

Saturday, April 6, 2013**Pre-Conference Excursion****7:30am – 12:00pm**

Pre-Conference Excursion – Program Committee Sponsored (\$50 Registration Fee – MUST be paid for in advance with registration. Maximum 39 participants.)

Journey to El Yunque

7:30am – 12:00pm, Excursion to Luquillo Long-Term Ecological Research Field Station. Bus departs from Main Entry of Río Mar to El Yunque.

Presenters:

Steven McGee, The Learning Partnership

Jess Zimmerman, University of Puerto Rico

Noelia Báez Rodríguez, University of Puerto Rico

Omar Perez-Reyes, University of Puerto Rico

Pauline Chinn, University of Hawai'i at Manoa

Rojjana Klechaya, Institute for the Promotion of Teaching Science and Technology in Thailand

ABSTRACT: The goal of this pre-conference excursion is to provide an experiential introduction to the longterm ecological research and outreach programs in the El Yunque National Forest, which is located in the Luquillo Mountains around 16 km southwest of the Wyndham Rio Mar. El Yunque is one of the oldest bioserves in the western hemisphere and is one of the most popular tourist destinations in Puerto Rico. Participants will be transported via bus from the hotel to the El Verde field station run by the University of Puerto Rico. Participants will participate in three main activities: (1) Participants will take a hike through the rainforest to learn about typical flora and fauna and the distinctive landscapes that have been shaped by the natural and land use history of the area. The hike will end at a rainforest stream where participants will learn about stream research. Participants will also have the opportunity to swim. (2) High school members of the schoolyard LTER program will guide participants in the collection of tree growth measures. (3) Participants will engage in the modeling activities of the *Journey to El Yunque* web site (<http://elyunque.net>) to learn about the impact of hurricane disturbances on the rainforest. Participants should be aware that the majority of the workshop will take place outdoor and should plan for potentially rainy, muddy conditions. El Verde is at 1000 m elevation and can be substantially cooler than the conditions at the hotel, so participants should dress in layers.

Pre-Conference Workshops**8:00am – 12:00pm****Pre-Conference Workshop—Equity and Ethics Committee Sponsored (Free)*****The S in STEM Education: Focusing on Social Justice Issues in Science Education***

8:00am – 12:00pm, Río Mar Salon 2

Organizers:

Felicia Moore Mensah, Teachers College, Columbia University

Joi Merritt, Michigan State University

Matthew Weinstein, UW Tacoma

Deborah Roberts-Harris, University of New Mexico

Irene Osisioma, California State University

Jacqueline Samuel, University of Southern Mississippi

Presenters:

Regina Wragg, University of South Carolina

Blakely Tsurusaki, University of Washington

Leon Walls, University of Vermont
Gillian Bayne, Lehman College
Mary M. Atwater, University of Georgia
Sumi Hagiwara, Montclair State University
Deborah Morrison, University of Colorado at Boulder
Alicia Trotman, Mercy College
Alejandro J. Gallard, Georgia Southern University

ABSTRACT: The Equity and Ethics Committee sponsors this pre-conference workshop for scholars of color and individuals interested in scholarship involving equity and social justice in science education. Workshop participants will network with facilitators representing the spectrum of various career stages and research interests. Along with eminent scholars in the field, participants will have the opportunity to (1) discuss current topics and methods of equity and social justice research and (2) share experiences that help develop successful transitions in science education.

Pre-Conference Workshop—Publications Committee Sponsored (Free)

Developing High Quality Reviews for the Journal of Research in Science Teaching

8:00am – 12:00pm, El Morro 1 and 2

Angela M. Calabrese-Barton, Michigan State University
Joseph S. Krajcik, Michigan State University
JRST Associate Editors

ABSTRACT: The purpose of this preconference workshop is to provide professional development for JRST reviewers. It will also provide valuable information to new researchers on what reviewers look for in a manuscript and how to prepare a manuscript for publication. During this 4-hour workshop we will work with reviewers to develop knowledge and skills for preparing high quality reviews for JRST, foster conversation on expectations for and purposes of reviews, and discuss how to handle common reviewer problems and questions. This session welcomes returning reviewers as well as those who are new to academia and are interested in submitting to and getting published in JRST or anyone who would like to become a reviewer for the Journal. JRST Editors and Associate Editors will facilitate the session.

Pre-Conference Workshop—Research Committee Sponsored (Free)

Developing a Competitive Proposal for Programs in NSF's Division of Research on Learning in Formal and Informal Settings

8:00am – 12:00pm, Río Mar Salon 8

Ellen McCallie, NSF
Sandra Toro, NSF
Elizabeth VanderPutten, NSF
Julio Lopez, NSF
Janet Kolodner, NSF

ABSTRACT: The National Science Foundation funds learning, teaching, evaluation, and research in STEM through a number of programs in the Division of Research on Learning in Formal and Informal Settings (DRL). This workshop will help build participants' capacity to write competitive, high quality proposals. The workshop is comprised of multiple short sessions and opportunities for collaborative work, discussion, and questions. The content of the workshop includes: 1) the contexts of STEM educational research in DRL; 2) characteristics of and significant changes in DRL's major programs, including Research on Education and Learning or REAL (formerly REESE), Advancing Informal Science Learning or AISL (formerly ISE); Discovery Research K-12 or DR K-12, Promoting Research and Innovation in Methodologies for Evaluation or PRIME, and Faculty Early Career Development (CAREER); 3) NSF's proposal review process and merit review criteria; 4) hands-on experience refining proposal concepts; (5) characteristics of competitive proposals; and 6) common weaknesses in poorly-rated proposals. Novice and experienced proposers are equally welcome. Participants are encouraged to bring proposal concepts and letters of interest for discussion.

Pre-Conference Workshop—Research Committee Sponsored (Free)***Exploration of a New “Words-to-Images” Tool for Analyzing Videos of Science Teaching***

8:00am – 12:00pm, Río Mar Salon 4

Kathleen Roth, BSCS

April Gardner, BSCS

Molly Stuhlsatz, BSCS

ABSTRACT: Come practice using a new kind of “words to images” analytic tool for coding videos of science teaching. This new approach addresses a common problem in science education research: We may agree about the words we use to describe effective science teaching, but we often have very different images in our minds of what those words might look like in practice. The *Tying Words to Images of Science Teaching* (TWIST) project tackled this problem in a proof-of-concept study. This resulted in a coding tool, *A Guide for Video Analysis of Science Teaching: Coherence*, developed by an Expert Panel through a consensus building process. The ten panelists are all well-recognized researchers who brought diverse areas of expertise to this process, but they shared a common interest and experience in analyzing science teaching practice. The study tested whether the panelists could reach consensus in developing a “wordsto-images coding tool and how well that tool could be used by others in a field test. The tool includes five lesson videos and accompanying text materials and coding forms to guide analysis of coherence in science lessons. What if these videos became widely known and used among NARST members and used as benchmarks to guide our analysis of coherence in science teaching? What if there were more tools like this to assess other important aspects of science teaching? Come explore this tool and gain free access to the online *Guide for Video Analysis of Science Teaching: Coherence*.

Concurrent Session #1**1:00pm – 2:30pm****Research Committee Sponsored Session*****New Directions for Education Research and Development in the National Science Foundation's (NSF's) Directorate for Education and Human Resources (EHR)***

1:00pm – 2:30pm, Caribbean Salon 1

Discussants:

Brian J. Reiser, Northwestern University

Leona Schauble, Vanderbilt University

Presenters:Joan Ferrini-Mundy, National Science Foundation, jferrini@nsf.gov

Richard Duschl, National Science Foundation

Janice Earle, National Science Foundation

ABSTRACT: The U.S. National Science Foundation's (NSF) Directorate for Education and Human Resources (EHR) is undergoing changes that reflect a number of themes. Each of these themes will be addressed by the Panel through a series of questions: 1. Beginning October 1, 2012 EHR will initiate four core research areas that cross division lines. They are STEM Learning, STEM Learning Environments, Broadening Participation Research, and the STEM Workforce. How is the implementation of the core envisioned? How is it expected to grow? 2. How is EHR thinking about issues related to the creation, implementation and potential sunseting of programs? What new approaches to program evaluation are under consideration? How will this impact individual projects? 3. NSF and the U.S. Department of Education are developing common standards for research proposals in the hope that such standards will accelerate knowledge development and yield more robust proposals across both agencies. All of these issues will be addressed with regard to the implications for science education research.

Strand 1: Science Learning, Understanding and Conceptual Change***Related Paper Set - Relating Learning Progressions to Student Inquiry and Explanation Practices in Teaching for Environmental Science Literacy***

1:00pm – 2:30pm, Río Mar Salon 1

ABSTRACT: The papers in this session focus on using learning progressions to improve classroom assessment, curriculum, and instruction in the domain of environmental science literacy—on preparing students to act as informed citizens with respect to environment issues. We focus on two strands, both important for environmental science literacy and as part of the general science curriculum: (a) carbon: processes that transform carbon-based materials at multiple scales, including cellular and organismal metabolism, ecosystem energetics and carbon cycling, carbon sequestration, and combustion of fossil fuels, and (b) biodiversity and community ecology: understanding relationships among populations and abiotic factors in changing ecosystems. Paper 1 focuses on students' use of matter and energy conservation in reasoning about carbon-transforming processes. Paper 2 focuses on development of a learning progression for inquiry about carbon-transforming processes. Paper 3 focuses on development of learning progression-based written assessments. Paper 4 focuses on learning progression-based teaching practices. Paper 5 reports progress in developing a learning progression for biodiversity and community ecology.

Alternative Learning Trajectories toward Understanding Matter and Energy in Socio-ecological SystemsHannah K. Miller, Michigan State University, hkm@msu.edu

Jenny M. Dauer, Michigan State University

Charles W. Anderson, Michigan State University

Inquiry Learning Progression Framework for Carbon Transforming ProcessesJenny M. Dauer, Michigan State University, dauerjen@msu.edu

Hannah K. Miller, Michigan State University

Charles W. Anderson, Michigan State University

Designing Learning Progression Assessments that Assess Principles First

Kathryn Oleszkowicz, Michigan State University, oleszko4@msu.edu

Jennifer H. Doherty, Michigan State University

Charles W. Anderson, Michigan State University

Teachers' Implementation of Curriculum Units and Student Learning in Carbon-transforming Processes

Jiwon Kim, Michigan State University, kimjiwo1@msu.edu

Li Zhan, Michigan State University

Charles W. Anderson, Michigan State University

Using Scenario-based Assessments to Build a Learning Progression Framework for Reasoning about Ecosystems

Jennifer H. Doherty, Michigan State University, dohert59@msu.edu

Laurel M. Hartley, University of Colorado-Denver

Strand 2: Science Learning: Contexts, Characteristics and Interactions***Science Learning and Issues Related to Motivation, Self-Efficacy, and Epistemology***

1:00pm – 2:30pm, Río Mar Salon 10

Presenter: Andrea R. Milner, Adrian College*Beyond Cartesian Dualism: How does Emotion Influence Science Learning?*

Nancy L. Staus, Oregon State University, stausn@onid.orst.edu

ABSTRACT: Although many science educators and researchers believe that emotion is an important part of the learning process, few researchers have dealt with the topic in a systematic fashion. The purpose of this study was to examine the role of emotion in the learning process, particularly in the learning of science content. My study utilized a dimensional perspective which defined emotion in terms of arousal and valence, and drew on research from the fields of psychology and neuroscience to examine how emotion affects different aspects of cognition such as attention and memory. On the basis of these findings within a cognitive learning framework, I developed and tested a path model to investigate the predicted relationships among emotional arousal, valence, attention, intrinsic motivation and learning outcomes. My findings suggested that higher emotional arousal, less pleasant feelings about the content, and higher intrinsic motivation led to greater short-term learning outcomes. Therefore, science educators may be able to increase learning outcomes by incorporating emotional aspects within learning experiences around the science content they wish to teach.

Understanding Practical Epistemologies as Ideas or as Action: What are the Consequences for Science Education?

Per-Olof Wickman, Stockholm University, per-olof.wickman@mnd.su.se

ABSTRACT: This paper treats two widely used approaches to study practical epistemologies in the science classroom. The notion of practical epistemology was coined by Wickman and Östman at the AERA conference in the year 2001. It was later elaborated on in an article published by Wickman (2004) in Science Education. A year later, Sandoval (2005) published an article, also in Science Education, where he had adopted the term practical epistemologies. As Sandoval made no reference in his paper to Wickman and Östman, this has caused some confusion in the Science Education community about the relationship between our ideas. The purpose of this paper is to clarify this issue.

Science Self-Efficacy and School Transitions: Elementary to Middle School and Middle School to High School

Brandi Lofgran, Brigham Young University, brandilofgran@gmail.com

Leigh K. Smith, Brigham Young University

ABSTRACT: This study examined the science self-efficacy beliefs of students at two key school transitions: elementary school to middle school and middle school to high school. The purpose was to investigate how these beliefs differ across grade level, gender, and ethnicity. Data were collected through a modified Self-Efficacy Questionnaire for Children (Muris, 2001), which was adapted to focus on science self-efficacy. Multiple ordinary least squares regression was used

to analyze the data. Results indicated that grade level, gender, and ethnicity were significantly related to science self-efficacy. All grade levels showed a clear decline in science self-efficacy after sixth grade with females, Latino students, and ninth graders showing the greatest decline.

Strand 2: Science Learning: Contexts, Characteristics and Interactions

Science Learning within Biology Domains

1:00pm – 2:30pm, Caribbean Salon 2

Presider: Leslie Keiler

Socioscientific Issues as an Instructional Tool for Promoting Students' Communication Skills in the Science Classroom

Yoonsook Chung, Ewha Womans University, venuself@naver.com

Jungsook Yoo, Ewha Womans University

Hyunju Lee, Ewha Womans University

ABSTRACT: Communication skill is one of the essential competences for effective problem solvers who are able to respond to the variety of demands in our daily lives and to build joint understandings. The premise of this study is that SSI instruction can play a crucial role in promoting communication skills by increasing peer interactions and stimulating their reasoning. This study, therefore, aimed to investigate educational effects of implementing a SSI program on communication skills. A total of 132 9th grade students in Korea participated in the SSI program on genetic engineering technology over 3-4 weeks. We adapted mixed method approach. We developed a questionnaire to measure students' communication skills and compared pre- and post-scores. And we observed the classroom with field-notes while a teacher implemented the program, and conducted interviews with the teacher and students. In results, the SSI program had a moderately large impact on the extent the students became more competent in communicating with others. Especially, scores of students' Understanding of others' main points (U) and Respect to other's perspectives (R) significantly improved. Qualitative data also revealed that the students tried to pay attention to the other's argument and to find out the intent during the discussions.

Coauthoring the Curriculum: Testing a Strategy for Incorporating Students' Interests into the High-School Biology Classroom

Galit Hagay, Technion - Israel Institute of Technology, hagayga@012.net.il

Ayelet Baram-Tsabari, Technion

ABSTRACT: Many students feel the curriculum is detached from their lives and interests. This study presents a strategy to incorporate students' curiosity questions into the curriculum as a way to reduce the disparity between students' interests and curricular requirements. It draws on Self-Determination Theory to incorporate students' voice as input in high-school science teaching. The sample included 175 students and 5 teachers who were involved in the intervention, and 16 biology classes that served as comparison classes. In all classes, students were invited to anonymously write down their questions on certain topics and hand them in to the teacher. In the intervention classes teachers mapped these questions into the curriculum and addressed them during their teaching. The findings indicate that the strategy addressed the three basic needs identified by Self-Determination Theory, hence potentially increasing students' intrinsic motivation. Cognitive development clearly seen from the changes in level of questions asked in the main intervention class. These questions were more likely to explore issues beyond the curriculum, involve non-concrete and **ABSTRACT** ideas, and attempt to understand mechanisms rather than identify their components. It is argued that knowledge of students' interests can be viewed as part of teachers' pedagogical content knowledge.

Examining the Interaction between Content and Context: An Empirical Analysis of Genetics News Articles

Nicole A. Shea, Rutgers University, nlefur@eden.rutgers.edu

Ravit G. Duncan, Rutgers University

Lauren Giannetti, Rutgers University

ABSTRACT: Genetic literacy is becoming increasingly important as advancements in our application of genetic technologies such as stem cell research, cloning, and genetic screening become more prevalent. Research shows, however, that many high school graduates lack the genetic knowledge necessary to participate in public debates over

emerging genetic technologies. Few studies examine the kinds of genetic dilemmas individuals encounter in their daily lives and the knowledge needed to reason about such issues. We present our findings from an inductive content analysis of genetics news articles from the New York Times' science section. Our analysis sought to identify those contexts and their dimensions which arise most frequently across articles as well as the genetic content knowledge we anticipate as necessary to reason about featured issues. Overall, we found that dimensions of context which arise most frequently describe a pathology identified or discerned by technological applications. The majority of articles feature contexts with anthropocentric dilemmas concerning physiological disorders. From our content knowledge analysis, we anticipate that individuals need detailed knowledge of molecular mechanisms in order to reason about such issues. This work provides insights as to the conceptual obstacles and leverages involved in complex reasoning in the domain of genetics.

Science Teacher Authentic Classroom Instruction and Student Neuroscience Learning

Mary Hoelscher, University of Minnesota, hoel0039@umn.edu

Charlene Ellingson, University of Minnesota

Rachelle A. Haroldson, Science Museum of Minnesota

Selcen Guzey, University of Minnesota

Gillian Roehrig, University of Minnesota

ABSTRACT: Reforms in science education require fundamental changes in how students are taught and learn science. Classroom observations after a professional development program informed by research-based best practices revealed variations in teachers' scores on the standards of authentic classroom instructional practices. The impact of teachers' authentic classroom instruction on student learning was analyzed using Hierarchical Linear Modeling (HLM) suggesting that student post-test neuroscience knowledge is significantly predicted by teachers' higher-order thinking scores and depth of knowledge after controlling for classroom neuroscience implementation and student pre-test scores. Additional modeling suggested that the direction of these relationships was from improved authentic classroom instructional practices to improved authentic student learning. The combination of teachers' higher-order thinking score and depth of knowledge score resulted in loss of significance on both standards' effects on student learning suggesting construct overlap. No other standards of authentic classroom instruction were found to significantly relate to student learning in this study. The implications of this finding are discussed in terms of the relationship between authentic classroom instructional practices, inquiry-based instructional practices, and student learning suggesting uses of these findings for teacher education and evaluation.

Strand 3: Science Teaching--Primary School (Grades preK-6): Characteristics and Strategies
Dilemmas and Understandings in Elementary Science

1:00pm – 2:30pm, Río Mar Salon 3

President: Huseyin Colak

Astronomy in Preschool? Using Play-based Science Instruction to Teach Space Science Concepts to Preschool Children

Heather L. Miller, The Ohio State University, miller.5589@osu.edu

Mandy M. Smith, The Ohio State University

Kathy C. Trundle, Ohio State University

Mesut Sackes, Balikesir University

Katherine N. Mollohan, Ohio State University

ABSTRACT: This study describes children's understandings of the day/night sky, including identification of objects visible in the sky during different times of day. Preschool children participated in the study (n=21). Data were collected through interviews before and after inquiry-based instruction, and analyzed using the constant comparative method. Results indicated that older children started with more understanding of the day/night sky than the younger children, and made greater gains in the targeted content areas. Prior to instruction, few could provide evidence for the time of day or identify objects visible in the day or night sky. After instruction, 79% of 4 & 5 year olds could provide evidence for time of day, compared to 29% of the 2 & 3 year olds. The same number of 2 & 3 year olds could identify objects visible in the day sky (14%), but 71% could identify objects in the night sky after instruction. Sixty-four percent of the 4 & 5 year olds could identify objects in the day sky and 86% could identify objects in the night sky after instruction. Findings suggest

that children are able to make observations of the sky and increase their understanding of space science through play-based instruction.

Children's Conceptual Knowledge of Plant Structure and Function

Janice L. Anderson, University of North Carolina at Chapel Hill, anderjl@email.unc.edu

ABSTRACT: This study examines children's drawings to communicate their conceptual understanding of plant structure and function. The study explored whether the children's drawings accurately reflected their conceptual understanding about plants in a manner that could be interpreted by others. Data was collected from 254 students in grades K- 3 in the southeastern United States. The children were invited to demonstrate their knowledge and understanding about plants by responding to a drawing/survey activity. Children held a wide range of ideas about plants and rarely were the drawings difficult to interpret. The drawings demonstrated that younger children held very simple ideas about plants, while older children often held more complex, **ABSTRACT** notions about plant structure and function. Consistent with the drawings, the interviews presented similar findings.

Preservice Elementary Science Teachers' Reflections on Teaching Extended Inquiry Investigations

Arzu Tanis Ozcelik, Pennsylvania State University, axt252@psu.edu

Julia Plummer, Pennsylvania State University

ABSTRACT: This study is part of a larger project investigating preservice teachers developing inquiry-based investigations for elementary students in the domain of astronomy. The current study is continuation of the previous study as we take a closer look at a purposeful sample of students' reflections on their investigations. We investigated the ways the reflections help us understand why some students were able create extended inquiry investigations while others were not. Participants were preservice teachers in a 15-week elementary science methods course at a small, private suburban University. Pairs of students wrote and taught five lessons in an afterschool program. We selected five representative pairs to cover the variety of inquiry levels observed in the lesson plan sets. Each teacher wrote a reflection after all five lessons focusing on students' opportunity to participate in scientific inquiry during the lesson. Consistencies in teachers' reflections with our lesson plan analysis reveal the importance of their views of inquiry on their ability to create extended investigations. Our analysis also reveals differences in attention to students constructing explanations and the reflective approach preservice teachers took to support students' investigations across lessons.

A Comparative Study of Early Learners' Engagement in Scientific Practices in the U.S. and Germany

Cory T. Forbes, University of Iowa, cory-forbes@uiowa.edu

Kim Lange, University of Augsburg

Kornelia Möller, University of Münster

Mandy Biggers, University Of Iowa

Mira Laux, University of Münster

Laura Zangori, University Of Iowa

ABSTRACT: Elementary remains a crucial target of international science education reform, yet students' performance on widely-administered standardized science assessments varies widely by country. In an attempt to explain these differences, cross-national observational studies have been conducted at the middle and secondary levels, but not at the elementary level. The purpose of this study is to begin to comparatively analyze the extent to which elementary science learning environments in the U.S. and Germany – two countries that lag their OECD peers - engage students in scientific practices to foster their science learning. The study is embedded within two existing projects – one each in the U.S. and Germany – that rely on extensive video recorded observations of elementary science instruction. Video data was randomly-sampled from existing datasets ($n_1 = 45$, $n_2 = 45$) and scored using an observation protocol developed for and validated in elementary science learning environments. Findings highlight many similarities between science instruction in U.S. and German classrooms. However, students' comparison and evaluation of evidence-based explanations emerged as a predictor of overall effective sensemaking at the classroom level in both countries and this practice was more strongly emphasized in U.S. classrooms.

