm, Maryland Salon E

Presider: Sarah Halwany, Ontario Institute for Studies in Education, OISE)

A Conceptual Analysis of Perspective Taking in Support of Socioscientific Reasoning

Sami Kahn, University of South Florida

Dana L. Zeidler, University of South Florida

ABSTRACT:

Scientific literacy is concerned with the informed citizens' ability to negotiate controversial socioscientific issues (SSI) facilitated by the engagement of socioscientific reasoning (SSR), a component of which is perspective taking. Although widely studied, perspective taking is a particularly tangled construct that is applied interchangeably with related constructs such as role taking, empathy, and theory of mind. This ambiguity hampers construct validity and prevents science education researchers from honing in on the skills

they wish to study and promote. Moreover, prior research suggests that moral development is a key outcome of SSI, yet the precise nature of the relationship between SSR, perspective taking, and moral development has not been articulated. To investigate this gap and clarify the construct of perspective taking, this theoretical study undertook a conceptual analysis, ultimately devising a more precise construct linking perspective taking within SSR to moral development called socioscientific perspective taking (SSPT). Findings suggest that SSPT requires engagement with others and their circumstances, an etic/emic shift, and a moral context comprised of reflective and reflexive judgment. Implications for science education research, including SSPT instrument development and sociocultural approaches to science teaching, are discussed.

Case Studies of Secondary School Science Teachers Designing Technology Rich SSI-Based Instruction Engin Karahan, Eskisehir Osmangazi University

Gillian Roehrig, University of Minnesota

ABSTRACT:

Addressing socioscientific issues (SSI) has been one of the main focuses in science education since the Science, Technology, and Society (STS) movement in the 1970s (Levinson, 2006); however, teaching controversial socioscientific issues has always been challenging for teachers (Dillon, 1994; Osborne, Duschl, & Fairbrother, 2002). Although teachers exhibit positive attitudes for using controversial socioscientific issues in their science classrooms, only a small percentage of them actually incorporate SSI content into their science curricula on a regular basis (Sadler, Amirshokoohi, Kazempour, & Allspaw, 2006; Lee & Witz, 2009). Therefore, there is a great need for in-depth case studies that would focus on teachers' practices of designing and teaching SSI-based learning environments and their deeper beliefs and motivations for teaching SSI. This study presents case studies of three secondary science teachers within three high schools located along the Minnesota River Basin. The results of in-depth interviews and classroom observations indicated that teachers' practices of teaching SSI are strongly influenced by their backgrounds, beliefs, motivations, and experiences, as well as the conditions established in their communities and institutions.

Using Actor Network Theory to Critically Teach About Socio-Scientific Issues: A Multi-Layered Pedagogy Sarah Halwany, Ontario Institute for Studies in Education, OISE) Majd Zouda, University of Toronto Chantal Pouliot, Universite Laval John Lawrence Bencze, University of Toronto ABSTRACT:

Acknowledging gaps between science education and democratic participation on socio-scientific issues (SSI) (Levinson, 2010), scholars have been urging educators to engage students in educational activities that extend beyond debating controversial issues to acting on them. For students to act on socio-scientific issues, a more democratic practice would be for teachers to shed light on various actors, both living and non-living, that sustain networks of SSI. This study was conducted in the context of a pre-service teacher course aimed at supporting pre-service teachers to prepare students/citizens to act on socio-scientific issues. Actor Network Theory (ANT) was used as a pedagogical resource to enlighten student-teachers about ontologically similar roles of human, non-human and semiotic actants that influence decision-making on SSI. Then, student-teachers planned and designed primary research (in the form of correlational studies) and action on SSI of personal interest. Later, they introduced ANT and research-informed activism to a group of grade 9 students at a local public school. Analysis of the classroom discourse revealed a multi-layered ANT pedagogy that may have partly influenced student-teachers' critical thinking about socio-scientific issues and their willingness to adopt ANT in their future practice.

The Development of an Instrument for Assessing Pedagogical Content Knowledge for Socioscientific Knowledge (PCK-SSI)

Cigdem Han Tosunoglu, Marmara University

Norman G. Lederman, Illinois Institute of Technology

ABSTRACT:

The purpose of this paper is to describe the framework on which PCK-SSI is based, the development of the instrument, and a description of the administration and analysis procedure. Items in the instrument were developed based on Shulman's PCK model and results of previous research about SSI instruction. The items were examined and validated by five science educators who had experience and expertise with in-service science teacher education. There were two cycles of review and discussion among the five science educators before there was 100% agreement that each of the items covered the content that the study intended to measure. A pilot study was conducted with 4 science teachers who had experience in teaching biology. To establish reliability or consistency among the scoring of responses to the questions, we developed a rubric for scoring the instrument. Multiple raters analyzed the surveys and agreement was reached on 75% of the questions scored. Reform documents imply that SSI instruction needs to be included in science classroom within content knowledge. To realize SSI instruction in science classrooms, science teachers need to have some skills and understanding about SSI teaching. So, the PCK-SSI is one of the first instruments that will allow researchers to measure what teachers know about SSI teaching and what domains of teaching should be supported to effectively teach SSI in their classroom.