Strand 4: Science Teaching--Middle and High School (Grades 5-12): Characteristics and Strategies***Teaching Practices and Student Achievement***

1:00pm – 2:30pm, Pelican Room

President: Deborah C. Peek-Brown*An Efficacy Trial of Research-Based Instructional Materials with Curriculum-Based Professional Development*

Susan M. Kowalski, BSCS, skowalski@bscs.org

Joseph A. Taylor, BSCS

Stephen Getty, BSCS

Christopher Wilson, BSCS

Janet Carlson, BSCS

ABSTRACT: We describe the results of a large-scale efficacy trial of research-based instructional materials with curriculum-based professional development (PD). The instructional materials were designed to 1) address core concepts in science in a coherent way; 2) provide students opportunities to express and confront their prior conceptions; 3) help students to be metacognitively aware of their own learning; and 4) provide opportunities and scaffolding to enable students to engage in key science practices. The PD was designed to support teachers' use of reform-based practices while using the materials. Eighteen high schools in the state of Washington were randomly assigned to either treatment or business-as-usual (BaU) conditions. We provided treatment teachers with instructional materials and seven days of PD. BaU teachers used extant materials and received extant PD. We found that the intervention had a large effect ($g = 1.85$) on teacher practice as measured by the Reform Teaching Observation Protocol (Sawada et al., 2002), and a small effect ($g = .08$) on student science achievement as measured by the Washington state High School Proficiency Exam (HSPE). We were unable to detect whether or not the effect on student achievement was mediated by classroom instruction.

Evaluation of Project-based Science Learning/Teaching with Digital Backpacks: The CincySTEM Initiative

Gulbahar Beckett, University of Cincinnati, gulbahar.beckett@uc.edu

Annette Hemmings, Edgewood College

ABSTRACT: This paper will discuss 9th and 10th graders' and their teachers' experience and perceptions of science learning/teaching through CincySTEM high school science projects utilizing digital backpack equipment funded by an Innovative Technology Experiences for Students and Teachers National Science Foundation (iTEST NSF) Strategies Project Grant. The projects were designed and launched by teacher teams in a new science, technology, engineering and mathematics (STEM) urban public high school featuring project-based learning. The discussion will highlight findings from five projects during the past two years, but major findings from two of the projects – Roller Coaster and Global Climate Change that students worked on during 2011 fall semester utilizing laptop computers, iPod touches, iPads, TI Inspire Graphing Calculators, SONY Cybershot Cameras, Kodak Video Cameras, Livescribe pens and notebooks in digital backpacks. Mixed methods evaluations indicated that CincySTEM projects effectively promoted hands-on instruction, utilization of digital backpack equipment, high levels of student engagement, and more authentic scientific investigations of contemporary problems. The projects have pedagogically innovative applications for project-based science learning that can be adopted by high school teachers across the country.

Relationship between Different Science Teaching Strategies and Science Achievement

Su Gao, University of Nevada, Las Vegas, gaos2@unlv.nevada.edu

Zhiyong Zhong, Minzu University of China

Jian Wang, University of Nevada, Las Vegas

ABSTRACT: The global economy demands a country's workforce adequately educated in science. Inquiry-based teaching is assumed more effective than the popular direct instruction in helping students learn science effectively. China is determined to improve its students' science learning and narrow the achievement gap between its mainstream and minority students by pushing teachers to use the inquiry-based instruction. Drawing on the survey and assessment data collected using TIMSS 2007 instruments, this study examines whether and to what extent the inquiry-based, didactic instruction, and mixed teaching approaches influence differently the science achievements of eighth grade Han and

Mongolian Chinese students. It found that inquiry-based instruction has no significantly positive influences on two groups' science performance, which challenges the theoretical and policy assumption.

Using Simulations vs. Overheads: A Comparative Case Study of Questioning Strategies in Three Science Teachers

Norman T. Price, University of Massachusetts / SRRI, normprice@gmail.com

John J. Clement, University of Massachusetts

ABSTRACT: This study analyzes teacher behavior in lessons using visual media about the particulate model of matter that were taught by three experienced middle school teachers. Each teacher taught a lesson to one half of his students using static overheads, and taught the other half of his students using a dynamic simulation. The two types of lessons had similar content goals, lab activities, and handouts but differed in the type of image mode used during large group discussion. Video and transcripts of large group discussions from 12 lessons were analyzed using codes for a set of image-based discussion strategies and codes for teacher student interaction patterns. Results suggest that the simulation mode offered greater affordances than the overhead mode for planning and enacting discussions. Differences in teacher use of discussion modes such as presentation, IRE, and IRF suggest that teacher preferences for questioning strategies changed when either image was used. The changes in questioning strategies we observed suggest that accessing the affordances of an image involves moving beyond seeing the image as a "tool-for-telling". One way teachers used the image as a "tool-for-asking" was by executed the image-based discussion strategies as questions.

A Different Common Core: An Expert Delphi Study on Core Science Teaching Practices

Matthew Kloser, University of Notre Dame, mkloser@nd.edu

ABSTRACT: Knowledge and dispositions have largely been the focus of teacher education for the past three decades. However, an increasing emphasis is being placed on the specification of core teaching practices that support student learning. Based on a practice-based theory of teaching, this study used a Delphi panel of expert science teachers and university faculty who iteratively and anonymously moved toward consensus on a set of core science teaching practices. After three rounds of voting and justification, nine practices exceeded the pre-determined threshold for consensus. The most highly-rated practices included "Engaging Students in Investigations", "Facilitating Classroom Discourse", "Eliciting, Using, and Assessing Student Thinking about Science", "Constructing and Interpreting Models", and "Providing Feedback". There were no statistical differences between ratings from master teachers and university faculty. Panelists also identified the five practices most important for different contexts: a) general science teaching; b) pre-service science teacher education; and finally, c) in-service teacher professional development. The results from this study provide the groundwork for identifying the components of core science teaching practices and raise questions about how to help teachers learn these practices in pre-service or in-service training.

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

Courses or Programs Facilitating Science Practices

1:00pm – 2:30pm, San Cristobal

President: Nancy Moreno

Modifying Postsecondary Laboratory Courses to More Accurately Reflect NOS, Confront Misconceptions, and Retain STEM Majors

Lori M. Ihrig, Iowa State University, lihrig@iastate.edu

Michael C. Slade, Iowa State University

Michael P. Clough, Iowa State University

Craig A. Ogilvie, Iowa State University

ABSTRACT: Fewer than 40% of students who enter college seeking an associate or bachelor degree in a STEM discipline realize their aspirations. Students who leave report that their science courses lacked intellectual engagement, due to an emphasis on recitation of isolated facts; they also report that STEM professions appear to be solitary endeavors. Explicitly addressing these conceptions is a necessary component of retaining postsecondary STEM majors in science and providing students with an accurate notion of who scientists are, what scientists do, and what science is. Perhaps changing postsecondary STEM courses so that students experience more authentic, engaging and effective curricula

across their science courses, along with overt attention to the NOS, will mitigate some of the STEM attrition factors. This hypothesis lies at the heart of a Howard Hughes Medical Institute (HHMI) sponsored project aimed at attracting, retaining, and helping students succeed in science courses during their first two years at a large Midwestern university. This proposal focuses on the development, implementation, and results in two postsecondary undergraduate chemistry courses of employing authentic research experiences, designed to more accurately reflect NOS and explicitly confront students' NOS misconceptions.

The Impact of an REU and RET Program on Participants' Scientific Research Skills

Allan Feldman, University of South Florida, afeldman@usf.edu

Dilek Ozalp, University of South Florida

Fayez Alshehri, University of South Florida

Angela Chapman, University of South Florida

Vanessa Vernaza-Hernandez, University of South Florida

ABSTRACT: This paper reports on what undergraduates and teachers learn about doing research by participating in scientific research groups. It also reports on our modification of an instrument designed to evaluate the effects of research experiences on participants' scientific research skills. Two NSF-funded programs were studied: 1) A 10-week Research Experiences for Undergraduates (REU) program that included 21 students from universities and colleges throughout the US and the Caribbean in 2010-11; and 2) a six-week Research Experiences for Teachers (RET) program that included nine teachers from local school districts in 2012. Undergraduates and teachers worked in research groups led by professors in engineering and public health. The REU students increased their research skills and knowledge but not the ones needed to be independent researchers. The teachers also made large gains in their research skills. The professors attributed the rapid growth in teachers' skills to their maturity and enthusiasm. We also found that the undergraduates' and teachers' initial perceptions of the levels of their research skills were highly inflated. Our findings provide important knowledge to science educators who are interested in how and what undergraduates and teachers learn about doing research, which research skills are improved, and how they learn about them.

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

Assessing College Science Teaching

1:00pm – 2:30pm, Parrot Room

Presider: Sanghee Choi, University of North Georgia

Assessing Assessment: How Use of a Concept Inventory Influences Instructional Practices of a Biology Professor

Binaben H. Vanmali, Arizona State University, bina.vanmali@gmail.com

Marcelle Siegel, University Of Missouri-Columbia

ABSTRACT: Assessment has garnered increased interest in recent years. It is seen as critical to enhancing student learning and understanding. Formative assessment tools such as concept inventories (CIs) could be valuable in moving toward such goals. Concept inventories, a recent addition to biology education, hold much promise for helping faculty to understand the preconceptions their students hold and therefore, how to design lessons to better support students' conceptual change processes. While these are the hopes of developers of CIs, no one has examined what professors actually do with results of the CIs. Do such innovations help improve teaching and learning? How are they used and what can we learn from the experiences of faculty who use them? We used interviews with an experienced biology professor to examine how she used the collective results of the CINS (used as a pre- and post-test). Using observations and document analysis as supporting data, we identified themes that describe this professor's views of learning, knowledge of assessment principles, and knowledge of assessment interpretation and action-taking. Findings provide the first data for how CIs are interpreted by faculty and for identifying and developing methods to help college science faculty use CIs to enhance teaching and learning.

Assessing Undergraduates' Modeling Skills: A Study of Explanatory Model Construction in Chemistry

Gregory Pennington, Western Washington University, penning@students.wvu.edu

Emily Borda, Western Washington University

ABSTRACT: We describe the assessment of students' modeling skills in an undergraduate constructivist chemistry curriculum using a rubric based upon a learning progression for scientific modeling. The rubric was used to score students' responses to eight modeling prompts embedded in the curriculum over a ten week quarter. Most students were found to have emerging modeling skills at the beginning of the quarter, offering incomplete small particle causal mechanisms for macroscopic phenomena. Average scores to the eight prompts fluctuated throughout the quarter, with no apparent pattern. We believe this fluctuation may be due, in part, to unintentional upper limits to the modeling prompts used. Finally, we did observe a moderate correlation between students' modeling skills and their understanding of chemistry concepts. We plan to share our rubric with NARST members along with more comprehensive modeling prompts that make the highest positions on the learning progression more visible.

From Their Point of View: Assessing Undergraduate Educational Practices Using Point-of-View Cameras

Joseph A. Harsh, Indiana University, jharsh@indiana.edu

Adam V. Maltese, Indiana University

Joshua Danish, Indiana University

ABSTRACT: While much existing research attempts to determine the impacts of what students experience during their education, these studies often involve indirect measures of these experiences through data collected by self-report or by external observation. As an alternative, and novel, research method, the intent of this descriptive study is to introduce the use and applications of point-of-view (POV) cameras in educational research. Preliminary evaluations of POV recordings suggest the usefulness of this technology to examine shifts in students' attention and activities, and allow researchers and instructors to explore hypotheses regarding actual cues that students are attending to and responding. It is believed that this study will be of use to science educators and researchers for the implementation of this innovative technology.

Strand 6: Science Learning in Informal Contexts

Learning About the Natural Environment Outside of School

1:00pm – 2:30pm, Sea Gull Room

Presider: Catherine Eberbach

Students' Changing Mental Models of the Longleaf Pine Ecosystem

Alejandro J. Gallard, Georgia Southern University, agallard@georgiasouthern.edu

Michael Dentzau, Florida State University

ABSTRACT: It has been suggested that there is disconnect between children and local biodiversity at the same time that the National Research Council recommends that biodiversity education should be a foundational unit in elementary education. This research looks at the impact of an out-of-school environmental education program on 4th grade students' mental models of the longleaf pine ecosystem, which is a threatened community reduced to 3% of its historic range. Mental models are considered representations of concepts and are distinct from the conceptual models held by scientists. A total of 243 4th grade students were prompted to drawing and label their perception of the longleaf pine forest prior to and post attendance at a 4 day environmental education program focusing on the ecosystem. Drawings were coded using a combination of open and axial codes and used to develop 6 student mental models of the ecosystem. When the distribution of mental models from the pre and post engagement are compared there is a clear shift from inadequate and poorly defined mental models to those that have specific key attributes of the longleaf pine ecosystem. Implications to teacher education and student learning are discussed.

Girls Energy Conservation Corps: Study of a Girl Scout Program Focused on Energy Conservation

Gillian Puttick, TERC, gilly_puttick@terc.edu

Debra Bernstein, TERC

Polly Hubbard, TERC

ABSTRACT: This study presents outcomes data on knowledge, attitudes and behavior from a research and development project that produced a series of six patch guides related to energy conservation for Girl Scouts age 8-13. The program focused on integrating engaging online and real world activities that involved girls in learning about climate change and

their role in it, in saving energy, in using new media creatively to educate peers about energy conservation, and in understanding the importance of collective goals and action to address climate change. The paper focuses on how the iterative design process was informed by formative evaluation data, and discusses a small research study on the effectiveness of social norm messaging in extending the impact of the program. Positive changes in knowledge, behavior and attitudes, while preliminary, suggest that a carefully designed program can address the challenges of educating children about energy conservation and climate change. In addition, preliminary findings suggest that the use of social norm messages should be more widely researched in the context of energy conservation involving children.

Science Outdoors and In: Elementary Students' Science Knowledge, Environmental Attitudes, and Outdoor Comfort Levels

Sarah J. Carrier, North Carolina State University, sarah_carrier@ncsu.edu

Margareta M. Thomson, North Carolina State University

Linda P. Tugurian, North Carolina State University

ABSTRACT: Research shows that exposure to outdoor settings may impact a child's environmental awareness, science learning, environmental attitudes and outdoor comfort/fears; however, many children have few to no experiences in the natural world (Louv, 2009). Research studies have documented academic and personal benefits from having outdoor experiences (Malone, 2008; Pretty, Peacock, Sellens, & Griffin). The purpose of this mixed methods study was to explore elementary school students' views of environmental science in two elementary schools with different foci on outdoor science. Additionally, we documented views about elementary science instruction of 5th grade teachers, students' parents and the two schools' principals. We further examined students' attitudes toward the outdoors, science knowledge, and comfort levels in the outdoors related to outdoor fears. Overall results showed that students' outdoor knowledge and their environmental attitudes changed during the school year, but no significant differences were found between the two schools. Study results revealed that at both schools, the situation of standardized science testing in 5th grade provided the greatest influence on how and what teachers chose to teach in science. Qualitative results from the interviews and field observations documented minimal consideration of the outdoors as a setting for science instruction.

Strand 7: Pre-service Science Teacher Education

Symposium - Science Teacher Educators as Multiculturalists and Equity and Social Justice Agents

1:00pm – 2:30pm, Canary Room

Presider: Melody Russell, Auburn University

Discussant: Malcolm B. Butler, University of Central Florida, Malcolm.Butler@ucf.edu

Presenters:

Mary M. Atwater, University of Georgia, atwater@uga.edu

Natasha Johnson, University of Georgia

Neporcha Cone, Kennesaw State University

Obed Norman, Howard University

Celestine H. Pea, National Science Foundation

Sheneka Williams, University of Georgia

ABSTRACT: This ninety-minute symposium will focus on (a) some noteworthy historical and socio-cultural aspects of science teacher education, (b) the foundational concept of beliefs in science teacher education, (c) one important pedagogical issue for science teacher educators to consider – culturally relevant teaching, (d) equity, multiculturalism, and social justice in the learning environment and urban school settings, and (e) policy reform in science teacher education. The main purpose of this session is to look at the research findings that should impact science teacher educators as multiculturalists and equity and social justice agents.

Strand 8: In-service Science Teacher Education***Related Paper Set - Promoting Effective Science Teaching through Engineering and Engineering Design***

1:00pm – 2:30pm, Río Mar Salon 4

Presider: Chell Nyquist, Purdue University

ABSTRACT: This paper set examines the different dimensions of science teaching through engineering design. The panel represents a cadre of science, engineering, and technology education researchers who have been given the charge by national funding agencies to produce rigorous, evidence-based outcomes that link strong research designs to effective science teaching and science teacher professional development. Researchers answer one or more of the following questions: What constitutes effective professional development for teachers to teach science using engineering design? What models for in-service science teacher development in engineering has your team employed? What are examples of measures related to in-service teacher development your team has utilized? In what ways can researchers account for variation in instructional practices related to engineering and its impact on student success? What issues, dilemmas, or challenges related to in-service teacher education reform have science teachers and/or STEM researchers in your project experienced and what are the implications of these challenges? In this session we engage in a disciplined dialogue on what we value most among the various measures of effective teaching as we enter a new era of standards and assessments in science education.

Teaching and Learning about Engineering Design: Insights from Elementary Science Teachers and their Professional Development in Engineering Design

Brenda M. Capobianco, Purdue University, bcapo@purdue.edu

James D. Lehman, Purdue University

Chell Nyquist, Purdue University

Supporting Teachers Adopting an Engineering-Based, PBL Middle School Science Curriculum

Sabrina Grossman, Georgia Institute of Technology/CEISMC

Michael Ryan, Georgia Institute of Technology/CEISMC

Brian Gane, Georgia Institute of Technology/CEISMC

Marion Usselman, Georgia Institute of Technology/CEISMC

The Relationship between Teacher Self-Efficacy and Student Engineering Identity: An HLM Model

Kerrie Anna Douglas, Purdue University, douglask@purdue.edu

Heidi Diefes-Dux, Purdue University

A Collaborative Approach to Elementary STEM Inservice Professional Development

Carolyn Parker, John Hopkins University, Carolyn.Parker@jhu.edu

Strand 9: Reflective Practice***Teacher as Researcher / Self Study***

1:00pm – 2:30pm, Heron Room

Presider: Line A. Saint-Hilaire*Pre-service Teacher-as-Researcher: Pre-service Elementary Teachers' Perceptions about Teacher-Researchers*

Youngjin Song, University Of Northern Colorado, young1206@gmail.com

Timothy Pearson, University of Wyoming

Teresa M. Higgins, University of Northern Colorado

ABSTRACT: The purpose of this study is to explore pre-service elementary teachers' perceptions about the notion of teacher-as-researcher in the context of teaching science in order to support their development in a graduate teacher preparation program. The primary data were collected from 57 pre-service elementary teachers' responses to the Teacher as a Researcher activity sheet, which includes their drawings of a teacher and a researcher with explanations. Data were analyzed by inductive analysis utilizing a grounded theory approach and constant comparative methods. The

preliminary findings revealed two different perspectives. Most pre-service elementary teachers who had dual perspectives perceived a teacher and a researcher as separate entities in terms of knowledge generation, the nature of each career, and the positioning. Those who showed coexisting perspectives believed that a teacher can be /should be a researcher, but expressed naïve ideas about teacher-as-researcher. Both “functional” and “structural” views (Reis-Jorge, 2007) were detected in this group. Implications for elementary teacher preparation programs are suggested.

Looking at the Mirror: A Self-Study of Prospective Science Teacher Educators' PCK for Teaching Teachers

Sevgi AYDIN, Yuzuncu Yil University, sevgi.aydin45@hotmail.com

Betul Demirdogen, Middle East Technical University

Aysegul Tarkin, Yuzuncu Yil University

ABSTRACT: The purpose of this study is to investigate how re-designing and teaching re-designed practicum course offered to pre-service teachers (PTs) contributed to our, as science teacher education doctoral students, development of pedagogical content knowledge (PCK) for teaching science teachers. We utilized self-study as a methodology which is a kind of practitioner research. This self-study through which teaching assistants (TAs) of the practicum course reflected on their development of PCK for teaching teachers was conducted during a five-credit, compulsory 14-week-long practicum course. The data collected through multiple data sources, namely, journal entries, assignments of the course (e.g. reflection papers), transcripts of interviews conducted with PTs after they performed teaching practices, and formal and informal meeting with PTs and as a group of TAs through the year. Deductive analysis based on existing codes and categories was applied. Through this self-study we developed all PCK components, aligned our orientation with other PCK components (e.g., knowledge of instructional strategy), and built an interplay among all PCK components by translating our PCK for teaching teachers into our practice. The reflections made and points discussed in the study are hoped to catalyze other science teacher educators' reflection and actions, which results in better science teacher education.

Learning from One's Own Teaching: New Teachers Analyzing their Practice through Video Recorded Observation Cycles

Jennifer A. McNally, Curry College, jen.ceven.mcnally@gmail.com

ABSTRACT: Induction, the first three years of teaching, is a particularly formative period yet there exists only a limited literature base to support teacher educators who work with this population. Induction phase teachers benefit from experiences that support them to learn about teaching while they are teaching. This can occur when they receive feedback about their instructional practices and ideas on how to improve their work. One means for providing feedback is to engage teachers with mentors who observe a classroom episode and structure discussions before and after that observation. This observation cycle can support new teachers to inquire into an aspect of their practice with the help of an experienced educator. This study examined the implementation of video-recorded observation cycles in an established online mentoring program, e-Mentoring for Student Success. Qualitatively studying the interactions between mentors and mentees helped to identify the conditions that supported disciplined inquiry. New teachers also expressed that they reflected on and implemented changes to their instructional practice following the observation cycles. Observation cycles have the potential to equip teachers with the skills and dispositions to learn about teaching from the act of teaching each day of their careers.

Navigating the Challenges of Teaching Responsively: An Insider's Perspective

April C. Maskiewicz, Point Loma Nazarene University, aprilmaskiewicz@pointloma.edu

ABSTRACT: Teaching responsively means creating a classroom community where students learn to make their ideas and reasoning explicit so the class can grapple with the potential of those ideas, and together co-construct understandings and explanations. In this type of classroom environment, the ideas offered by students are numerous, and the paths one can pursue limitless; and consequently, tensions arise for the teacher as instructional decisions have to be made. The purpose of this paper is to make explicit some of those tensions. In this self-study I provide an insider's perspective on how I navigated some of the challenges of teaching responsively as I led a two-week professional development science workshop: (1) the challenge of promoting mechanistic explanations responsively, (3) the challenge of relinquishing control, and (4) the challenge of allowing “wrong” ideas to linger. Reflecting on and articulating my experiences and decisions as I confronted these challenges will serve to generate insight and knowledge about the practice of teaching

responsively because these challenges are not unique to my particular situation. We must help teachers learn to expect and accept these challenges if they choose to teach responsively.

Strand 10: Curriculum, Evaluation, and Assessment

Applying Item Response Theory Models to Assessment Development and Validation in Science Education

1:00pm – 2:30pm, Río Mar Salon 2

Presider: Hendrik Haertig

Developing Affective Measures in Science Education with the Rasch Model

Toni A. Sondergeld, Bowling Green State University, tsonder@bgsu.edu

Carla C. Johnson, University of Cincinnati

Janet Walton, University of Cincinnati

ABSTRACT: With the demand for quality quantitative instruments in the field of science education rising, additional measures of currently un-assessed affective variables need to be constructed. In this study, we discuss the survey creation and evaluation process of the STEM Awareness Community Survey (SACS) through an application of Liu's (2010) framework for developing and using new affective instruments in science education. Liu's (2010) survey development framework uses Rasch modeling methods in survey evaluation to ensure a psychometrically sound measure is created. In surveying K-12 teachers, community business members, and higher education faculty, a unidimensional construct of STEM Awareness and Support was empirically established after 9 misfitting items were removed and scale modifications were made. Further instructions on how to use results produced from the SACS are provided so that even those with no or limited knowledge of Rasch analysis could use the instrument and interpret their findings with respect to the construct of STEM Awareness and Support.

Using Rasch Measurement to Validate the Instrument of Students' Understanding of Models in Science (SUMS)

Silin Wei, Hangzhou Normal University, silinwei@163.com

Xiufeng Liu, State University of New York At Buffalo (SUNY)

Jing Wu, Hangzhou Normal University

ABSTRACT: Scientific models and modeling play an important role in science, and students' understanding of scientific models is essential for their understanding of scientific concepts. The measurement instrument of Students' Understanding of Models in Science (SUMS), developed by Treagust, Chittleborough & Mamiala (2002), has been used to measure students' understanding of models in science. SUMS was developed using the Classical Test Theory (CTT). Due to limitations of CTT, in this study we applied the Item Response Theory (IRT), specially the Rasch model, to further validating SUMS. SUMS was given to 629 students in 18 classes of grades 9 and 10 from six high schools in China. The results showed both additional evidence for the validity and reliability of SUMS and the need for further improvement. This approach of validation of a published instrument by Rasch measurement can be applied to other measurement instruments developed using CTT.

Do Computer-Generated Written Explanation Scores Closely Approximate Oral Interview Scores? Evidence from Rasch Modeling

Elizabeth P. Beggrow, The Ohio State University, beggrow.7@osu.edu

Minsu Ha, The Ohio State University

Ross H. Nehm, The Ohio State University

William Boone, Miami University

ABSTRACT: Many studies have used written assessments to elicit student understanding of evolution through explanation, which is widely recognized as a core scientific practice. Our study explored patterns of knowledge and naive idea correspondence among four different assessment methods: (1) clinical oral interviews; (2) computer-scored written explanations; (3) human-scored written explanations; and (4) a multiple-choice test. A sample of undergraduates (n = 104) exposed to varying amounts of evolution content completed three assessments: A 20-minute clinical oral interview; the written ACORNS assessment; and the multiple-choice (MC) CINS test. The large sample size allowed for the use of Rasch modeling to generate measures for comparison. The CINS displayed poor person and item fit (MNSQ > 1.3), while

both oral interview scores and computer-generated written response scores had good fit (interview: person 0.97, item 0.97; Computer: person 1.03, item 1.06). CINS scores were more weakly associated with interview scores ($r = 0.35$) than the computer-scored explanations ($r = 0.63$). The results indicate that computer-scored written explanations (1) have strong correspondence to oral interview scores; (2) are capable of capturing students' key concepts and naive ideas as accurately as human scoring, and (3) exceed the performance of the MC assessment.

Using Multilevel Multidimensional Item Response Theory to Assess Efficacy of Science Writing Heuristic Teaching Approach

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Mack Shelley, Iowa State University

Luke Fostvedt, Iowa State University

Joan Baenziger, Iowa State University

Brian M. Hand, University of Iowa

William Therrien, University of Iowa

ABSTRACT: We applied the theoretical framework of Multilevel Multidimensional Item Response Theory (MMIRT) to analyze binary responses to the Cornell Critical Thinking Test (CCT). Respondents were over 2000 fifth graders from 48 randomly chosen schools in Iowa. The analysis combined multidimensional IRT and multilevel modeling techniques to evaluate the inherent multidimensional structure of the CCT test. Our primary goal is to evaluate the efficacy of the Science Writing Heuristic (SWH), a science instructional technique that combines inquiry, collaborative work, and reflective writing. Multidimensional IRT allows us to estimate students' performance along several dimensions simultaneously. Combining MIRT with multilevel modeling also allows us account for the hierarchical structure of the item response data that are nested within students, students nested within teachers, and teachers nested within districts. The mirt and mlrt packages in the open source R software were utilized for this model. Preliminary analysis outcomes from comparing student performance between the two groups, taught with and without SWH, validate the effectiveness of SWH in teaching science. Keyword: Multidimensional IRT, MLIRT, multilevel modeling, Science Writing Heuristic, Cornell Critical Thinking Test, Teaching Science.

Strand 11: Cultural, Social, and Gender Issues

Related Paper Set - Promoting Effective Science Teaching for English Learners: Lessons Learned From Classroom Observations

1:00pm – 2:30pm, Río Mar Salon 8

ABSTRACT: This session presents research and practice focused on the improvement of science teaching and learning for the rapidly growing population of English learners (ELs). For at least thirty years, the science achievement of ELs has lagged behind that of native English speakers. Researchers from three independent research and development projects will share empirical classroom observation data focusing on the integration of the teaching of science and academic language and literacy for ELL. While the three projects utilize unique approaches to gauging practices of science teaching with ELs in mind, all projects shed light on areas for further development for teachers to more effectively address the needs of this rapidly growing population. The papers provide a comprehensive analysis of classroom observation protocols and data gathered from these protocols to better understand teacher practices as they relate to meeting the science and language learning needs of ELs. Each paper will present: (1) the theoretical framework and empirical basis for the project's observation scheme; (2) a description of the developmental process for the observational protocol; and (3) results from the empirical studies that examined the practices of teacher participants (pre-service teachers, in-service teachers or both).

Integrating Science, Language and Literacy Learning for ELL: Theoretical and Empirical Foundations

Trish Stoddart, University of California - Santa Cruz, stoddart@ucsc.edu

Gauging Pre-Service Teacher Science & Language teaching practices with the Dialogic Activity in Science Inquiry (DAISI) instrument

Marco Bravo, San Francisco State University, mbravo@sfsu.edu

Trish Stoddart, University of California - Santa Cruz
Jorge Solis, University of Texas, San Antonio
Eduardo Mosqueda

What Classroom Observations Can and Can't Tell Us about the Implementation of Science and Language Practices in Middle School Classrooms

Cory A. Buxton, University of Georgia, buxton@uga.edu
Martha Alleksaht-Snider, University of Georgia
Shakhnoza Kayumova, University of Georgia
Susan Harper, University of Georgia

How Professional Development can Shape Teachers' Pedagogical Delivery of Science and Language Teaching in Middle School Classrooms with English Language Learners (ELLs) and English-Speaking Minority Students

Rafael Lara-Alecio, Texas A & M University, a-lara@tamu.edu
Fuhui Tong, Texas A & M University
Beverly Irby, Sam Houston State University
Cindy Guerrero, Texas A & M University

Strand 11: Cultural, Social, and Gender Issues

Symposium - Inside Personally Relevant Science Learning Contexts: How Do Learners Connect Science to their Everyday Lives?

1:00pm – 2:30pm, El Morro 1 and 2

Presider: Bryan A. Brown, Stanford University

Discussant: Angela Calabrese-Barton, Michigan State University

Presenters:

Erika D. Tate, bluknowledge LLC, erika@bluknowledge.com
Tamara Clegg, University of Maryland
Heather T. Zimmerman, Pennsylvania State University
Christina Garnder-McCune, Clemson University
Takumi Sato, Michigan State University

ABSTRACT: When people learn science in personally relevant ways, they have opportunities to connect science to their everyday lives. Research has shown that situating science in personally relevant contexts (e.g., nature parks, gardens, and kitchens) can increase learners' motivation to become everyday or professional scientists (e.g., Linn, Davis, & Bell, 2004; Lim & Barton, 2006; Author 3, this proposal). Although research has established the need for helping learners connect science to their daily lives, it can be hard to implement in practice; and understanding learning and engagement in such contexts can be even harder. In this symposium, researchers, who are expert at promoting and understanding science in the context of learners' everyday life, come together to discuss (a) approaches for helping learners connect science to their lives, (b) theoretical lenses for understanding learning in personally meaningful contexts, and (c) case studies illustrating findings in light of these learning contexts and theoretical frameworks. Through different theoretical lenses, including knowledge integration (Linn, Davis & Bell, 2004), socio-cultural (Brown, Collins, and Dugid, 1989), socio-technical (Wenger, 1998), and identity frameworks (Gee, 2000), researchers will present case studies of learners engaged in everyday science in a range of contexts (e.g., classrooms, out-of-school programs, and informal experiences).

Strand 13: History, Philosophy, and Sociology of Science***Symposium - A Critical Review of HPS Scholarship in Science Education***

1:00pm – 2:30pm, Río Mar Salon 9

Presider: Ron G. Good, LSU (Emeritus)**Discussants:**

George E. DeBoer, AAAS Project 2061,

Michael R. Matthews, University of New South Wales

Presenters:

Sibel Erduran, University of Bristol

Mike U. Smith, Mercer University School of Medicine

Zoubeida R. Dagher, University of Delaware

Jose Chamizo, Facultad De Quimica, UNAM

Olivia Levrini, Department of Physics, University of Bologna

Niklas Gericke, Karlstad University, Sweden

Gregory J. Kelly, Penn State University

Norman Lederman, Illinois Institute of Technology

ABSTRACT: For the past three decades there has been a growing body of evidence of historical and philosophical research in science education. This is evidenced in the publication of *Science & Education: The Contribution of History and Philosophy of Science* since 1992, the establishment of Strand 13 in the NARST program since the late 1990s, and the publication of perhaps a dozen major books in the field over this time. As the volume of scholarship grows, it is apparent that a comprehensive and critical analysis of HPS in science education is needed to help inform and guide future research programs and to assist curriculum writers and teachers who increasingly are dealing with HPS and Nature of Science issues. To this end an 80-chapter Handbook of HPS and Science Teaching scholarship will soon be a reality and the 2013 NARST meeting will be the first opportunity to discuss its contents and potential to assist in future research and classroom practice. This symposium brings together a selection of HPS scholars to discuss the purpose, rationale, and contents of the Handbook and how it might be used to guide future research and practice in science education.

Strand 14: Environmental Education***Education for Sustainability in Upper Secondary and Post Secondary Education***

1:00pm – 2:30pm, Río Mar Salon 7

Presider: Erica Blatt***Education for Sustainability in a Higher Education Institution: Characteristics and Learning Outcomes***Keren Mintz, Technion, kerenk@technion.ac.il

Tali Tal, Technion

ABSTRACT: Education for sustainability (EfS) in higher education is an emerging specialization in the field of EfS. EfS includes cognitive, affective and behavioral aspects and aim at enhancing a variety of learning outcomes in these domains. An integration of sustainability into the curriculum requires decisions on content as well as on pedagogies, and understanding of the ways different practices promote different learning outcomes. The present study aimed to contribute to the knowledge about students learning outcomes yielded by different forms of EfS courses' design. The study was designed as a qualitative multiple case-study of ten courses. Data were collected through interviews, class observations, documentation, and questionnaires. For each course, we identified its characteristics in terms of contents and pedagogies, and analyzed students self-reported learning outcomes. By comparing all the courses we looked for trends in the ways various features promote different learning outcomes. We found that: a) courses with the higher degree of participatory learning, and system approach were the courses that promoted higher and most varied learning outcomes b) courses with the least learning outcomes were characterized as lecture-based c) field trips promote EfS learning outcomes only when accompanied with more advanced pedagogies.

Modeling the Relationships between Recycling Behavior and Gender

Dilek S. Kilic, Hacettepe University, dsultan@hacettepe.edu.tr

Ceren Tekkaya, Middle East Technical University

Gaye Teksoz, Middle East Technical University

Savas Pamuk, Akdeniz University

Elvan Sahin, Middle East Technical University

ABSTRACT: In this study, we hypothesized that, the factors shaping recycling behavior is different regarding gender according to both socialization and structural theories. We modeled recycling behavior separately for women and men, rather than evaluating the differences through classical comparison methods to see possible differences beginning from front end, rather than trying to find differences at the ending. The data was gathered from 292 university students via online administration of the TPB Survey and analyzed by Structural equation models using AMOS18. Results revealed that, attitude is the major factor for shaping students recycling behavior of men and that of women is perceived behavior control, implying that recycling behavior of women can be developed mostly by offering suitable recycle conditions. Men's recycling behavior may be supported by means of developing their recycling attitude. One of the important reasons for women to recycle is found to be their belief on the societal expectation for recycling, while men do not consider society's expectations. Although a training program is needed for men, to develop their recycling behavior, what women need is, to be supplied with necessary facilities. Findings offer a different viewpoint to the audience for evaluating gender difference in environmental education practice.

ESD Oriented Chemistry Education – A Theoretical Model

Kirsti Marie Jegstad, Norwegian University of Life Sciences, kirsti.jegstad@umb.no

ABSTRACT: One of the conscious challenges teachers face with respect to the incorporation of education for sustainable development (ESD) in their teaching is the inclusion of even more content into an already overloaded curriculum. In response to this, it has been suggested that ESD should be introduced as an integrated perspective applied across the content in all existing subjects. However, teachers seem to lack knowledge of how to include ESD in their teaching. This theoretical paper offers a framework for how ESD may be integrated into upper secondary chemistry teaching. The theoretical framework begins by presenting a model approach for implementing issues of sustainable development in formal chemistry education. Through the paper, this model approach is further elaborated via constant reference to specific ESD competencies and a focus on 'education through science', yielding a more detailed framework. Finally, the paper concludes by suggesting implications for teacher education programs and how this approach towards ESD can be included in the education of chemistry teachers.

Bottom-up and Top-down Processes for Embedding Education for Sustainability in a College of Education in Israel: A Case Study

Iris Alkaher, Kibbutzim, irisalkaher@gmail.com

Ilana Avisar, Kibbutzim

ABSTRACT: This interpretative study aims to identify the views of college participants in leadership training-programs for EfS with regard to program outcomes and the factors which both enabled and limited mainstreaming of sustainability on the campus. We adopted the Australian whole-school approaches to sustainability. Data collection included interviews, observations, and a questionnaire. 40% of the faculty and staff and 60% of the student program participants became EfS leaders. Enablers of embedding EfS included the institution's administration's support, collaboration with colleagues, organizations and other institutions and development of a culture of sustainability-oriented discourse. Challenges addressed institutional and individual levels. Positive impacts of bottom-up and top-down processes found herein could serve as a model for other institutions that wish to adopt EfS approaches.

Concurrent Session #2**2:45pm – 4:00pm****Presidential Sponsored Session*****Anticipating NGSS: Building Collaboration and Infrastructure for Implementation***

2:45pm – 4:00pm, Caribbean Salon 1

Presider: Lynn Bryan, Purdue University**Presenters:**

Christopher Lazzaro, The College Board

Martin Storksdieck, National Research Council

Steve Pruitt, Achieve, Inc.

Peter McLaren, Chief State Science Supervisors

Sharon J. Lynch, George Washington University

ABSTRACT: The Next Generations Science Standards (NGSS), with an anticipated completion date in early 2013, will construct a set of clear, state-led standards for Science and Engineering. The new standards, however, will be nothing more than words on paper. In order for them to be implemented effectively in the classroom they must be translated into new curriculum and assessments that prepare all students for college. In addition, new professional development frameworks for teachers and a long-term research agenda that evaluates the fidelity and efficacy of these new, NGSS-aligned programs are vital to their success. The College Board and NARST will bring together a panel of experts to discuss the development of new state and local policies that will support the NGSS and how these policies can aid in the transformation of how science is taught in the classroom. To date, 26 states have signed on to the NGSS, and most states have STEM initiatives listed explicitly in their educational priorities.

Strand 1: Science Learning, Understanding and Conceptual Change***Assessing and Dealing with Students' Preconceptions of Evolution***

2:45pm – 4:00pm, Río Mar Salon 1

Presider: Anat Yarden*A First Appraisal to Chilean Teachers and Undergraduate Students' Understandings of the Evolution Theory*

Juan P. Jimenez, Illinois Institute of Technology, jjimen10@iit.edu

Hernan Cofre, Illinois Institute of Technology

Claudia Vergara, Illinois Institute of Technology

David Santibañez, Universidad Catolica Cardenal Raul Silva Henriquez

ABSTRACT: In spite of the importance of Theory of Evolution (TE) as scientific knowledge, several misconceptions continue to be found in secondary education. The aim of the present study was to evaluate knowledge of evolution among freshmen students from three distinct universities and compare the knowledge of evolution among elementary and biology teachers from Santiago, Chile. To carry out this research a nine-item questionnaire was administered that covered three topics; Nature of theory and law, evolution acceptance, and evolution understanding. The instrument included eight Likert scale questions and one open-ended item. The analysis of data revealed that most of teachers and undergraduate students were unsure about the concept of scientific theories and their relationship to laws; most participants recognized TE as established scientific knowledge; and undergraduate students agreed more with the Darwinian explanations of evolution compared to the teachers. However, when participants explained the evolution of bats, the most prevalent views of students and teachers (33%) was evolution through need via purposeful change. Only 12.5 % of the participant's responses were considered Darwinian, and 10% were found to include more than a view of evolution. The multiple implications for teaching TE in high school and science teacher education are addressed in this study.

Development and Field Testing of the Middle School Version of Conceptual Inventory of Natural Selection

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Patricia L. Evans, Point Loma Nazarene University

ABSTRACT: While the Conceptual Inventory of Natural Selection (CINS) has served as a useful assessment tool at the college level, there was not a similar tool validated for use with students aged 12-14 (middle school in the US). We revised the structure and reading level of the original CINS to produce and field test a middle school version that can be used as a 20-item set, or be easily split to make two 10-item pre and post tests. Qualitative data from 10 individual interviews and quantitative data from 452 middle school students at two ethnically and socioeconomically diverse public schools in southern California indicate that the ten pairs of items are comprehensible to middle school students, and are of equal difficulty. The new version is a promising new tool awaiting further tests of reliability and validity with larger populations.

Domain-Specific Differences in Students' Argumentation Practices - Students' Arguments about Evolutionary Theory and Genesis Narration

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Ute Harms, Leibniz Institute (IPN) Kiel, Germany

Helmut Prechtel, University of Potsdam

ABSTRACT: The aim of this qualitative study was to provide insight into similarities and differences in students' argumentation practices in different domains, i.e. biology and theology. Students (N=48, 16-19 years old) from secondary schools were confronted with the question how living beings occurred on earth by addressing the relationship of evolutionary theory and genesis narration. Students were asked to write a speech on this issue, either from the perspective of a biologist or a theologian. To identify students' argumentation practices the frequency of argumentation schemes applied in the argumentations were compared using an inductively elaborated categorical system showing satisfying reliability (IRR: 93%). Overall, 361 schemes were identified in the texts. In comparison students showed a larger percentage of teleological schemes and arguments from analogy in reasoning about theological content. In contrast, in case of reasoning about the biological content, students showed a tendency to causal argumentation and referred to authorities in their arguments. In both domains, students used a large amount of example-based argumentation and arguments based on similarity and difference. In the following these elaborated similarities and differences in argumentation practices will be used to describe in more detail domain-specific and general aspects of argumentation.

The Social Psychology of Evolution Denial

Leonard Bloch, UGA Department of Science Education, lenbloch@uga.edu

ABSTRACT: The current "warming trend" in conceptual change research makes it clear that to teach evolution effectively educators need to be aware of the often-unconscious motives behind students' struggles to understand, believe, or accept evolution. Numerous motives exist. These range from the desire to conserve cognitive resources, to the need for harmonious relationships, to the profound existential need to find meaning and purpose in life. Many studies have examined student misconceptions about evolution, and many authors acknowledge the affective and motivational issues surrounding the topic, but few authors have explored the complex psychology of evolution denial. This conceptual literature review will look at evolution denial through the lens of social psychology-- the study of human behavior in social situations. I will argue that social psychology offers a useful conceptual framework and vocabulary, and that its research methodology offers promise in addressing one of the most vexing problems in science education. Finally, I will review some social psychological interventions that have proven extremely effective in other fields of education, and suggest ways to adapt these to address evolution denial.

Strand 2: Science Learning: Contexts, Characteristics and Interactions***Science Learning and Science-related Identities, Interests, and Attitudes***

2:45pm – 4:00pm, Río Mar Salon 10

Presider: Audrey De Zeeuw*Extending the Analysis of Student Role Identities across Geographical and Subject Area Boundaries*

Marie-Claire Shanahan, University of Alberta, mcshanahan@ualberta.ca

Martina Nieswandt, University of Massachusetts, Amherst

ABSTRACT: In an effort to better understand course and degree choices and persistence in these programs, this study examines role identity perceptions among 192 urban American high school students enrolled in physics and chemistry courses. Comparisons are made to previous studies of rural and urban Canadian high school students in general science courses with regards to their perceptions of themselves and ideal science students as intelligent, scientifically minded, skilled in science and well behaved. Results suggest strong consistency across geographical areas with similar patterns of identification observed in both groups. Discrepancies were found, however, in the responses of physics student for whom the expectation of intelligence (defined by students through characteristics such as good grades and always having right answers) was stronger.

Large-Scale Validation of an Instrument to Assess Precollege Students' Attitudes toward Science

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

Ryan Summers, University of Illinois at Urbana-Champaign

Michael Culbertson, University of Illinois at Urbana-Champaign

Heather Friesen, College of the North Atlantic, Qatar

ABSTRACT: This study reports on the validation of "Assessing Arabic Speaking Students' Attitudes toward Science Survey" (ASSASS), which is part of a larger project aimed at identifying factors that impact precollege Qatari students' interest in, and attitudes toward, science. ASSASS was grounded in the most recent revision of the theories of reasoned action and planned behavior (TRAP). A 10-member international panel of science educators and education researchers reviewed an initial pool of 74, 5-point Likert scale items for alignment with TRAP. A revised pool of 60 items was piloted with a purposively selected sample of 396 grade 3–12 students, which was followed by individual interviews with a 10% random sample of the students. Analyses of pilot data resulted in the deletion of 14 items. Next, the resulting 46-item version of ASSASS was administered to a nationally representative sample of 2,778 grade 3–12 students in Qatar. Data analyses resulted in a robust model showing very good fit with a Root Mean Square Error of Approximation (RMSEA) at .042. The model included a single global factor plus four orthogonal residual factors: Negative outlook toward science, intention to pursue or engage in science, perceptions of school science, and perceived utility of science.

Factors that Affect Learning in High School Science; Measuring Motivation, Achievement, and Interest in Science

Steve Getty, Biological Sciences Curriculum Study, SGetty@BSCS.org

Chris Hulleman, University of Virginia

Kenneth E. Barron, JMU, Harrisonburg, VA

Molly Stuhlsatz, BSCS

Jane C. Marks, Northern Arizona University, Flagstaff AZ

ABSTRACT: Personal motivation is a key factor as individuals perform and complete tasks, particularly in academic settings and in subjects such as science. Various motivation instruments have been used in such settings, yet they have practical limitations for routine, widespread use in secondary science classrooms. This study describes several validity tests of a new measure of student motivation used alongside high school science instructional materials. In two different studies, we have used hierarchical path modeling to test the relationships among components of motivation, student achievement, and future interest in science. The measure is rapid and practical (low response burden), intuitive, and grounded in Expectancy-Value Theory (Eccles et al., 1983). Moreover, the instrument extends prior expectancy-value work by incorporating a task-related Cost as a key factor that may mitigate student learning outcomes. Benefits of the work will be having a tool to assess the degree to which teaching innovations or technologies can increase achievement or interest in science, as well as extending research to evaluate not only achievement gaps, but also "motivation gaps."

Conducting the validation work across a range of grades, classroom settings, and student populations enables the researchers to compare motivation components among different student populations.

Science-related Aspirations from Late Primary to Early Secondary School: The More Things Change. . .

Jennifer DeWitt, King's College London, jennifer.dewitt@kcl.ac.uk

Louise Archer, King's College London

Jonathan F. Osborne, School of Education, Stanford University

ABSTRACT: Students' engagement with school science and the numbers pursuing further study of science continue to be a concern amongst policymakers, particularly in Western countries, although there is some suggestion of a trend towards greater uptake of post-compulsory science in recent years. Previous research reflects that most children have positive attitudes to science at age 10 but that by age 14, attitudes towards and interest in further pursuit of science have declined. The ASPIRES project, a 5 year longitudinal study, seeks to trace and track changes in students' interest in science and scientific careers over this key period of ages 10 to 14. Building on an initial survey of over 9000 children in their last year of primary school, we explore shifts in attitudes and aspirations in science as reflected in our second survey of this cohort, completed when children were in their second year of secondary school (ages 12-13). Survey findings are supplemented by longitudinal interview data from 85 children. Data suggest that the majority our sample continue to enjoy school science and hold positive views of scientists. However, these positive attitudes also continue not to translate into an interest in 'being' a scientist.

Strand 2: Science Learning: Contexts, Characteristics and Interactions

Issues Related to Science Teaching and Instruction

2:45pm – 4:00pm, Caribbean Salon 2

Presider: Leah Bricker, University of Michigan

Fostering Scientific Inquiry with Experimental Worked Examples

Jenna Sanger, University of Duisburg-Essen, jenna.saenger@uni-due.de

Markus Emden, University of Duisburg-Essen

Elke Sumfleth, University of Duisburg-Essen

ABSTRACT: Scientific inquiry is an important part in international science education standards for secondary schools. As many schools add extra learning times to their lesson plans, there is a need for materials which allow individual learning by the students. This study's aim is to develop teaching materials composed of worked examples with integrated experiments and prompts, because they allow for individual learning. It is investigated to which extent worked examples with integrated experiments with or without prompts foster learning in scientific inquiry. Experimental problem solving tasks are administered allowing for comparison. Teaching units were developed and administered over a period of ten weeks with 11- to 12-year-olds in secondary schools. The present findings show that worked examples with integrated experiments and experimental problem solving tasks foster learning efficiently, whereas worked examples with additional prompts also foster learning but seem to be less efficient. These findings imply that fostering scientific inquiry with worked examples with integrated experiments is possible.

Pre-service Teachers' Dialogues on Local Environmental Problems: A Case Study of Presumptive Argumentation on Socioscientific Issues

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Robert Anthony, University of Victoria

David Blades, University of Victoria

ABSTRACT: Contemporary curriculum in science is beginning to address the goals of scientific literacy for citizenship by including everyday-life problems in the curriculum and inviting students to consider competing claims and to search for relevant information regarding those problems. Argumentation is characteristic of everyday civic interaction on socioscientific and environmental issues which involves multiple goals, multiple agents, and diverse solutions and alternatives as these issues are complex and predicting outcomes uncertain. School science programs that explicitly include argumentation have been recognized as a promising approach for enhancing students' critical thinking, reasoning and decision making on scientific and socioscientific issues. Students' problem solving processes and

conclusions emerge from the dynamic relationships of goals, agents and contexts. To understand the dialogical nature of argumentation, this study looks into students' decision making and problem solving on local environmental issues by adopting Walton's (1996) argumentation schemes for presumptive reasoning. Students at a western Canadian university were engaged in a process of discussion and collaborative decision-making on the two local socio-scientific topics. Research findings identify topic-dependent differences in the presumptive argumentation schemes used and the complexity of knowledge integration used in the discussions.

Education for Sustainability: A Sustainable Model for Primary Teacher Candidates?

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Krsitin Redington Bennett, {in}Mind Consulting

ABSTRACT: Education for sustainability is emerging as a national priority in the United States prompting the development of educational opportunities for students interested in pursuing careers aligned with sustainability. Education for sustainability (EfS) curricula offer a unifying theme through which to explore content and relate multiple disciplines simultaneously in primary classrooms. To increase the likelihood that our primary teacher candidates become capable of embracing and developing curricula focused on EfS, two primary teacher education courses (one math and one science) were developed around the theme of sustainability. This study examined how collaboratively planned and intentionally designed courses in primary science and mathematics methods impact primary teacher candidates' understanding and application of EfS. This study followed a single cohort of teacher candidates (n=18) and examined teacher candidates': a) pre and post course definitions of sustainability, b) ability to design instructional units around the issue of sustainability, c) ability to design units that encourage the development of 21st century skills in primary grade students, and d) ability to design units with a futures perspective. Instructor journals, recorded instructor planning sessions, candidate surveys, candidate and course artifacts, and interviews served as primary data sources.

Modifying Eighth Grade Science Students' Views of Learning: A Quasi-experiment Investigating the Impact of Instruction

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Jerrid W. Kruse, Drake University

Benjamin C. Herman, University of South Florida

ABSTRACT: As with all conceptions, students' views on learning are shaped both implicitly and explicitly from their past experiences including classroom science instruction. Unfortunately, in today's school climate, students are repeatedly sent the message that learning equates to rote memorization. Because of this shallow understanding of learning, students resist attempts by teachers to focus instruction toward deep understanding of content. This research first sought to develop strategies that may be used to explicitly instruct students on learning in an eighth grade science classroom. Secondly, a quantitative instrument based on previous literature was developed to assess students' views on learning and monitor changes in views. Control and treatment groups of 8th grade science students were each given pre and posttests. Pretests were given near the beginning of the school year, posttests near the end of the school year. During the school year, the treatment group received reform-based instruction and explicit instruction on the nature of learning. The control group received traditional instruction of the same content and did not receive explicit instruction on learning. Results demonstrate significant differences between pre and posttests of the treatment group as well as significant differences between the treatment and control groups.

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

Elementary Teachers' Growth in Science Teaching

2:45pm – 4:00pm, Río Mar Salon 3

Presider: Deborah C. Peek-Brown

Elementary Teachers' Ideas about, Planning for, and Implementation of Learner-Guided and Teacher-Guided Inquiry

Mandy Biggers, University of Iowa, mandy-biggers@uiowa.edu

Cory T. Forbes, University of Iowa

Laura Zangori, University of Iowa

ABSTRACT: Using a framework for variations of classroom inquiry (NRC, 2000, p. 29), this study explores 40 elementary teachers' planning, modification, and enactment of kit-based science curriculum materials. We employed mixed-

methods to investigate three questions: 1. In what ways do inservice elementary teachers adapt existing elementary science curriculum materials across the inquiry continuum? 2. Is there a relationship between the overall quality and variations of inquiry in elementary teachers' enacted science instruction? 3. How do inservice elementary teachers' ideas about the inquiry continuum influence their adaptation of elementary science curriculum materials? Lesson plans and videos were scored using the [instrument name withheld for review]. Findings indicate only one significant difference between planned and enacted lessons, and no correlation between the inquiry quality and the variations along the continuum. Case study findings also reveal that teachers' science instruction was teacher-directed while their conceptions were student-directed. This study is a first attempt at looking at inservice elementary teachers' ideas about the continuum. This study contributes to existing research on preservice teachers' learning about the continuum and inservice teachers' ideas about the five features of inquiry.

Elementary Science Teachers' Use of Educative Curriculum Materials to Engage Students in Sensemaking Discussions

Amanda Benedict-Chambers, University of Michigan, mbenedi@umich.edu

Sylvie M. Kademian, University of Michigan

Elizabeth A. Davis, University of Michigan

Annemarie S. Palincsar, University of Michigan

ABSTRACT: This study focuses on characterizing the ways in which teachers appropriate educative curriculum materials (ECMs) to mediate their use of scientific argumentation to support students' learning. We define scientific argumentation to include both written and spoken products and processes in which students use evidence to evaluate and justify claims. This work centers on the teaching of fourth-grade units on electric circuits or ecosystems. The curriculum materials included kit-based inquiry units that were enhanced with educative supports intended to promote teacher learning and use of scientific practices and content. First, we investigate video recordings and field notes about teachers' enactments to understand how often and to what extent teachers engaged students in argumentative discussions. Second, we use cultural-historical activity theory to examine the ways in which teachers appropriated educative features to mediate their goal of engaging students in constructing scientific explanations. Finally, we identify the contradictions that teachers faced as a result of introducing this new scientific practice into their classrooms. Understanding the ways in which teachers appropriate educative features to engage students in argumentative discussions provides insight for research on teacher learning and may inform the design of educative curriculum materials.

A Professional Development Intervention's Effectiveness on Elementary Teachers' Science Content Knowledge and Student Achievement Outcomes

Brandon S. Diamond, University of Miami, b.diamond@umiami.edu

Jaime Maerten-Rivera, University of Miami

Okhee Lee, New York University

ABSTRACT: Teacher knowledge of science content is an important but rarely studied construct. An intervention including a fifth grade science curriculum and professional development was studied for 2 years to determine its effects on teacher science content knowledge as measured by three instruments: a science knowledge test, self-reported science knowledge from a questionnaire scale, and classroom observations of the science teachers. These three measures were examined for 197 fifth grade teachers prior to the intervention, after one year of the intervention, and after two years of the intervention to examine change in teacher knowledge. Year 1 results indicate that the intervention had a significant effect on the treatment group teachers' science knowledge test scores and questionnaire responses compared to the control group, but did not have a significant effect on classroom observation ratings. In addition, the three measures of year-end science content knowledge along with college science courses taken were used to examine the effect of year-end teacher science content knowledge on student achievement outcomes. Year 1 results indicate that test scores and questionnaire responses were significant predictors of student achievement outcomes. Year 2 analysis is in progress at the time of proposal submission.

Strand 4: Science Teaching--Middle and High School (Grades 5-12): Characteristics and Strategies***Related Paper Set - Examining the Nature and Assessment of Secondary Science Teachers' Topic Specific Pedagogical Content Knowledge***

2:45pm – 4:00pm, Pelican Room

Presider: Julie Gess-Newsome, Willamette University**Discussant:** Jan H. Van Driel, Leiden University

ABSTRACT: The teacher is the most important school-based factor in student learning. In order to improve student learning in science, we must understand how teachers learn to teach. Pedagogical Content Knowledge (PCK) has been a useful construct in science education research to understand teacher learning. Although PCK has been defined as topic-specific, the research literature lacks a robust set of empirical studies investigating topic-specific PCK. This paper set consists of four studies that examine both the nature and assessment of secondary science teachers' PCK for teaching specific topics: natural selection, chemical equilibrium, acids and bases, and photosynthesis. The four studies include participants that span the continuum of teacher education. The researchers use different lenses and methods to examine PCK, providing a platform to discuss the usefulness and limitations of each. The studies follow a trajectory from understanding the nature of teachers' PCK to developing assessments that could be used in future research contexts or contribute to the development of curricula, instructional resources, and professional development initiatives to improve teachers' PCK. By collectively examining these four studies, we can better understand the nature of topic-specific PCK and ways to assess this specialized knowledge for improving student learning.

The Development of Beginning Biology Teachers' PCK for Teaching Natural Selection

Aaron J. Sickel, Ohio University, sickel@ohio.edu

Patricia J. Friedrichsen, University of Missouri

Julie Gess-Newsome, Willamette University

Jan H. Van Driel, Leiden University

The Implementation of Topic-Specific PCK in a Chemistry Pre-Service Programme

Elizabeth Mavhunga, University of the Witwatersrand, Elizabeth.Mavhunga@wits.ac.za

Marissa S. Rollnick, University of the Witwatersrand

PCK by CoRes and PaP-eRs for Teaching Acids and Bases at High School

Andoni Garritz, Universidad Nacional Autonoma de Mexico, andoni@servidor.unam.mx

Clara Alvarado, Universidad Nacional Autonoma de Mexico

Florentina Canada, Universidad de Extremadura

Vicente Mellado, Universidad de Extremadura

Development and Validation of a Survey Measure of Secondary Teachers' Topic Specific PCK

Soonhye Park, University of Iowa, soonhye-park@uiowa.edu

Jeekyung Suh, University of Iowa

Kyungwoon Seo, University of Iowa

Tina Vo, University of Iowa

Strand 4: Science Teaching--Middle and High School (Grades 5-12): Characteristics and Strategies***Symposium - Teachers' Views of 21st Century Content Themes, Skills, and Contexts: An International Perspective***

2:45pm – 4:00pm, San Cristobal

Discussant: Justin Dillon, King's College London, UK**Presenters:**

Sara L. Salloum, Long Island University, Brooklyn, New York, sara.salloum@liu.edu

Danielle E. Dani, Ohio University, Athens, Ohio

Saouma BouJaoude, American University of Beirut, Lebanon

Rola Khishfe, American University of Beirut, Lebanon

Nader Wahbeh, A. M. Qattan Foundation, Palestine
 Nasser Mansour, University of Exeter, UK
 Justin Dillon, King's College London, UK
 Saeed Alshamrani, King Saud University, Saudi Arabia

ABSTRACT: There are calls for preparing students for the sociopolitical contexts and global economy of the 21st Century. For us as science educators this means developing new visions of science literacy that encompass 21st Century content and skills that integrate current global and socioscientific issues (e.g. environmental literacy). We developed a framework and tool for analyzing/assessing the adequacy of science curricula in addressing 21st Century content themes, skills, and contexts: "A Tool for Analyzing Science Standards and Curricula (TASSC)." TASSC identified key 21st Century themes, skills, and contexts and was based on multiple frameworks including the Partnership for 21st Century skills, Organization for Economic Co-operation and Development (OECD) among others. We expand our work by incorporating practitioners' perspectives on the extent to which such skills and content are included in their practice. A questionnaire containing Likert-type and open-ended questions based on TASSC was developed and administered to secondary science teachers in four countries with different cultural contexts (USA, UK, Lebanon, and Palestine) to assess their enacted curricula with respect to addressing 21st Century themes and skills. The questionnaire was followed by focus groups interviews. The panelists will share teachers' views and comparisons among different international settings. The symposium concludes with future directions for 21st Century teaching and learning.

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

Pedagogical Approaches to Science Teaching

2:45pm – 4:00pm, Parrot Room

Presider: Sanghee Choi, University of North Georgia

Scientific Humor in University Lectures

Francine Wizner, Albany University, imnotfran@hvc.rr.com

Alandeom W. Oliveira, University at Albany, SUNY

ABSTRACT: This study explores cognitive and social processes in scientific humor, a content-embedded type of humor produced by two professors (renowned scientists) orally and in writing during university lectures and course examinations. Drawing upon Lemke's (1990) work, we combine semantic analysis (taxonomic classification and construction of thematic patterns) with visual microethnographic analysis (construction of interactional maps that depict social interaction visually). Our findings reveal that scientific humor in university lectures takes varied verbal and visual forms (cartoons, humorous PowerPoint slides, jokes) and entails cognitive processes (identification, agency, token, and reason) and social processes (double alignments through fictional characters, celebrities, and social groups) that are both varied and complex. It was also found that the professors tapped into stereotypes and stigmas pervasive in US culture with regard to sexual orientation and race. The main significance of this study is that it underscores the rational nature of scientific humor, its added cognitive load, potential as a tool for interpersonal emotion management, as well as the risk of engendering emotional and social harm to students. It is argued that the commonsensical perception of humor as merely a potential source of amusement and entertainment in the science classroom is too simplistic and narrow.

Student Writing Reveals Their Heterogeneous Thinking about the Origin of Genetic Variation in Populations

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Jennifer K. Knight, University of Colorado - Boulder

Michelle K. Smith, University of Maine

Mark Urban-Lurain, Michigan State University

ABSTRACT: Variation is a core concept of genetics which helps set the foundation for evolutionary thinking for undergraduate biology students. We investigate whether students rely on surface features or a deeper understanding of genetic variation by analyzing students' written explanations. These constructed response assessments allow students to demonstrate their thinking in their own words. Because constructed response assessments can be more difficult to analyze than multiple choice assessments, we employ computerized lexical analysis, which has been shown to reveal student thinking about complex biology concepts. For this study, we developed a pair of constructed response items

asking students to explain the origin of new alleles in animal and bacterial populations. Our results show that some students rely on surface features and did not recognize origins of new alleles common to both populations. Fewer than five percent of the responses addressed mechanisms unique to bacterial populations. We also observed that students incorrectly identified natural selection as the predominant mechanism by which new alleles arise. Coupling constructed response assessment with lexical analysis revealed that students rely on surface level features to explain genetic variation and hold heterogeneous ideas (both correct and incorrect) about variation.

Re-examining the Foundations of Expert-Novice Categorization Experiments

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Daniel P. Dougherty, Lyman Briggs College Michigan State University

Gerd Kortemeyer, Michigan State University

ABSTRACT: A seminal study by Chi et al. firmly established the paradigm that novices categorize physics problems by "surface features" (e.g. "incline," "pendulum," "projectile motion," ...), while experts use "deep structure" (e.g. "energy conservation," "Newton 2," ...). Yet, efforts to replicate the study frequently fail, since the ability to distinguish experts from novices turns out to be highly sensitive to the problem set being used. Exactly what properties of problems are most important in problem sets that discriminate experts from novices in a measurable way? To answer this question, we studied the categorizations by known physics experts and novices using a large, diverse set of problems. This set needed to be large so that we could determine how well experts and novices could be discriminated by considering both small subsets using an exhaustive Monte Carlo approach and larger subsets using simulated annealing. We found that the number of questions required to accurately classify experts and novices can be surprisingly small so long as the problem set is carefully crafted to be composed of problems with particular pedagogical and contextual features. Finally, we found that not only was what you ask (deep structure) important, but also how you ask it (problem context).

Strand 6: Science Learning in Informal Contexts

Impact of Professional Development on Out-of-School Educators

2:45pm – 4:00pm, Sea Gull Room

Presider: Natalie Swayze

Crowd-sourced Bibliographic Review of Family Learning Research: A Viable Strategy?

Ana K. Houseal, University of Wyoming, ahouseal@uwyo.edu

Matthew C. Wenger, Oregon State University

Colleen Bourque, University of Wyoming

John H. Falk, Oregon State University

Lynn D. Dierking, Oregon State University

ABSTRACT: This paper presents the results of a recent effort to develop and implement a crowd-sourced method of reviewing research articles for a bibliographic review. As part of a focus on family audiences, the National Park Service (NPS) requested a review of family and intergenerational learning to inform them of effective ways of engaging family groups in the parks. Free-choice learning literature from museums and other non-formal settings was identified as the most relevant source of research. With a traditional bibliographic review article, one person reviews and interprets a large body of related literature. In this case, the research team attempted to supplement limited resources by engaging NPS employees as volunteer reviewers to read and provide feedback and analysis of the selected literature. This approach generated a broader perspective in the literature review, provided a professional development opportunity for reviewers, and tested the feasibility of this methodology. Fifty-two NPS and NPS related personnel submitted 67 reviews for 26 articles. Each reviewer was asked to identify the article's key ideas and possible connections between the research and the NPS. A description of the crowd-sourcing process and discussion of benefits and challenges are provided.

Professional Development for Informal Science Educators: A Collaborative Model

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Natalie Tran, California State University, Fullerton

Maria Grant, California State University, Fullerton

Michelle Vanderveldt, California State University, Fullerton

James F. Kisiel, California State University, Long Beach

ABSTRACT: The Professional Development for Informal Science Educators (PDISE) model was developed collaboratively with university faculty and informal science educators to determine effective professional development strategies that meet the needs of informal science educators. PDISE was designed with an understanding of effective K-12 teaching and research-based rationales applicable to a variety of instructional situations where informal educators work. Data collected from participants who participated in two activities, a Collaborative Symposium and Two-part Workshop series will be presented. Findings indicate that participants found the PDISE model valuable, particularly in the areas of institutional culture changes, research-based practices, and collaboration within and among other informal science institutions. Overall, educators described the development of a greater sense of community as well as a growing awareness of informal science education as a discipline in itself.

Teacher Satisfaction and Science Content Learning during Professional Development at an Informal Science Institution

Gary M. Holliday, The University of Akron, gholliday@uakron.edu

Norman G. Lederman, Illinois Institute of Technology

Judith S. Lederman, Illinois Institute of Technology

ABSTRACT: This study looked at a life science course that was offered at and taught by education staff of a large Informal Science Institution (ISI) located in the Midwest. The curriculum, materials, and agendas for the course were developed by education staff and complemented a permanent life science exhibition. The researcher developed a content test based on the course instructional objectives and lessons provided by education staff. In addition, all participating elementary and middle school teachers ($n = 62$) were asked to complete an evaluation at the end of each day's session. This included several questions that required participants to reflect upon the content presented throughout the course of the day, focusing on their satisfaction and effectiveness of instruction. Overall, teacher responses on the daily and final evaluations for both courses were extremely positive. However, after participating in the ISI course, teachers' gains in science content knowledge were not as strong as they had perceived. The findings described here can assist developers of informal science professional development for elementary and middle school teachers that desire to incorporate inquiry, pedagogy, and science content into their teacher learning experiences.

Strand 7: Pre-service Science Teacher Education***Argumentation in Science Teaching***

2:45pm – 4:00pm, Río Mar Salon 9

Presider: Maria Evagorou

Enhancing Argumentative Discourse through Model Based Teaching

Deniz Eren Belek, Marmara University, fbekiroglu@marmara.edu.tr

Feral Ogan-Bekiroglu, Marmara University

ABSTRACT: The purpose of this study was to examine effects of model-based teaching on students' argumentation skills. Experimental design with qualitative methods guided to the research. The participants of the study were pre-service physics teachers. The argumentative intervention lasted seven weeks. Data for this research were collected via video recordings and written arguments. Results show that construction of concrete models and using them in their discussions and explanations provide learners with more quality (accurate, consistent, appropriate, and relevant) argumentations. In addition, models' quality affects the numbers of claims, data and reasoning that are produced during argumentation. The closer learners' models are to the real situations, the more argument components they generate.

Engaging Pre-service Teachers in Argumentation in an Upper Level Physical Science Content Course

Victoria Deneroff, Georgia College & State University, victoria.deneroff@gcsu.edu

Rosalie A. Richards, Georgia College & State University

Karynne L. Kleine, Georgia College & State University

ABSTRACT: We have come to see that the practice of school science does not provide pre-service teachers with the identity of scientist, and that the task of our instruction is to serve as brokers between these two worlds. As a consequence we have come to see conversation as our principal tool for instruction. Conversation implies an equality of status between the parties. Although as instructors we are more knowledgeable about the concepts of our course, only the students can articulate their prior experiences and the conclusions they have drawn from them.

Pre-service Science Teachers' Understanding and Evaluation of Arguments

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Sibel Erduran, University of Bristol

Pinar S. Cetin, Abant Izzet Baysal University

ABSTRACT: This paper reports on a study that examined pre-service science teachers' understanding and evaluation of scientific arguments using quantitative and qualitative methods. The study was conducted with 252 pre-service science teachers in a BA programme in Education in Europe. The test developed by Sampson and Clark (2006) was used as an instrument to collect quantitative data. After determining the general tendencies of pre-service teachers in evaluating a given claim or challenge, 3 pre-service teachers were engaged in a think-aloud protocol to collect qualitative data. The results show that pre-service teachers have limited understanding of scientific argument and they demonstrate difficulties in differentiating types of justification. Furthermore, the results indicate that pre-service teachers use the criteria such as appeal to experimental procedure and perception of inaccuracy of numerical data. While pre-service teachers give examples of rote learning on the importance of experimentation and mathematical reasoning, given their performance in the quantitative measures are not coherent with these results. Since the sample included pre-service science teachers from different stages of instruction, the paper will be relevant for researchers interested in initial teacher training and developmental aspects of teaching expertise in the context of scientific argumentation.

Strand 7: Pre-service Science Teacher Education***Understanding Preservice Teachers' Challenges***

2:45pm – 4:00pm, Canary Room

Presider: Carolyn S. Wallace*Conflict Negotiation: Pre-service Teachers Attempts to Implement*

John L. Bencze, University of Toronto

Darren G. Hoeg, University of Toronto

ABSTRACT: Humans are facing many challenges associated with fields of science and technology. Arguably of most concern is Climate Change, but there are many other issues, such as food quality, distribution and safety. Many of these problems may be related to individuals' tendencies towards repeating cycles of consumption of goods and services. Progress has been made in addressing such issues by, for example, encouraging students to consider complex socioscientific issues, take positions about them, and develop plans of action to address them. In the study reported here, though, we concluded — based on constant comparative analyses of qualitative data — that there are significant challenges to student-teachers ability to implement science education programs based on STSE-activism in the classroom. Particularly challenging to student-teachers was the reconciliation between fulfilling the expectation that students acquire pre-determined scientific knowledge (content), and proceeding in lessons in which new knowledge is constructed in the open-ended experiences which occur during STSE-activism education. This suggests that preparing teachers to better incorporate content teaching in STSE-activism frameworks might be required to ensure more successful implementation of these frameworks in school science.

*Preservice Science Teachers' Nature of Science Misconceptions and Epistemological Beliefs about Physical Science*Yusuf Sulun, Mugla University, syusuf@mu.edu.tr

Aylin Cam, Mugla University

Mustafa S. Topcu, Mugla Sitki Kocman University

ABSTRACT: In this study, relationships between preservice science teachers' epistemological beliefs (EB) about physical science and their nature of science misconceptions (NOS-M) were examined. The study revealed five misconceptions: theories could be collapsed and refuted in time; scientific knowledge is certain and gets certain in time; unreliability of scientific knowledge; scientific method equals to step by step method; and scientists' imagination occurs only at the beginning of the subject matter selection. Participants having NOS-M had naïve EB about nature of knowing and learning (46%), moderate EB about structure of scientific knowledge (62%), sophisticated EB about source of ability to learn (54%), evolving knowledge (58%) and real-life applicability (42%). The relationships explored were discussed in the discussion and conclusion section in detail.

*Emotional Climate in Pre-service Science Teacher Education*Alberto Bellocchi, Queensland University of Technology, alberto.bellocchi@qut.edu.au

Stephen M. Ritchie, Queensland University of Technology

Kenneth G. Tobin, The City University of New York

Donna King, Queensland University of Technology

Maryam Sandhu, Queensland University of Technology

Senka Henderson, Queensland University of Technology

ABSTRACT: Emotions and emotional climates are underresearched aspects of pre-service science teacher education. We explore pre-service science teachers' perceptions of emotional climates in a science education class and their associated perceptions of quality learning experiences. We use data sources such as students' perceptions of the emotional climate, analysis of conversation, and cogenerative dialog from multiple theoretical perspectives related to the sociology of emotions. Quality learning experiences as perceived by pre-service teachers included the professor's science demonstrations, that were associated with highly positive emotional climate ratings, as well as the professor's reflections on her practice, that were associated with lower ratings of emotional climate. We co-relate emotional climate data and students' comments during cogenerative dialog to expand our understanding of quality experiences in science teacher education. Our study also contributes refinements to the theorization of emotional climate.

Strand 8: In-service Science Teacher Education***Symposium - Teacher Professional Learning in the Digital Age***

2:45pm – 4:00pm, Río Mar Salon 4

President: Marian Pasquale, Education Development Center**Discussant:** Janet Carlson, BSCS**Presenters:**Lauren B. Goldenberg, EDC Center for Children & Technology, lgoldenberg@edc.org

Marian Pasquale, Education Development Center

Al Byers, National Science Teachers Association

Jackie Miller, Education Development Center

Sue Doubler, TERC

Rob Steiner, American Museum of Natural History

Arthur Eisenkraft, University of Massachusetts-Boston

ABSTRACT: Can innovative professional development approaches that incorporate technology help us achieve effective, sustainable changes in the teaching and learning of science? This collaborative symposium begins with a dilemma: the realization that professional development often falls short of expectations for refining instructional practices and improving classroom learning. Advances in technology and theories of professional learning may provide new potential for meeting professional learning challenges for teachers of science. Symposium presenters will share their perspective on these issues through discussion of their research and development projects. Symposium participants will contribute to the discussion about developing a research agenda for technology-facilitated professional learning for teachers of

science. Participants are encouraged to think in advance about the following questions: (1) What does effective professional learning for teachers of science look like? (2) How can technology help? (3) What new questions arise when technology is in the mix?

Strand 9: Reflective Practice

Reflective Writing

2:45pm – 4:00pm, Heron Room

Presider: Gillian U. Bayne

Our Story: Improved Practice through Teacher-research, Presentations, and Reflective Writing

Mary E. Hobbs, Center for STEM Education, maryhobbs@utexas.edu

Robert Williams, University of Texas

James P. Barufaldi, The University of Texas at Austin

ABSTRACT: In 2008 the National Science Foundation (NSF) funded Building Base Line Objectives for Children's Knowledge & Skills for Science (BLOCKS), a 4-year project integrating research and applied teaching to take a close look inside prekindergarten classrooms and document what children know about science by the time they enter kindergarten. Twenty-four prekindergarten teachers were selected to work as teacher-researchers on the project. The teachers were from varied backgrounds and they taught in a variety of settings allowing access to students who were both culturally and economically diverse. Major aspects of the work with teachers involved professional development and mentoring support provided by content experts and our team of university researchers, and empowering professional growth opportunities afforded through participation in state and national conferences and writing for publications. Implications include the use of the model of conducting teacher research as a motivation for relevant and effective professional development of teachers with the addition of presentations and writing as means to promote reflective practice.

Using Culture and Writing to Teach Science Content to Preservice Teachers

Line A. Saint-Hilaire, Queens College, CUNY, Line.Augustin@qc.cuny.edu

ABSTRACT: This article describes how the incorporation of an assignment into the syllabus, a book about culture and science, was used to foster science content learning in a methods course for preservice teachers. Pre-service teachers learned science in the reflective and enjoyable approach and learned how to utilize culture for effective teaching of science. They also gained an understanding of the importance of making science relevant to students.

Reconfiguring the Urban Science Experience: The Power of Diversity, Social Context, and the Local Environment

Erin A. Hashimoto-Martell, Boston College/Boston Public Schools, hashimer@bc.edu

Michael J. Clinchot, Boston Public Schools

Fiona Bennie, Boston Public Schools

Haven Daniels, Boston Public Schools

ABSTRACT: In this collaborative teacher researcher study, four urban science teachers (two elementary science teachers, one middle school science teacher, and one high school science teacher of Deaf students) investigated how changing the learning environment, both physically and socially, had an impact on the science teaching and learning experience. Students participated in local field experiences to learn basic ecology concepts, and were heterogeneously grouped across grade levels, schools, and hearing status. Employing a sociocultural lens, teacher and student narratives were analyzed using a categorical-content approach to understand how the physical structures and social context linked to underlying interpretations and meanings of the experience for participants. Thematic analyses indicated the combined importance of learning local science content, the unique social interactions amongst the students, and students sharing roles of expertise. This suggests how thinking broadly across science and social contexts can provide authentic and engaging learning experiences for urban students.

Policy and Practice: Reflective Diaries of Teachers and Teacher Trainers in an Inclusive Curriculum Project

Meshach M. Oggunniyi, University of the Western Cape, mogunniyi@uwc.ac.za

ABSTRACT: Curriculum reforms are construed in many countries as a transformative agent of social change. For the first democratically elected government of South Africa the new outcomes-based curriculum was regarded as a rallying symbol of an educational ideology signifying a change in policy from the racially based apartheid curriculum to one that acknowledges and celebrates unity in diversity. One of the objectives of the new curriculum is to integrate indigenous knowledge (IK) with school science. Beyond the controversies surrounding the new curriculum since its inception in 1997, the nagging question has been: "How do teachers integrate two distinct worldviews namely, school science with IK?" This report presents a few snippets of the experiences of 25 teachers and science educators (teacher trainers) exposed to an argumentation-based instructional model that attempted to integrate school science with IK. Findings based on the subjects' responses to a questionnaire consisting of five open-ended questions show that despite the challenges the subjects encountered most of them became more favourable disposed to implementing the new curriculum than was the case before they participated in the study thus confirming the potential of argumentation instruction in knowledge building and belief revision. Key words: inclusive science-IK curriculum, argumentation, argumentation framework

Strand 10: Curriculum, Evaluation, and Assessment***Development and Validation of Learning Progressions: Examples and Tensions***

2:45pm – 4:00pm, Río Mar Salon 2

Presenter: Knut Neumann

Learning Progressions as Tools for Evaluation: Assessment of Contextualizing Instruction in a Project-based Chemistry Curriculum

Kathryn F. Drago, East Carolina University, dragok@ecu.edu

ABSTRACT: Numerous existing reform-based science curricula will have to be revised to align with learning progression (LP) research. These revisions will improve curricula such that students will be better supported in developing sophisticated science understandings over extended units. In this paper, I evaluated an 8th grade project-based chemistry unit to determine how its existing contextualizing instruction provided students with opportunities to advance along the learning progression for carbon cycling in socio-ecological systems. My methods included coding the curriculum for five categories of contextualizing instruction, coding what level of students' science understandings this contextualizing instruction supported, searching for patterns in these codes across the materials, and creating assertions supported by the data. The overall findings from my analysis were 1) the curriculum prompted all five of the categories of contextualizing instruction to varying degrees, and 2) yet, the curriculum infrequently leveraged this contextualizing instruction at the molecular level. The findings from this study suggest in what ways this project-based curriculum should be revised and provide insight into the implications of LP research for other existing reform-based curricula. The analytic method I used provides a means for assessing reform-based curricula for revision or the development of new materials that align with LPs.

Challenges in Developing Classroom Assessments Linked to Multidimensional Learning Progressions

Erin M. Furtak, University of Colorado at Boulder, erin.furtak@colorado.edu

Deborah Morrison, University of Colorado at Boulder

Heidi Iverson, University of Colorado Denver

Michael J. Ross, University of Colorado - Boulder

ABSTRACT: Although many of the learning progressions currently developed in science education focus on single, unidimensional constructs, some conceptual areas are difficult to parse in this manner. In this paper, we discuss the differences between unidimensional and multidimensional learning progressions and focus on the multiple consequences we encountered when developing a classroom assessment linked to a multidimensional learning progression, including the tension between developing assessments with classroom feasibility and construct reliability, the trouble in accurately representing the multiple dimensions of a learning progression, and complications in interpretation of diagnostic information. We illustrate these consequences and frame implications for future work in this area.

Development of a Learning Progression for Water Cycling with Ordered Multiple Choice Items for Korean Elementary Students

Seungho Maeng, Kangwon National University, Korea, seunghom@gmail.com

Yeonseon Seong, Seoul National University of Education, Korea

Shinho Jang, Seoul National University of Education, Korea

ABSTRACT: This study shows a case of water cycling LPs for Korean elementary students from fourth grade to sixth using ordered multiple choice items and item response theory based on Rasch model. The four building blocks were applied to design and interpretation of the assessment as well as to development process of LPs. Along the four building blocks we first, built a construct map of water cycling based on literature review. Next, we designed a set of ordered multiple choice items comprising three contexts of rain falling, evaporating water in a puddle, and being damped by rain. Then, eight OMC items assessment were conducted by 165 elementary students in Korea, and answering options of each OMC item were scored. Finally, the Partial Credit Model was applied to analysis of students' responses, item options characteristic curves, and a Wright map. Based on the Wright map, we interpreted the results of assessment, refined the original construct map, and determined the water cycling LPs. Consequently, Korean elementary students' understanding of water cycling showed a developmental pathway from a basic idea to canonical scientific idea, and differences in each sub-system. It signifies that different instructional sequences for each sub-system are required for students' learning pathways.

Towards the Validation of a Learning Progression for the Concept of Matter

Jan Christoph Hadenfeldt, IPN Uni Kiel, hadenfeldt@ipn.uni-kiel.de

Knut Neumann, Leibniz Institute for Science Education (IPN) Kiel

ABSTRACT: Over the past years learning progressions received increasing attention as a measure to align educational standards, instructional contents and students' learning. Learning progressions (LPs) describe students' growth in understanding core concepts of science. However a valid LP must be supported by empirical evidence. This study aims to investigate the validity of a hypothesized LP of matter. Based on a previous study, which suggested that Ordered Multiple Choice (OMC) can be utilized to assess students progression in understanding the matter concept, altogether 39 OMC have been developed for different aspects of the concept of matter and have been administered to N=1364 students from grade 6 to 12. Rasch analysis was used to investigate the structure of the construct, the structure of students' level of understanding in the hypothesized LP and the progression of students' abilities. Analysis revealed that the hypothesized LP has some preliminary validity. Suggestions for further validation are discussed.

A Longitudinal Assessment of a Learning Progression for Structure-Property Relationships – Chemistry, Life, the Universe, and Everything (CLUE)

Sonia M. Underwood, Clemson University

Melanie M. Cooper, Clemson University

Leah M. Corley

ABSTRACT: The relationship between the molecular-level structure of a substance and its properties is an essential tool for developing a robust understanding of chemical principles; unfortunately, students struggle with this connection. Previous research has shown that many students are unable to decode property information from Lewis structures. Intermolecular forces (IMFs) are a crucial part of this inference chain from structure to properties, and are particularly difficult for students to determine. We developed a new general chemistry curriculum, Chemistry, Life, the Universe and Everything (CLUE), which was designed to address these difficulties. This report documents a quantitative longitudinal study to evaluate the effectiveness of the learning progression leading to an understanding of IMFs. Both immediate and long-term effects were assessed by tracking two equivalent cohorts of students progression through general chemistry, and following on through a year of organic chemistry. Two assessments were administered in this study – the Implicit Information from Lewis Structures Instrument (IILSI) and a free form IMFs assessment that required students to construct representations. The CLUE curriculum helped students develop a deeper understanding of IMFs and structure-property relationships.

Strand 11: Cultural, Social, and Gender Issues***Related Paper Set - Leveraging an Online Scientific Community to Enhance Contextual Science Education***

2:45pm – 4:00pm, Río Mar Salon 8

ABSTRACT: Ciencia Puerto Rico (CienciaPR) was established in 2006 as an online community to disseminate information about Puerto Rican scientists and about science as it relates to Puerto Rico. As its scientific membership and credibility grew, more concrete projects to improve science education, communication, and research mentoring were implemented. The purpose of this paper set is to introduce NARST members to CienciaPR and highlight some of its educational strategies, and outcomes. The first three papers provide a historical background to the organization; describe its role in science advocacy and communication via traditional and social media; and explain how the book “Ciencia Boricua” developed as a unique resource to make science culturally relevant to the Puerto Rican public. The last two papers report the outcomes of workshops to help K-12 teachers contextualize science education through use of the book and of using the book and other interventions to increase elementary and middle school students’ interest in science. NARST members will be interested in this paper set because it presents a novel approach to recruit local and diaspora scientists to enhance contextual science education and public understanding of science, and shares findings that support the use of culturally-relevant tools in science education.

An Online Membership Organization to Promote and Enhance Science Education in Puerto Rico

Giovanna Guerrero-Medina, giovanna.guerrero@gmail.com

Greetchen Díaz-Muñoz

Samuel Díaz-Muñoz,

Monica Feliú-Mójer

Jacqueline Flores-Otero

Yaihara Fortis-Santiago

Wilson González-Espada

Marcos López-Casillas

CienciaPR: Science Education through Media and Informal Settings

Monica Feliú-Mójer, moefeliu@cienciapr.org

Giovanna Guerrero-Medina

Daniel Colón-Ramos

Marcos López-Casillas

Jacqueline Flores-Otero

Wilson González-Espada

Yaihara Fortis-Santiago

Greetchen Díaz-Muñoz

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Ciencia Boricua: A Culturally Relevant Science Book

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Daniel Colón-Ramos

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Impact of "Ciencia Boricua" on Science Teachers' Professional Development

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Monica Feliú-Mójer

Daniel Colón-Ramos

Wilson González-Espada

Impact of "Ciencia Boricua" on Elementary and Middle Students' Perception of Science

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Yaihara Fortis-Santiago
Giovanna Guerrero-Medina
Nicole Ortiz-Vega
Daniel Colón-Ramos
Monica Feliú-Mójer

Strand 14: Environmental Education

Using Authentic Data to Teach and Learn Environmental Concepts

2:45pm – 4:00pm, Río Mar Salon 7

Presider: William C. Kyle, Jr., University of Missouri – St. Louis

Improving College Science Students' Data Skills through a Short-Term Stream Sampling and Graphing Unit

Mikaela Schmitt-Harsh, Carleton College, mschmitt@carleton.edu

Joseph A. Harsh, Indiana University School of Education

ABSTRACT: Adequate proficiencies in graphing are held as a central element for scientific literacy given the importance of succinctly communicating complex information. Despite this perception, and the position of graphs in daily life, evidence indicates that learners of all ages and levels of expertise have difficulties in displaying and reading visual data. While numerous studies have investigated the enactment of various activities to improve graphing in the college science classroom, most of this work has focused on graphing difficulties and the implications of general instructional strategies as part of semester-long curriculum. As few studies have discussed how specific interventions can be implemented to effectively hone graphing abilities, the purpose of this study was to evaluate the impact of an inquiry-oriented stream ecology data collection and graphing unit, based on five key instructional features, on nonscience majors' analytical skills. Comparing pre- and post-test data, as well as a supplemental questionnaire, student (n=37) responses demonstrated significant positive impacts on graphing skills and attitudes towards graphing, and outlined features of the unit that were considered successful. While the intervention described here focuses on a stream ecology activity, the framework and depiction of the design features can be applied using other case studies across disciplines.

Ecology Disrupted: The Impact on Student Learning of Linking Ecological Function to Human Impact

Yael Wyner, City College of New York, ywyner@ccny.cuny.edu

Jonathan Becker

Bruce Torff

Janice Koch, Hofstra University

ABSTRACT: The National Science Education Standards (NRC 1996) separate human impact and ecology into different units of study. The recently developed New Framework for Science Learning (NRC 2011) links human impact and ecology into the same learning strands. We hypothesized that this new explicit link between human impact and ecological function would increase student learning of both human impact and ecological function, since the integration of these topics would allow human impact to be used to understand ecological function. To test this hypothesis, we replaced urban 9th grade biology students' regular human impact curriculum with a curriculum that overtly links human impact to ecological function (n=2,234). We compared student performance between treatment and control classrooms. We found that treatment students significantly outperformed students who had experienced the regular human impact curriculum in their understanding of ecology and human impact.

An Authentic Climate Change Research Experience for Secondary Students at the Camuy Cave, Puerto Rico

Vanessa Vernaza-Hernández, University of South Florida, vanessav@mail.usf.edu

Allan Feldman, University of South Florida

Bogdan Onac, University of South Florida

Angela Chapman, University of South Florida

Dilek Özalp, University of South Florida

Fayez Alshehri, University of South Florida

Juan Carlos Millán, University of South Florida

ABSTRACT: The purpose of this study was to help students to understand how the study of caves can provide information on how climate has changed over time and how it can be used to predict future changes in climate and sea level. The study was conducted in Puerto Rico and a total of 3 schools and 91 students participated in the project. A mixed-methods approach was used for this study. During the first phase of the research the students made an educational visit to the Camuy Cave during which they had the opportunity to interact with a geology professor from a US university who is an expert on caves. During the second phase the students participated in a scientific activity in which they analyzed temperature and relative humidity data inside and outside the cave. The statistical analysis of the pre/mid/post test showed that this authentic science research experience allowed students to develop knowledge about climate change and cave deposit, and also helped them to develop science research skills and their self-perception as scientists. Also, the results show that the grade level of the students is a decisive factor to determine whether there is significant difference between the results of the tests.

Strand 15: Policy

Symposium - STEM Educational Reform State of the Scene - Challenges, Successes, and Moving Forward

2:45pm – 4:00pm, El Morro 1 & 2

President: Carla C. Johnson, University of Cincinnati

Presenters:

Carla C. Johnson, University of Cincinnati, carla.johnson@uc.edu

Charlene M. Czerniak, The University of Toledo

Catherine M. Koehler, Southern Connecticut State University

Toni A. Sondergeld, Bowling Green State University

Andrea R. Milner, Adrian College

Abdulkadir Demir, Georgia State University

ABSTRACT: This symposium will present research included in Secondary STEM Educational Reform, an edited book focused on challenges associated with integration of STEM within science and other disciplines. Four research studies will be briefly introduced, followed by a panel discussion focused around three guiding questions: 1) What is the state of the scene in integration of STEM within science reform projects, 2) What are the challenges related to integrating a STEM approach within a school, district, region, and state, and 3) What are the next steps in moving STEM reform forward? Implications for the future will be discussed and questions and input from participants will help shape the conversation and outcomes of the session.

Plenary Session #1***Design, Make, Play: Growing the Next Generation of STEM Innovators***

4:30pm – 5:50pm, Río Mar Ballroom 5 and 6

Presider: Sharon Lynch, George Washington University

Keynote Presenter: Margaret Honey, New York Hall of Science, NYC

ABSTRACT: Children are born curious and come equipped with a desire to learn that rivals even the most determined scientist. Early in school, however, this spark – what psychologists have dubbed intrinsic motivation – is all too frequently extinguished by the extrinsic goals and expectations of school. Fortunately, there is research-based evidence that says it is possible to rekindle this natural motivation to learn by designing environments that are supportive, that engage learners in meaningful activities, that lessen a student's anxiety and fear, and that provide a level of challenge matched to students' skills. Through a series of interactive examples, this talk will explore the use of *design-make-play* learning strategies to illustrate methodologies of engagement that foster motivation and deeper learning in the STEM fields.

Sunday, April 7, 2013

Concurrent Session #3

8:30am – 10:00am

Publications Advisory Committee Sponsored Session***Symposium - Reflections from Contemporary Researchers on the Influence of Past JRST Scholarship***

8:30am-10:00am, Caribbean Salon 1

Presiders:

Carolyn S. Wallace, Indiana State University, carolyn.wallace@indstate.edu

Julia D. Plummer, Pennsylvania State University

Discussant: Angela Calabrese Barton, Michigan State University**Presenters:**

Gregory J. Kelly, Penn State University

Troy D. Sadler, University of Missouri

Nancy B. Songer, University of Michigan

Katherine L. McNeill, Boston College

ABSTRACT: In recognition of the 50th anniversary of the Journal of Research in Science Teaching, the Publications Advisory Committee has organized a session to reflect on the ways in which past JRST scholarship has influenced the research community. Our goal in this session is to take a personal look at the stories of NARST members and the articles they selected as influencing the direction of their scholarship. In this session, four science education scholars, who began their career during various decades of JRST publication, will share the ways in which previous JRST literature shaped the direction of their own research. In this way, we hope to elicit a discussion around how JRST has influenced the direction of science education research over the past 50 years.

Strand 1: Science Learning, Understanding and Conceptual Change***Cognitive Development and Reasoning***

8:30am-10:00am, Río Mar Salon 1

Presider: Catherine Eberbach***How Metacognitive Processes Regulate Cognitive Processes In Self-Developed Explanatory Models of Magnetic Phenomena***

Meng-Fei Cheng, National Changhua University of Education, mcheng2@cc.ncue.edu.tw

David E. Brown, University of Illinois at Urbana-Champaign

ABSTRACT: The purpose of this study was to investigate in detail the processes involved when the promotion of metaconceptual evaluation facilitates fifth grade students' use of conceptual resources to develop explanatory models for magnetic phenomena. In this study, a video-taped, multi-session teaching experiment was conducted with a small number of fifth grade students in order to study in detail the interactions between students' metacognition and their development of explanatory models to account for magnetic phenomena. In this teaching experiment, students in both the fully and partially scaffolded groups were asked to develop or modify their explanations for magnetic phenomena. Only fully scaffolded groups were explicitly asked to reflect on the metaconceptual modeling criteria of visualization and explanatory power. The result of the study shows that reflection on the metaconceptual modeling criteria of visualization and explanatory power helped the fully scaffolded students to inspect, activate, apply, and reorganize their conceptual resources from the observational level to the microscopic level in order to construct coherent explanatory models similar to a simplified version of the scientific domain model of magnetism. By contrast, without reflection on the metaconceptual modeling criteria, students in the partially scaffolded groups were unable to apply appropriate conceptual resources from the observational level to further hypothesized and unobservable levels. They ended up developing piecemeal and disconnected explanations to account for magnetic phenomena.

Elementary Students Use of Argumentation and Evidentiary Support In Science Notebooks

Eric N. Wiebe, North Carolina State University, eric_wiebe@ncsu.edu

Angela Shelton, North Carolina State University

Lindsay Patterson, North Carolina State University

Megan Hardy, North Carolina State University

Mike Carter, North Carolina State University

Chip Sheffield, North Carolina State University

ABSTRACT: This research investigated elementary students use of argumentation and evidentiary support in an electronic science notebook software environment. The research was interested in understanding how evidence was used in supporting claims in the context of inquiry lab activities where students were prompted to formulate arguments that were either hypothetical or empirical in nature. Student responses to prompts were analyzed for presence of evidentiary support and the quality of their argumentation structure. Findings indicated that overall, students provided evidence as often for hypothetical prompts as for empirical prompts, but there were differences in cases where the software designers expected evidence to be provided, or not. When evidence was expected, students did better with hypothetical prompts than with empirical prompts, while the reverse was the case when evidentiary support was not explicitly prompted for. Overall, the quality of the student argumentation was higher for the hypothetical prompts than the empirical prompts. The findings will both inform the development of the software and current research on supporting argumentation in elementary science.

Embodied Modeling of a Bioinspired Kinetic Assembly: Visual, Aural And Kinesthetic Representations of Strandbeest Locomotion

Gokul Krishnan, Vanderbilt University, gokul.krishnan@vanderbilt.edu

ABSTRACT: The paper investigates the generation and elaboration of multiple representations of a bioinspired kinetic assembly through an embodied modeling approach. Specifically, the research is based on observations of groups of students working collaboratively, aged 10-12 (6th grade), as they self-generate, negotiate and co-construct multiple representations of a complex organismal phenomenon (locomotion). The physical model employed in the study is called the 'Mini-Strandbeest' designed by Theo Jansen. Modeling the Mini-Strandbeest's movement kinesthetically employed sensory modalities; while learning the patterns of locomotion through invention of notation systems made use of communicative modalities. In the study, multiple sensory and communicative modalities facilitated the group of sixth grade students in constructing relations among body movements and multiple representations of locomotion. The current study extends research in learning by illuminating the significant role of sensory modalities when used in combination with communicative modalities. Including one's own movements into the learning activity to directly change the representations enables a continuous dialogue between the concrete and the **ABSTRACT**. The paper argues that creating symbols through physical movement directly maps the learner's own movement to the features of the representation, and therefore can create strong conceptual links to the symbol and its changes.

Size And Scale Tasks and Their Relation To Evolutionarily-Based And Culturally-Based Knowledge

Cesar Delgado, University of Texas at Austin, Cesar_Delgado@austin.utexas.edu

Gail M. Jones, North Carolina State University

Hye Sun You, University of Texas at Austin

Laura E. Robertson, East Tennessee State University

Justin Halberda, Johns Hopkins University

ABSTRACT: Scale, proportion, and quantity constitute a "crosscutting concept" in science education – a concept that pervades science and can help students connect their knowledge across topics and disciplines. An understanding of wide ranges of size is a prerequisite for the learning of scale. Students must have a good understanding of size and scale if they are to leverage them to connect their science understanding. In this study, we examine two qualitatively different types of knowledge that may underlie the understanding of size and scale: the evolutionarily-based approximate number sense, and the culturally-based understanding of measurement units. We explore how closely these two types of knowledge are related to size and scale knowledge useful for secondary science classrooms. This study has implications for instruction: evolutionarily-based abilities are biologically primary, are acquired universally, and are motivating, whereas culturally-based abilities are biologically secondary, and depend on instruction, practice, and

external motivation. Different educational approaches might be better suited to biologically primary and secondary abilities. The results of an empirical study with 36 seventh grade students are reported.

Critical Transitions In Coming to Understand Natural Selection

Stephanie Sisk-Hilton, San Francisco State University, stephsh@sfsu.edu

Eric Berson, University of California, Berkeley

Kathleen E. Metz, University of California, Berkeley

ABSTRACT: This study analyzes young children's progress along a learning progression toward normative understanding of natural selection when engaged in a curriculum explicitly designed to support this development. The analysis identifies three critical transitions along the learning progression that proved particularly challenging to children, as well as the pedagogical supports that allowed them to make progress at these points. Critical transitions included: attending to variation rather than reasoning in terms of a prototypical species member; moving from understanding individual survival advantage to its impact on generational trait distribution; and creating precise generational explanation versus an explanation relying on aggregated generations. The analysis shows inconsistent student performance across contexts at these three transition points and identifies pedagogical supports that scaffolded students' more normative understanding. The study provides evidence that children as young as second and third grade are capable of constructing normative explanations of natural selection when critical transition points are pedagogically supported.

Strand 2: Science Learning: Contexts, Characteristics and Interactions

Science Learning and the Importance of Authenticity and Relevancy

8:30am-10:00am, Caribbean Salon 2

Presider: Mei-Hung Chiu

Authentic Classroom Science Using Scientist-Mentors: Successes and Challenges in Blending Online and Laboratory Learning

Stephen C. Scogin, Texas A&M University, scs2639@tamu.edu

Carol L. Stuessy, Texas A&M University

Gokhan Ozturk, Texas A&M University

Cheryl A. Peterson, Texas A&M University

ABSTRACT: PlantingScience (PS) is an award-winning program recognized for its complex design engaging classroom teachers, students, and scientist-mentors in an innovative, web-supported science learning environment. Students engage in authentic science learning as they work with plants in the classroom and communicate asynchronously about their scientific inquiries with practicing plant scientist-mentors. Despite nationwide trends showing an increase in student disinterest towards STEM fields, PS demonstrates success in motivating students and supporting meaningful, participatory science learning. In an effort to evaluate the PS program and identify specific reasons for its success, a focus group consisting of 19 experienced PS participants was organized. Using qualitative methods, researchers analyzed the two day discussions of the focus group and identified five thematic categories playing important roles in the success of PS: a) orchestration of the learning environment, b) website design, c) participation in authentic science, d) curricular modules, and e) student motivation. The research group filtered the findings of the study through a motivational framework, self-determination theory (SDT), in an effort to discover the underlying reasons behind the success of PS. According to SDT, the fulfillment of autonomy, competence, and relatedness promotes self-determination in learning. PlantingScience was found to support these three basic psychological needs.

Recommendations for the Development and Use of Visualizations in Science Teaching

Linda M. Phillips, University of Alberta, linda.phillips@ualberta.ca

Stephen P. Norris, University of Alberta

ABSTRACT: There is a pervasive lack of clarity about precisely what constitutes visualization. Yet, there is general agreement that visualizations are an effective teaching tool. Based on an extensive five-step review process, this paper will report on select findings from a review of 65 empirical studies of visualization in science education. The goal of this paper is to provide recommendations for the development and use of visualizations in science teaching. We identified

three important distinctions in the conceptualization of visualization, namely: visualization objects, introspective visualization, and interpretative visualization. These distinctions are important for understanding the demands and contexts of visualization use and for determining the most effective applications of visualization in the science classroom. The main conclusion is that visualizations are effective to the extent that they meet relevant instructional goals and objectives and that students have the necessary background knowledge and skills to understand and interpret the information presented in them. The effectiveness of visual representations is related to the contexts in which they are used: there is no direct path from visualization to understanding. Recommendations for animation and computer-based visualizations will be presented. However, further research is needed to assess whether and how they improve learning.

Catalyzing Involvement in Student Research with Science Fairs: Case Studies of Exemplary Programs

Peter Rillero, Arizona State University, rillero@asu.edu

Jon K. Price, Research & Evaluation Intel® Corporation

ABSTRACT: There is increased discussion and recognition of the importance of project-based learning in education (Chin & Chia, 2004; Krajcik, Czerniak, & Berger, 1998; Lam, Cheng, & Ma, 2009). Full-inquiry science research projects develop science content and develop and assess all of the standards-based science process skills and inquiry skills. In the dawn of project-based learning moving beyond talk and into implementation, full-inquiry science research should be the gold standard of independent project work. We propose that policy people, leaders, and teachers have the following three main goals for science fairs: (a) Winning Goal, (b) Quantity Goal, and (c) Quality Goal. These goals may not be explicitly stated but they do shape behavior. The winning goal is common but focusing efforts on elite students doing elite projects may limit the amount of students participating. For this research we selected programs that were exemplary in maximizing participation but yet were interested in quality research. Case study analyses of science research programs in Costa Rica, Ireland, and Marlborough, Massachusetts were conducted. Interviews of leaders, supporters, and students were conducted. These interviews and supporting documents were analyzed. Each of these case studies is described and conclusions from comparing programs are presented.

Beyond Hands-on: The Importance of Relevance and Discussion in Promoting Students' Interest in School Science

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Junqing Zhai, National Institute of Education

Aik-Ling Tan, National Institute of Education

ABSTRACT: Recent research has revealed that students' interest in school science begins to decline at an early age. As this lack of interest could result in fewer individuals qualified for scientific careers and a population unprepared to engage with scientific societal issues, it is imperative to investigate ways in which interest in school science can be increased. This study aimed to investigate how grade 4 students' perceptions of their science classrooms affect their interest in school science. Data was collected through the use of a questionnaire, drawing activity, and interviews conducted in 12 grade 4 classrooms in Singapore. Results indicate that, while hands-on activities are viewed as fun and interesting, connecting learning to real-life and encouraging students to discuss their ideas with their peers has a greater impact on student interest in school science. These findings suggest that simply engaging students in hands-on activities is not sufficient to increase their interest in science. Instead, student interest may be increased by ensuring that classroom activities, whether hands-on in nature or not, emphasize the everyday applications of science and allow for peer discussion.

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

Literacy in Elementary Science

8:30am-10:00am, Río Mar Salon 3

Presider: Sarah J. Brasiel

Elementary Teachers' Views of the Role of Literacy In Science

Brian M. Donovan, Stanford University, briand79@stanford.edu

Michelle Friend, Stanford University

Michael Metz, Stanford University
Jonathan F. Osborne, Stanford University
Alexis Patterson, Stanford University
Diego X. Roman, Stanford University

ABSTRACT: The new US Common Core Standards for Literacy are not only for literacy in language arts but also for history and science. Teachers are expected to educate students about how to read informational texts and their major features. Yet, what do teachers of elementary science know and understand about the nature of scientific text or the rationale for its form? In addition, what do they see as the challenges posed by language and literacy in science and what instructional strategies do they commonly use? To date, no studies have explored this question. In this paper, we report a study conducted using extended interviews with a sample of 20 teachers drawn from the full range of elementary schools in a major urban district with the goal of answering these questions. Data from the interviews were transcribed and systematically coded with NVivo 9 to identify the major knowledge and understanding teachers held about the role of language in science. Elementary teachers would appear to have a good understanding of the strategies for teaching reading but lack a knowledge of the complexities of expository text. The implications of these findings are discussed.

Cross-Subject Analysis On Questions In Elementary Science Textbooks and Japanese Language Textbooks in Japan

Manabu Sumida, Ehime University, msumida@ed.ehime-u.ac.jp

Chika Shimomiya, Fukuyama Myoodai High School

ABSTRACT: The purpose of this study was to investigate characteristics of “Scientific Questions” by comparing questions in elementary Science textbook with those in Japanese Language textbook in Japan. Japanese science education officially starts at grade three. In this study, 461 questions were extracted from grade three Science textbook and Japanese Language textbook published in 2011 under the new national course of study. The original framework was developed for cross-subject analysis on these questions. The results showed: 1) Science textbook contained fewer Yes/No type questions than those in Japanese Language textbook; 2) meta-questions (from others to others) were very few in Science textbook; and 3) there were more experience-based questions in Science textbook and more thinking-based questions in Japanese Language textbook. The study highlights that there was a different rate of certain types of questions asked in Science and Japanese Language, and this could have implications on studies related to nature of Science and other subjects. It is important both for children and teachers to take note that the characteristics of Science questions may differ from other subjects even when some subjects, such as Science and Japanese Language, are taught coordinately in the early grades.

Blended / Tiered Approach to Teaching Academic Vocabulary Within a Two-Way Immersion Classroom

Cristina White, University of Nevada, cristina.white11@gmail.com

David T. Crowther, University of Nevada, Reno

ABSTRACT: Most academic vocabulary instruction for English Language Learners utilizes a frontloading dominant approach found within direct instruction. This research utilizes a combination of a blended approach to scaffold vocabulary (Carr, Sexton & Lagunoff, 2006) while utilizing the tiered vocabulary distinction (Beck, McKeown, & Kucan, 2002 & 2008) to develop the Blended / Tiered Model of Academic Vocabulary Instruction for English Language Learners for inquiry science (Author, 2012). This research follows the premise that teachers must be given the background knowledge and time necessary to plan explicit vocabulary instruction in science as well as understand the application therein for an inquiry based approach (Lee, Adamson, Maerten-Rivera, Lewis, Thornton, & LeRoy, 2008). This study applied the Blended / Tiered model in a two-way immersion (Spanish and English) second grade classroom physical science unit. The Blended / Tiered approach was adapted for a bilingual setting. The findings of the study show a statistical significant difference in a pre, post, post test experimental group design. The study is further indication that the Blended / Tiered approach to teaching academic vocabulary within inquiry based science is an effective way to deliver inquiry science instruction in regular and bilingual two-way immersion classrooms.

The Development of Insightful Implementation of Science Notebooks

Lori Fulton, University of Hawaii at Manoa, fultonl@hawaii.edu

Janelle M. Bailey, University of Nevada, Las Vegas

David T. Crowther, University of Nevada, Reno

Jian Wang, University of Nevada, Las Vegas

ABSTRACT: Science notebooks have the potential to impact students' understandings of science when used in an insightful manner; however, their use tends to be mechanical in nature, preventing the true potential of the notebook from being realized. This is not surprising, as notebooking resources tend to focus on what notebooks should look like and how to get them going, rather than how to facilitate them in a manner that furthers students' learning. This study examined three primary teachers' beliefs and practices, related to science notebooks as a result of participating in a study group. The findings led to the development of a substantive theory on the progression of science notebook implementation, *The Development of Insightful Implementation of Science Notebooks*. This theory examines the progression of notebook implementation from mechanical to insightful use, providing a description of what insightful use of the science notebook looks like, including gradual shifts in the teacher's instruction and the use of supports and scaffolds to structure student learning.

Strand 4: Science Teaching--Middle and High School (Grades 5-12): Characteristics and Strategies***Investigating Teacher's Pedagogical Content Knowledge***

8:30am-10:00am, San Cristobal

President: Ava Zeineddin

Influence of Different School Types on Chemistry Teachers' PCK and CK

Oliver Tepner, University of Duisburg-Essen, Germany, oliver.tepner@uni-due.de

ABSTRACT: Teachers' professional knowledge is seen as an important precondition for instructional quality. To date, an information gap exists concerning the influence of chemistry teachers' teaching experiences on their content knowledge and pedagogical content knowledge. Thus a valid and reliable test instrument was implemented to collect generalizable data in this study's first stage. To simplify data analysis – especially in large-scale assessments – and to increase test participation willingness, a paper/pencil test using a closed-item format was given to 242 in service chemistry teachers of different school types. Results show significant differences between teachers working at lower level secondary schools and teachers working at mid-level secondary schools. No significant differences were found between teachers working at upper level secondary schools and teachers working at comprehensive schools. Implications for teacher education concerning the development of professional knowledge could be given.

When Teaching Makes Difference - Developing Science Teachers' Pedagogical Content Knowledge (PCK) Through the Approach of Learning Study

Pernilla Nilsson, Halmstad University, pernilla.nilsson@hh.se

ABSTRACT: The aim of this paper is to develop science teachers' PCK through their participation in a learning study. The research question that frames the study is "How do science teachers' learning about science teaching (PCK) develops as a shared practice through their participation in a learning study? As such, the project aims to investigate how teachers' increased (or not) professional knowledge of teaching is enhanced, and further, how students' learning might be developed as a consequence. During one semester, three secondary science teachers and a science education researcher worked together in a learning study in which the object of learning was to understand the concept of ion and how ions are formed. Data were collected from video recorded lessons and stimulated recall sessions in which the teachers and the researcher reflected on the lessons to analyze how the teachers developed knowledge of students learning and the impact of that knowledge on their own teaching. The results indicate that teachers' participation in the learning study proved to be helpful in their (re)considerations of their science teaching in that it points to the particular role of research-based learning in providing a metacognitive lens through which to analyze science teaching and learning.

A Scienceteacher'S PCK: Those Who Can, Do. Those Who Understand, Teach

Dilek Karisan, Middle East Technical University, dilekkarisan@gmail.com

Ayşe Senay, Middle East Technical University

Behiye Ubuz, Middle East Technical University

ABSTRACT: Teachers are usually considered to be the most essential element in student learning. Teachers' Pedagogical Content Knowledge (PCK), whether pre-service or in-service, is one of the most important factors that affect learning process. The purpose of the study is to investigate an experienced science and technology teacher's PCK on the topic of fluid pressure in physics in two classes with different academic success levels at an elementary public school. The study can be defined as a qualitative case study. Purposeful sampling method was used to explore an elementary science and technology teacher's PCK. Timeline for the data collection is divided into three part; conducting pre-interview, classroom observations, and conducting post interview. All the interviews and audio recordings of the classes were transcribed verbatim. To establish inter-rater reliability of the data analysis, Pre-interview transcriptions were coded by three researchers independently. The rate of agreement on the coding results between three researchers was found as 85%. The results of this study showed that the participant teacher was knowledgeable about the goals and objectives of the science curriculum, students' prior knowledge, and what the students will learn in future regarding the liquid pressure topic.

PCK Change Over Time: Assessment of Within Field and Out-of-Field Teachers Across Content Disciplines

Charles Weeks, Arizona State University, cbweeks@asu.edu

Kathleen M. Hill, Arizona State University

ABSTRACT: Studies investigating the impact out-of-field teaching has on student achievement abound in the research literature. However the studies are inconsistent in defining out-of-field teaching. Furthermore very few studies profile how within field and out-of-field teaching affects the pedagogical practices to secondary science teachers. This study examines 130 beginning secondary science teachers over 5 years in order to understand how the pedagogical content knowledge (PCK) of within field teachers and out-of-field teachers changes over time. This multiple methods study used analysis of variance and semi-structured interviews to explore teacher content knowledge and pedagogical practices of within field and out-of-field teachers. The quantitative data analysis revealed no significant results, but the PCK scores converged over time regardless of whether a teacher taught within or out-of-field. Qualitative data reveals that methods course work positively impacts a teacher's PCK, and that out-of-field teachers seek content-specific professional development to enhance their own content knowledge.

Teacher Knowledge Versus Student Learning In Context-Based Chemistry Education: PCK-Related Analyses of Student Data

Ineke Henze-Rietveld, University of Technology Delft, ineke.henze@ziggo.nl

Erik Barendsen, Radboud University Nijmegen, ILS-RU

ABSTRACT: PCK has been a subject of research since the 1980s, and much has been written about its importance as a foundational knowledge base for science teaching. While many researchers believe that high levels of PCK will predict high levels of student achievement, little is known about the relationships between teachers' PCK and student learning, actually. This paper describes an in-depth case study using qualitative tools and methods to measure and to analyze teacher knowledge and student outcomes, in the context of a context-based chemistry lesson module. Results of the study show how the relationship between teacher PCK and student learning is dominated by the teacher's limited knowledge about his students' conceptual understanding, abilities, interest and need in the context of the lesson module. From the results, we worked out an approach to help teachers to develop their PCK of a specific subject through qualitative analyses, and reflection on their students' outcomes, with the ultimate goal to improve teacher knowledge and practice.

Strand 4: Science Teaching--Middle and High School (Grades 5-12): Characteristics and Strategies***Factors Affecting Teachers' Use of Inquiry and Questioning Skills***

8:30am-10:00am, Pelican Room

Presider: Christine Lotter, University of South Carolina***Effects of Level of Openness in Inquiry Teaching on Student Science Achievement and Attitudes: Evidence from Propensity Score Analysis with Pisa 2006 U.S. Data***

Feng Jiang, New York University, fj3@nyu.edu

William F. McComas, University of Arkansas

ABSTRACT: Gauging the effectiveness of specific teaching strategies remains a major topic of interest in science education. Inquiry teaching among others has been supported by extensive research and recommended by the National Science Education Standards. However, most of the empirical evidence in support was collected in research settings rather than in normal school environments. The purpose of the study reported here is to examine whether the successes of the teaching strategies, especially inquiry teaching, demonstrated in research settings can be transferred to normal school settings. With propensity score analysis, causal effect was estimated through observational data. By analyzing U.S. data from Programme for International Student Assessment (PISA) 2006, we found that inquiry teaching had a statistically significant impact on student science achievement and attitudes. Increasing the openness of inquiry teaching had significant positive effects on student science attitudes, but negative effect on student science achievement. It was suggested that more studies must be conducted to explain this finding in the future.

From Research to Practice: Fostering Pre-Service Science Teachers' Skills in Facilitating Effective Whole Class Discussions

Grant Williams, St. Thomas University, grantw@stu.ca

ABSTRACT: Many of the scientific topics that students encounter during their K-12 learning experience require them to grapple with very abstract and conceptually challenging ideas. This is because the phenomena involved may occur on scales that are either too large or too small to be readily observed, occur at rates that are either too fast or too slow to be witnessed, or occur in hidden or concealed situations. It is the job of classroom teachers to find ways to make these conceptually challenging scientific ideas accessible to students. Our research team has documented experienced teachers' abilities to facilitate engaging, inquiry-focused classroom discussions in order to foster students' abilities to construct, evaluate, and revise workable explanatory models for the concepts they are learning. For our team, the next step is applying the results of this research in the development of courses and learning modules in which pre-service teachers can acquire and practice these discussion-leading skills. This paper provides an overview of one of the classroom discourse investigations that our research team has carried out over the past few years and explains the 4 step process that we have developed to share what we are learning with pre-service science teachers.

Characterizing the Relationship Between High-Quality Task Setup and Teachers' Instructional Practices During Lessons Incorporating Scientific Practices

Carrie-Anne Sherwood, University of Michigan, casher@umich.edu

Savitha Moorthy, SRI International

Carrie A. Bemis, University of Colorado - Boulder

Christopher J. Harris, SRI International

ABSTRACT: Developing and using models to advance questions and explanations and to communicate ideas is a core scientific practice outlined in the Framework for K-12 Science Education (NRC, 2011). Although many teachers consider models useful for teaching science content, because of the "high demand" placed by modeling activities on them, they experience many challenges when attempting to enact the kind of reform-based instruction described in the Framework. We know teachers play a critical role in structuring and guiding students' understanding of science content and practices. However, there is little research that provides guidance on the instructional practices necessary for enacting the reform-based science outlined in the Framework, specifically those practices that may help students engage in authentic model-based inquiry. Our paper addresses the gap in research and practice by conceptualizing the relationship between features of classroom instruction and opportunities for participating in scientific modeling, focusing specifically on the setup phase of modeling activities. Our goals for this research are to (a) identify the key

features of setup for modeling activities, and (b) describe the relationship between features of task setup and teachers' instructional practices during other phases of the activity that scaffold students into model-based inquiry.

Impact of a Professional Development Program on Middle School Teachers' Inquiry Teaching Efficacy

Christine R. Lotter, University of South Carolina, lotter@mailbox.sc.edu

Stephen Thompson, University of South Carolina

Tammiee Dickenson, University of South Carolina

Grant Morgan, University of South Carolina

ABSTRACT: In order to effectively teach science as inquiry, teachers must have confidence in their own abilities to implement this approach. In this study, we used the Teaching Science as Inquiry (TSI; Smolleck & Yoder, 2008) instrument to examine changes in middle school science teachers' self-efficacy to teach science as inquiry after participating in a year-long professional development program. The TSI instrument was administered three times to 52 teacher participants: before and after a two-week summer institute and at the end of the academic year. Changes between time points of TSI administration were examined for personal self-efficacy and outcome expectation across five essential features of classroom inquiry. The results indicate the effectiveness of the professional development program at increasing participants' personal self-efficacy and outcome expectancy around inquiry-based science instruction. The professional development program which engaged teachers in inquiry instruction as students (content instruction) and provided time for teachers to enact inquiry with enrichment students and receive immediate feedback during group reflection sessions helped to increase the teachers' efficacy with inquiry instruction.

The Distinction Between Experimental and Historical Sciences as a Framework for Improving Classroom Inquiry

Ron Gray, Northern Arizona University, ron.gray@nau.edu

ABSTRACT: Inquiry experiences in secondary science classrooms are heavily weighted toward experimentation. We know, however, that many fields of science (e.g., evolutionary biology, cosmology, paleontology), while they may utilize experiments, are not justified by experimental methodologies. With the focus on experimentation in schools, these fields of science are often not included in the inquiry experiences our students receive. I propose utilizing the distinction between experimental and historical sciences as a way to improve the diversity of scientific methodologies represented in school science inquiry. This distinction can provide a framework for teachers to examine their own inquiry practices in light of the diverse methodologies present in science today.

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

Innovative Pedagogies for College Science Learning

8:30am-10:00am, Parrot Room

Investigating the Effect of Peer Teachers on Learning Environments in Large STEM Courses

Meredith T. Knight, Boston University, mtknight@bu.edu

Peter S. Garik, Boston University

Adam Moser, Boston University

Nic Hammond

Manher Jariwala, Boston University

Kathryn Spilios, Boston University

Angela Seliga, Boston University

Nick Gross, Boston University

Dan Dill, Boston University

Bennett Goldberg, Boston University

ABSTRACT: Peer learning can play an important role in the transformation of undergraduate and graduate science, technology, engineering and math (STEM) courses from passive to active learning environments. We present a mixed method study exploring the effect of two peer teaching programs at a research university: the Learning Assistant program and the Undergraduate Assistant program. Study results show benefits for the peer teachers and the undergraduates in the courses. Additionally, the peer teachers can provide an important feedback loop for professors, teaching fellows, and course administrators, thereby enabling pedagogical changes within the same semester. A more

intense approach to peer teacher training, ongoing support, and higher levels of assigned responsibility for peer teachers are associated with more positive outcomes for the peer teachers and STEM courses.

Impacting The Scientific Reasoning Abilities Of STEM Majors Through An Introductory Physics Laboratory Course

Kathleen M. Koenig, University of Cincinnati, kathy.koenig@uc.edu

Carol Fabby, University of Cincinnati

Larry Bortner, University of Cincinnati

ABSTRACT: Research indicates that students enter college with wide variations in scientific reasoning abilities, and that students with formal reasoning patterns are more proficient learners. Unfortunately, these reasoning abilities are not developed in the typical college course. As a result, we have previously designed and implemented a general science course built around a scientific reasoning (SR) framework that has demonstrated significant improvement in student SR abilities. Unfortunately, the course is a general science course that is not part of a STEM major's program of study. In an effort to better target the development of scientific reasoning abilities of STEM majors, we have applied the SR-focused curricular framework of our general science course to a traditionally-taught introductory physics lab course required of most STEM majors. The curricular revisions enable students to become more involved in the actual design of the experiments and place more emphasis on student use of evidence-based reasoning and written argumentation. The impact the changes have had on student development of scientific reasoning abilities will be discussed along with how the SR-focused curricular framework can be applied to other college level introductory science courses.

Promoting Scientific Literacy of Bio-Medical Engineering Students Via Reading Research Articles and Online Discussions

Yehudit J. Dori, Technion-Israel Institute of Technology, yjdori@technion.ac.il

Amira Allouche, Technion-Israel Institute of Technology

Hagit Yarden, Technion-Israel Institute of Technology

ABSTRACT: We investigated how reading research articles and online discussions affect biomedical engineering students' scientific literacy. About 100 students participated in one or two of the courses From Cell to Tissue and Tissue Engineering during the same academic year. The courses consisted of face to face lectures and weekly asynchronous forum discussions on reading scientific research articles. Research tools included pre- and post- case-based questionnaires and students' discourse in the forums. The questionnaires included open-ended questions focusing on three scientific literacy skills: question posing, identifying article structure, and experiment design. We found that student scientific literacy average gains in the first two skills were significantly positive. Moreover, taking the two courses in sequence yielded the best results in post average scores for the three skills examined, indicating the value of practicing these skills continuously. Qualitative analysis of students' discourse revealed similar progression. As discussions progressed, the scientific literacy level of questions and answers increased and some reached critical thinking. Our findings indicate that reading research articles can promote scientific literacy and may be achieved via designing hybrid courses.

Strand 6: Science Learning in Informal Contexts

Influence of Informal Learning Environments for Future Education and Careers

8:30am-10:00am, Sea Gull Room

Presider: Jennifer DeWitt

A Qualitative Examination of the Components of Family Encouragement Associated with Science Interest

Devashmita Chakraverty, University of Virginia, dc5na@virginia.edu

Robert H. Tai, University of Virginia

ABSTRACT: Family involvement plays an important role in informal science learning. Family encouragement is an important component of involvement and a predictor of positive educational outcomes. We use a combination of Cultural Capital Theory (CCT) and Social Cognitive Career Theory (SCCT) to understand how family encouragement inspires and sustains an early interest in science. Our research question is: "How do physical scientists make sense of the several aspects of family encouragement they perceive as being supportive that shape their own interest in science?" We use an interpretivist paradigm and analytic induction to qualitatively analyze 27 interviews (13 males, 14 females; 17

physicists, 10 chemists) on experiences related to family encouragement in motivating science pursuits. We found that family encouragement was provided through material support for learning (by working hands-on with materials, etc.), or through other means of support that did not include materials (for example, setting high learning expectations, creating positive home learning environment, and by providing verbal encouragement, advice, and counseling). In future, we need a focused examination of the components of family encouragement and the mechanisms by which they induce early science interest and selection of STEM careers.

Exploring Benefits of an International Science Olympiad: STEM Career Interests

Alpaslan Sahin, Texas A&M University, sahin_alpaslan@yahoo.com

Ozcan E. Akgun, Sakarya University, Turkey

Niyazi Erdogan, Texas A&M University

Mehmet Oren, Texas A&M University

Robert M. Capraro, Texas A&M University

Mary Margaret Capraro, Texas A&M University

ABSTRACT: As the global economic competition gets tougher, countries are interested in finding ways to increase the number of students pursuing STEM-related majors. This paper investigates the impacts of International science Olympiad's in its contestants' STEM career interests, decision, and 21st century workforce skills. Data were collected from the 2012 International Sustainable World Energy, Engineering, and Environment Project Olympiad. An online survey was administered to 500 high school participants from 65 countries with 172 completing the survey from 31 countries. Of these respondents 45% were male. Qualitative coding, descriptive, chi-square, t-statistics, and ANOVA statistics were used to analyze the data. Students reported that their science teachers (101), personal interests (77), and parents (64) had a greater influence on their STEM career interests. Chi-square analysis showed that there was a statistically significant relationship ($\chi^2=17.01$ $p<.05$) between students' personal STEM interests and the grade level when they participated in their first science fair. The study also revealed that participation in ISWEEP Olympiad reinforced most of the students' STEM career selection decisions. Last but not the least, participants believed that the ISWEEP Olympiad clearly increased their 21st century skills (communication, presentation, problem solving, collaboration, innovation, creativity, technology, critical thinking, life and career).

Critical Experiences that Fostered Choice of Geoscience Careers

Heather A. Pacheco, Arizona State University, pacheco.heather@gmail.com

Nicole D. LaDue, Michigan State University

ABSTRACT: This inductive study reports on critical experiences 37 geologists identified to be associated with their choice and participation in geosciences. The sample included 17 females and 20 males, upper undergraduates ($n=8$), and BS/BA, MS/MA and PhD geologists ($n=29$). Participant responses were gathered from one question, "How did you get interested in geology?", situated within a larger interview protocol for an expert-novice study in field geology. Researchers employed a grounded theory approach and developed a keyword-based coding rubric, which resulted in the emergence of three themes: Academic, People and Earth. Phrase-based analysis of participant responses established theme presence and frequencies within each participant response. A moderate correlation between gender and Academic theme was identified and subsequent t-test revealed that males mention Academic experiences more than females ($t(36) = 2.136$, $p=.04$). Findings confirm previous studies, identifying the important roles undergraduate introductory courses and faculty have in sparking interest and engagement in geosciences. Findings also illuminate the less well-described role that family and recreation-based informal learning plays in fostering interest and supporting choice of geoscience career path. Data suggest that informal learning experiences are a substantial component of choice and participation in the geosciences.

Science Research Experience in a Museum: Early Evidence for Impact on College Readiness for Science

Alix Cotumaccio, American Museum of Natural History

Preeti Gupta, American Museum of Natural History

Jacqueline DeLisi, Education Development Center, Inc

Hilleary Osheroff, American Museum of Natural History

ABSTRACT: This inductive study reports on critical experiences 37 geologists identified to be associated with their

choice and participation in geosciences. The sample included 17 females and 20 males, upper undergraduates ($n=8$), and BS/BA, MS/MA and PhD geologists ($n=29$). Participant responses were gathered from one question, "How did you get interested in geology?", situated within a larger interview protocol for an expert-novice study in field geology. Researchers employed a grounded theory approach and developed a keyword-based coding rubric, which resulted in the emergence of three themes: Academic, People and Earth. Phrase-based analysis of participant responses established theme presence and frequencies within each participant response. A moderate correlation between gender and Academic theme was identified and subsequent t-test revealed that males mention Academic experiences more than females ($t(36) = 2.136, p=.04$). Findings confirm previous studies, identifying the important roles undergraduate introductory courses and faculty have in sparking interest and engagement in geosciences. Findings also illuminate the less well-described role that family and recreation-based informal learning plays in fostering interest and supporting choice of geoscience career path. Data suggest that informal learning experiences are a substantial component of choice and participation in the geosciences.

The Long-Term Impact of a Summer Science Academy Experience

Karen B. Marshall, Washington Adventist University, kmarshall@wau.edu

ABSTRACT: The Long-Term Impact of a Summer Science Academy Experience This study reports the qualitative findings of the long-term impact of prolonged participant engagement in a summer science academy; and is a seven year follow-up of a study conducted within the model of out-of-school time (OST) learning. Studies within this model suggest that what is learned by students outside of the classroom may offer positive benefits. The goal of this study is to qualitatively assess the long-term impact of prolonged participant engagement in an OST science setting. Specifically, this paper seeks to (1) describe the long term impact of OST science experiences and (2) provide a qualitative assessment of the impact of this long-term OST science experience on in-school science performance, science experiences, and future career choice. The source of data for this research study was the transcriptions of the semi-structured interviews with the OST participants and their parents, and two focus groups of parents and participants. Preliminary findings from this study indicate that long-term OST science experiences have prolonged positive impacts on in-school science performance, science experiences, and the desire to pursue STEM as a future career goal.

Strand 7: Pre-service Science Teacher Education

Reflective Practices in Preservice Teacher Education

8:30am-10:00am, Río Mar Salon 9

Presider: Anna Lewis, University of South Florida

Quality of Pre-Service Teachers' Reflections in Their Portfolios and Their Perceived Reflections: Do They Intersect?

Feral Ogan-Bekiroglu, Marmara University, feralogan@yahoo.com

ABSTRACT: The purposes of this study were to determine reflective thinking in pre-service teachers' portfolios and to compare it with their perceived reflections. Data were collected through the participants' portfolios and interviews. Findings show that most of the pre-service teachers were expert reflectors and demonstrated evidence about their teaching skills in their portfolios. These findings indicate that the instructor's supervision and help throughout portfolio preparation might provide the pre-service teachers for creating more reflective portfolios. Results also present that the instructor's evaluation of the pre-service physics teachers' portfolios was compatible with their perceived reflections. They were aware of how much they could reflect their teaching profession to their portfolios. The critical thinking they gained during their preparation of portfolios might supply this consistency.

Use of Evidence and Standards-Based Reflection in Elementary Science Methods

Wendy P. Ruchti, Idaho State University College of Education, ruchwend@isu.edu

ABSTRACT: Standard-based and evidence-based criteria is now often used to evaluate teachers and teacher candidates. Therefore, preservice teachers must be able to reflect on how they make decisions about instruction and assessment, and must be able to make evidence-based claims and observations about their own teaching and about their students' learning. In this study, preservice elementary science teachers reflected on their teaching through prompts that required evidence of meeting the State Core Teaching Standards (CTS) for the course. The reflections were then coded into

categories to examine if a) the types of reflections changed over the teaching sequence, b) those reflections increased in sophistication over the teaching sequence, c) the role peer observation played in their level of reflection, and if d) the reflections showed changes in teaching. Analysis showed that meaningful, evidence-based reflection can facilitate change in teacher candidate's beliefs and practices and that scaffolding teacher reflection through guiding questions and feedback can deepen evidence-based reflection on practice and meaningful, evidence-based reflection can facilitate change in teacher candidate's beliefs and practices.

Activity System as a Lens to Understand Pre-Service Science Teacher Reflection

Anton Puvirajah, Georgia State University, apuvirajah@gsu.edu

Brett Criswell, Georgia State University

ABSTRACT: This paper presents a new lens for analyzing written reflections on personal teaching experience. The lens, which borrows heavily from Activity Theory, allows researchers and teacher educators to identify tensions, conflicts, and contradictions within teachers' written reflections as a means to help the participants identify, come to terms with and perhaps reconcile internal and external motives that drive their teaching. The paper provides a brief history of our work, definitions of terms, a description of the lens and a preview of how it might be implemented using two case studies. It also discusses implications of the findings for programs that place highly-qualified science teachers in high-needs schools, specifically issues which emerged from the two case studies relevant to these programs.

The Role of Video analysis in the Preparation of Reflective Science and Mathematics Teachers

Maria S. Rivera Maulucci, Barnard College, mriveram@barnard.edu

ABSTRACT: This study provides a cross-case analysis of the types of teacher reflections afforded within a video annotation tool, Video Interactions for Teaching and Learning (VITAL). In VITAL, preservice teachers view, analyze, and reflect on 15-minute lessons taught to their peers in a secondary methods class. They prepare reflective essays incorporating video clips to illustrate their claims. The analysis encompasses four cases, two science and two mathematics preservice teachers. The findings show that the teachers' general reflections captured their overarching beliefs about science or mathematics, effective teaching, multiculturalism, and the impact of VITAL on their learning. Implications and questions for further research are discussed.

Strand 7: Pre-service Science Teacher Education

Understanding and Developing Identities in Science Classrooms

8:30am-10:00am, Canary Room

President: Leigh A. Haefner

Storied Strategies: How Teacher Candidates' Storied Identities Leveraged their Teacher Learning

Amal Ibourk, Michigan State University, ibourkam@msu.edu

ABSTRACT: There is a growing corpus of literature that reveals the relationships among beginning teachers' identity work and their developing instructional practices in the classroom. While many of these studies have focused on experienced teachers, few have honed in on beginning teachers. In this study, I use a storied identity framework and narrative inquiry methodology to examine how four interns construct a teaching identity through their stories about their lead teaching and their previous experiences as science learners and people studying to be science teachers. These interns identified several "storied strategies" as supporting their teacher learning. Some of these strategies included: how they positioned themselves in regards to their students or tapping into the same frustration of learning as their students.

Exploring Pre-Candidate Teachers' Identity Formation

Jaime Sabel, University of Iowa, jaime-sabel@uiowa.edu

Nurcan Keles, University of Iowa

Soonhye Park, University of Iowa

Eulsun Seung, Indiana State University

ABSTRACT: This study investigated pre-candidate teachers' identity formation. The analysis was based on data collected on pre-candidate teachers who were taking an introductory course on teaching math and science that was developed to

recruit science, engineering, and math undergraduates into the teaching profession. As a part of the study, we developed a new framework for categorizing teacher identity and used that framework to examine the identity of pre-candidate teachers participating in the course. Our qualitative analysis has revealed some trends in pre-candidate teachers' identity and how that identity developed with participation in the course. Our results have implications for understanding what drives students to choose a path toward teaching so that we may determine the factors that may lead others toward the same path. Additionally, our work demonstrates the importance of teacher education programs to give pre-candidate teachers opportunities to experience the classroom and develop their identities.

Potential Science Teachers' Understanding of Students: Contrasts by Gender, Ethnicity, Language, and Major

Julie A. Bianchini, University of California, Santa Barbara, jbianchi@education.ucsb.edu

Hilary A. Dwyer, University of California, Santa Barbara

Ashley Iveland, University of California, Santa Barbara

Ethny A. Stewart, University of California, Santa Barbara

ABSTRACT: We investigated potential science teachers' views of students and student learning. Our 12 potential teacher participants were undergraduates enrolled in An Introduction to Secondary Science Teaching course. The course included both a weekly seminar and a 15-to-30 hour placement in a local secondary science classroom. We asked: How did our potential teacher participants describe secondary science students and their learning? How did their descriptions of students differ by their own gender, ethnicity, first language, and undergraduate major? To answer these questions, we collected four types of data: surveys, individual interviews, videotapes of seminar sessions, and completed course assignments. Findings from our qualitative analysis of data underscore the importance of encouraging undergraduates from diverse backgrounds to consider science teaching as a career. We conclude by discussing implications of our study for the recruitment and preparation of science teachers – for ways to continue to move science teacher education closer toward the goal of science for all students.

Blogging and the Development of Science Teacher Identity in Pre-Service Elementary Teachers

Steven D. Wall, UNC - Chapel Hill, sdwall@email.unc.edu

Janice L. Anderson, University of North Carolina at Chapel Hill

ABSTRACT: Research has shown that pre-service teachers (PSTs) have anxiety and a limited perception of their own ability to teach science in elementary classrooms. The pedagogical abilities necessary to be a successful science teacher are influenced by the teaching identities of PSTs including individual, contextual, and interactive factors. Accepting that science teaching is influenced by these factors, blogs generated through methods courses were analyzed to aid understanding of "what factors related to the use of blogging meaningfully influenced the PSTs' science teaching identity?" Data analysis demonstrated evidence of development in the science teaching identity of the elementary PSTs through the use of blogs. While blogging was initially disruptive, PSTs acknowledged one another through the use of blogs with comments serving as a mechanism for perceptual input and an outlet for newly formed ideas about science PCK.

Strand 8: In-service Science Teacher Education

Related Paper Set - Promoting Interdisciplinary Science Teaching and Learning in Schools

8:30am-10:00am, Río Mar Salon 4

President: Xiufeng Liu, State University Of New York At Buffalo (SUNY)

ABSTRACT: This related paper-set focuses on improving interdisciplinary scientific inquiry (ISI) teaching and learning in middle and secondary schools by supporting teachers through a Interdisciplinary Science and Engineering Partnership program between university and public schools. In this session we present five papers addressing different aspects of ISI. The first paper focuses on defining meanings of ISI from scientists' perspectives. The next three papers employ a theoretical framework of Pedagogical Content Knowledge and emphasize developing in-depth understanding of different aspects of PCK towards ISI instruction. Specifically, the second paper sheds light on how teachers develop an understanding of ISI and translates it into their curriculum decisions; the third paper deals with understanding teachers' pedagogical knowledge to implement ISI in the classroom; and the fourth paper focuses on overarching components of the PCK framework commonly known as orientations. Finally, the last paper, by employing a Communities of Practice (CoP) framework, analyzes how teachers and STEM graduate and undergraduate students develop partnerships to

improve ISI teaching and learning in the classroom. This paper set provides insights into ISI implementation in an era of next generation science standards. We make suggestions for implementing ISI in the classroom effectively for various stakeholders.

Understanding Meanings of Interdisciplinary Science Inquiry in an Era of Next Generation Science Standards
Xiufeng Liu, State University of New York At Buffalo (SUNY), xliu5@buffalo.edu

The Development of Interdisciplinary Inquiry Curriculum Knowledge
Erica L. Smith, State University of New York at Buffalo (SUNY), elsmith4@buffalo.edu

Examining Science Teacher's Development of Interdisciplinary Science Inquiry Pedagogical Knowledge and Practices
Bhawna Chowdhary, State University of New York at Buffalo (SUNY), bc@buffalo.edu

Understanding In-Service Teachers' Orientation Towards Interdisciplinary Science Inquiry
Vanashri Nargund-Joshi, State University of New York at Buffalo (SUNY), vanashri@buffalo.edu

STEM Students as Facilitators of Interdisciplinary Science Inquiry Teaching and Learning
Brooke Grant, State University of New York at Buffalo (SUNY), bgrant@buffalo.edu

Strand 9: Reflective Practice

Way of Knowing Science

8:30am-10:00am, Heron Room

President: Nancy G. Caukin

The Will of the Ancestors: A Collaborative Elementary Science Curriculum Design Initiative

Irasema Ortega, University of Alaska-Anchorage, iortega2@uaa.alaska.edu

Naqucin Ayuluk, Kashunamiut School District

Apala Ayuluk, Kashunamiut School District

Cathy Coulter, University of Alaska, Anchorage

Rebecca Nayamin, Kashunamiut School District

ABSTRACT: Currently there is a need to design science curriculum that honors Indigenous knowledge systems while simultaneously presenting Western knowledge systems. Rural schools across Alaska stand to benefit from an increase alignment between science curriculum implemented elementary schools and the content and practices taught in teacher preservice programs that aim to prepare Alaska Native teachers. This manuscript describes in detail a science curriculum writing partnership between Alaska Native elementary teachers and university professors. We present an account of stage one of a two-stage partnership to design culturally responsive curriculum for grades K-3. Through the lens of Cultural Historical Activity Theory we analyze the first stage of our cooperation effort aimed at creating a curriculum framework and science lessons. Data such as personal reflections by the participants, classroom observations and student work samples help reconstruct a narrative that illuminates a transformative and collaborative effort for designing and implementing science curriculum that responds to the needs, traditions and values of Alaska Native students and their teachers.

Crossing Through Nepantla on the Way to Science Learning and Teaching

Deborah Roberts-Harris, University of New Mexico, drober02@unm.edu

Jean Rockford Aguilar-Valdez, University of North Carolina, Greensboro

Carlos A. LopezLeiva, University of New Mexico

Diane Torres-Velasquez, University of New Mexico

Gilberto Lobo, Albuquerque Public Schools

Carol Westby, University of New Mexico

ABSTRACT: We present a reflective study by a group of science educators, which explores the complexities of teaching

science with Latina/o students in various contexts including dual language settings and where students are actively engaged in code-switching between students' home language and culture, and scientific concepts and experiments. The reflective practices of various educators at various levels of science education are presented as a journey for transformation within the practice of science education for Latina/o students. We utilize ethnographic and narrative examples across grade levels, including dialogic interactions with students, classroom observations, and student work samples to argue that Latina/o students appropriate the dialogue and tools of science as an element of their biculturality or multiculturalism as they straddle many identities in Spanish, English, Latina/o home culture, school culture, and the world of scientific dialogue and content. We present a transformative notion of Latina/o science learning as "living on the bridges" of many dialogic and cultural practices, or "Nepantla" (Anzaldúa & Keating, 2002), where Latina/o students dwell in the in-between spaces, and where transformations and healing are possible. We reflect on our own roles as Nepantlera/os, who guide students and ourselves through Nepantla on the way to science teaching and learning.

A Case Study on In-Service Teachers' NOS Views and NOS Teaching in Turkish Context

Seda Cavus, Gazi University

Jale Cakiroglu, Middle East Technical University

Nihal Dogan, Abant Izzet Baysal University

Kader Bilican, Ataturk University

ABSTRACT: The purpose of this study was to explore the impact of intensive nature of science summer workshop on science teachers' views of NOS and their instructional practices. Each NOS aspect was introduced to the participants explicitly through activities followed by group discussions on reflected NOS aspects through the activities at one week intensive summer professional development program. Through the following semester teachers' instruction at class were observed for five times. Data were collected through Views of Nature of Science Questionnaire-Form VNOS-C, interviews and classroom observations. Data analysis revealed some improvements on NOS views and observed efforts to include NOS into their teaching explicitly. The nature of teachers' NOS practice was discussed and implications for teacher education were given in full paper.

Promoting College Students' Argumentation Skills and NOS Understanding Through Class Debate

Jianlan Wang, Indiana University, hurricane355wjl@gmail.com

Gayle A. Buck, Indiana University

ABSTRACT: Argumentation and the nature of science (NOS) are two important concepts in science education. In this project, we were seeking to depict a clearer picture of the relationship between argumentation skills and NOS understandings. Meanwhile, we were interested in whether the pedagogical strategy, class debate over a controversial topic, could promote both of the academic capacities. In a semester-long study, we recorded 28 college students' arguments in their class discussion and paper work. The VNOS-C survey was taken 3 times, which were at the beginning of the project, before the debate over the nature of light, and at the end of the project. The result shows that the class-debate activity could help students achieve high-level argumentation skills and sophisticated NOS knowledge, and argumentation is highly correlated with some aspects of NOS, including science being empirically based, various methods in doing science, science being creative and imaginative, and science being tentative. Moreover, this action research suggests a fairer and more reliable model in assessing argumentation skills. We suggest that rebuttal is not the only characteristics of sophisticated argumentation. There should be a chance for learners to synthesize a variety of evidence and combine multiple perspectives to draw a conclusion.

Strand 10: Curriculum, Evaluation, and Assessment***Symposium - Using the FCI to Conceptualize Learning Progressions of the Force Concept: Content and Measurement Challenges***

8:30am-10:00am, El Morro 1 & 2

Presider: Gavin W. Fulmer, National Institute of Education**Discussant:** David L. Fortus, Weizmann Institute of Science***Presenters:***

Gavin W. Fulmer, National Institute of Education, gavin.fulmer@nie.edu.sg

Irene Neumann, Ruhr-Universität Bochum

Ling L. Liang, La Salle University

Knut Neumann, Leibniz Institute for Science Education (IPN) Kiel

Jim E. Minstrell, FACET Innovations

ABSTRACT: Learning progressions (LPs) emphasize the relationships among students' concepts across years of schooling. LPs hold great promise in the coordination of instruction, curriculum development, and assessment. In parallel with LPs' growing importance, it is also essential to continue exploring approaches for critically analyzing, validating, and refining LPs and related assessments. An important, unanswered question in LP literature is how aspects of a scientific concept are to be articulated in single or multiple LPs. In this symposium, we discuss perspectives on specifying and measuring aspects of concepts in LPs. We build from a specific focus on force and motion. We begin with challenges in matching a proposed LP on force and motion (LP-FM) with the Force Concept Inventory (FCI), an established instrument that addresses many of the same aspects of the force concept. In response to these challenges, we propose a new LP for Newton's Third Law (LP-N3), and present results on the validity of the LP-N3. We will conclude with a general discussion of broader methodological issues in LP-based measurement. Discussion will focus on the implications for how LPs are articulated and validated, and the approaches to creating or adapting assessments that align with LPs.

Strand 10: Curriculum, Evaluation, and Assessment***Research on Teachers' Instructional Practices and Learning Communities***

8:30am-10:00am, Río Mar Salon 2

Presider: Ann E. Rivet, Teachers College***Professional Learning Communities (PLCs) a Means for Science Curriculum Change***

Christi L. Browne, Columbia Teachers College, christibrowne@gmail.com

Ann E. Rivet, Teachers College Columbia University

ABSTRACT: The challenge of school-based science curriculum and educational reform is often presented to teachers and school departments, not necessarily prepared for the complexity of considerations that change movements require. The development of a Professional Learning Community (PLC) may provide the necessary tools to foster sustainable school-based curriculum change. This piloted study involved the development and evolution of a science department PLC. The research collected was qualitative in nature and deepened by quantitative analysis and a transformative mixed model case study was chosen to guide investigation, data collection, and analysis. Data includes detailed researcher field notes, audio-taped and transcribed PLC meetings, participant pre- and post- Lickert scale surveys, open-ended reflection questions, and all artifacts resulting from the PLC meetings (emails, questions, handouts, presentations, etc). The data analysis includes both pre-determined and emerging themes, coding using the 5 dimensions of PLCs, multi-source descriptive and analytical statistic analysis, and textual coding analysis. The mixed methods approached allowed for triangulation, convergence, and expansion. Findings document the essential development steps, the increased frequency of the 5 essential dimensions of successful PLCs, and influences the PLC had on a middle school science departments' progression through school-based science curriculum change.

Looking at Quality of Instruction and Students' Performance: Where do the Teachers' Questions Come From?

Maria Araceli Ruiz-Primo, University of Colorado Denver, maria.ruiz-primo@ucdenver.edu

Min Li, University of Washington

Erich Birby, University of Colorado Denver
Ashley Edwards, University of Colorado Denver
Ting Wang, University of Washington
Derek Yiran Zhao, University of Washington
Michael Giamellaro, University of Colorado Denver

ABSTRACT: The paper proposed focuses on assessing transfer of learning by developing items at different distances from the intended science modules for which they are developed. At a close level, assessments are curriculum-sensitive; they are close to the content and activities of the curriculum. At a proximal level, assessments consider the knowledge and skills relevant to the curriculum, but context (e.g., scenarios) differs from the one studied in the module. At a distal level, assessments are based on state or national standards. Assessments with items at different distances have been named, instructionally sensitive assessments (ISAs). In the parent project we have studied an approach to developing ISAs. The paper proposed is a validity study conducted to support the second interpretative argument of the assessments developed: ISAs provide information about the quality of instruction students received on the curriculum materials at hand. The study focuses on one aspect of curriculum materials and their implementation, questions. It is guided by the following inquiries: What module questions are suggested in the curriculum materials and what are their characteristics? How closely do teachers implement the questions suggested in the curriculum materials? Is there any relation between the questioning practices and students' learning?

Use of Social Network Analysis to Study Teacher Communities in Design Based Implementation Research

Bill Zoellick, Schoodic Education & Research Center Institute, bill@sercinstitute.org
Jonathan Shemwell, University of Maine
Daniel K. Capps, University of Maine
Shirly Avargil, University of Maine

ABSTRACT: It is generally accepted that success in implementing new approaches to science education is affected by the network of informal collegial relationships within which teachers work. Consequently, science education reform initiatives often seek to use social network analysis (SNA) to study the structure of such networks. Many of these initiatives are engaged in "design based implementation research" (DBIR), where the focus is on improving implementation effectiveness. In such research, changes in the size and makeup of the teacher network are often part of the design model and a focus of the research. But changing network extent creates methodological issues that potentially limit the ability to use SNA to study network structure. Such methodological constraints have been encountered by other researchers and were a topic of discussion in a recent NSF-sponsored conference on applications of SNA in education research. This paper shows how maintaining a focus on the model underlying a project can help in resolving what might otherwise appear to be insurmountable issues in using SNA within a science education DBIR project. Using examples drawn from a large rural science education initiative, the paper describes methodological approaches that can be used in other implementation research efforts.

Video Analysis of Science Teaching: Developing a Shared "Words-To-Images" Analytical Tool

Molly Stuhlsatz, BSCS, mstuhlsatz@bscs.org
April L. Gardner, BSCS
Kathleen J. Roth, BSCS

ABSTRACT: The science education research community has no agreed upon "words-to-images" language for describing science teaching. Our findings are difficult to interpret because similar words are used (e.g., "inquiry practices", "coherence," "model-based reasoning") but they are not anchored to shared visual images of teaching in action. This exploratory study addressed this problem by engaging diverse science educators in developing a consensus, image-based language for describing one aspect of science teaching – coherence. A panel of 10 experts with different perspectives collaborated to develop a consensus language for describing features of coherence in science lesson videos. This words-to-images online Guide to Video Analysis of Science Teaching: Coherence was then field tested by 20 science educators. The results show high interest in this consensus-building approach, surprisingly high levels of interrater agreement, and the need for further work. This study proposes a unique approach to addressing a critical problem in research on science teaching that breaks down the "silo" approach to science education research and demonstrates the feasibility of developing consensus analytical tools that can be used widely. By providing video images

linked to research language, this tool will improve both the quality of science education research and the translation of research to practice.

Strand 11: Cultural, Social, and Gender Issues

Related Paper Set - Attending to the Intellectual Repertoires of Diverse Teachers and Students in Teacher Learning

8:30am-10:00am, Río Mar Salon 8

Discussant: Maria Varelas, University of Illinois at Chicago

ABSTRACT: This related paper set explores learning opportunities for teachers that draw attention to issues of culture, race, and language in science education as critical to the creation of high quality educational spaces for all teachers and students. The first paper is on teacher learning reports on findings from a study that aimed to operationalize the concepts of funds of knowledge and third space in a pre-service secondary science education course. The goal was to enable teachers to develop specific instructional practices that would support students' thinking and ways of sense-making. The second paper uses counternarrative to chronicle the shifting journey of a teacher of color as she navigated a contested, racialized teacher education program and into a full time position in a classroom as an elementary teacher of science. The third paper reports on results from a pre/post transcript-based interview task designed to assess teachers' attunement to students' heterogeneous sense-making repertoires following the teachers' participation in an in-service seminar focused on learning in and from classroom practice. The fourth paper explores how teacher researchers in a science-literacy project made sense of their science teaching and their students' meaning making repertoires across three years of iterative curriculum development and implementation.

Developing Ambitious and Culturally Responsive Science Teaching Practices with Pre-Service Teachers

Gale A. Seiler, McGill University, gale.seiler@mcgill.ca

Speaking Up and Making Sense of Who I Am

Felicia M. Mensah, Teachers College, Columbia University, moorefe@tc.columbia.edu

Getting to the Root: Assessing Teachers' Understandings of Classroom Discourse in a Practice-Based Inquiry Seminar

Eli Tucker-Raymond, TERC, eli_tucker-raymond@terc.edu

Ann S. Rosebery, TERC

Beth Warren, TERC

Christopher G. Wright, TERC

Folashade Cromwell Solomon, TERC

Integrating Science and Literacy in Urban Elementary Classrooms: Teachers and Children Making Meaning

Justine M. Kane, Wayne State University, jmkane@wayne.edu

Strand 14: Environmental Education

Preservice Teachers' Perceptions in Teaching and Knowing about the Environment

8:30am-10:00am, Río Mar Salon 7

Presenter: Line A. Saint-Hilaire

Is Science Inherently Green? Improving Preservice Teacher Attitudes Towards Science Doesn't Change their Environmental Worldview.

Bryan Nichols, University of South Florida, bryanhnichols@gmail.com

ABSTRACT: Preservice teachers were assessed for their views on science education (VOSE: Chen, 2006) and their environmental worldview (NEP: Dunlap, Van Liere, Mertig, & Jones, 2000) at the beginning and end of a required science methods course (6 terms, same instructor). Total scores the VOSE changed significantly ($t(703)=3.04$, $p=.002$) by the end of the course, but NEP scores did not ($t(583)=-1.57$, $p=0.12$), despite the instructor's background in ecology and environmental education. This discrepancy suggests that attitudes toward science education are not directly associated

with environmental attitudes, and can improve independently. This has implications for the relevance of many types of science education, particularly in light of the environmental and climate-related challenges that new teachers and their students will face. However, explicitly addressing environmental issues, even in a modular way (ie., adding a homework assignment on the Story of Stuff), did change post-test NEP scores ($p=.04$, $n=221$), suggesting that the thoughtful integration of environmental issues into science methods courses has the potential to improve teacher attitudes in both dimensions. The presentation will include tips and suggestions on using or adapting each of the instruments in your own work.

A Sociocultural, Regional Comparison: Pre-Service Elementary Teachers' Outdoor Experiences

Patricia Patrick, Texas Tech University, trish.patrick@ttu.edu

Erica Blatt, College of Staten Island

ABSTRACT: In his recent book, *Last Child in the Woods* (2005), Richard Louv makes the argument that young people need to spend time in nature for various reasons, including identity development, emotional health, conservation behavior, and improved student educational outcomes. Louv (2005) also describes the current generation of technology-savvy youth as growing up unexposed to the natural environment around them. Utilizing the theory of participatory appropriation (Rogoff, 1995) this study defines how pre-service teachers' past experiences contribute to the present and shape their ideas about their future teaching. In relation to teacher education, it is unclear if current pre-service elementary teachers have had experiences in the outdoors and if these experiences have shaped their current ideas about the environment and teaching. This study investigates the outdoor experiences of undergraduate students in pre-service elementary teacher programs at urban colleges in the Northeastern and Southeastern United States. The participants included 40 pre-service teachers enrolled in science methods courses and were asked to write a response essay. The findings reveal a surprising number of positive outdoor youth and adult experiences and the value pre-service teachers place on exposing their own students to nature and the outdoors.

A Sociocultural Analysis of Pre-Service Elementary Teachers' Perceived Obstacles in Taking Students Outdoors

Erica Blatt, College of Staten Island, erica.blatt@csi.cuny.edu

ABSTRACT: This research, the second part of a larger qualitative study, investigates the obstacles pre-service elementary teachers perceive they will face in taking their students outdoors. A qualitative methodology based on interview methods, combined with a sociocultural focus, is utilized in exploring both the social and cultural constraints and affordances that these pre-service teachers believe they will experience in both taking their students outdoors and teaching science at the elementary level. The participants include 10 undergraduate pre-service teachers (ages 21-30), who were previously enrolled in Part 1 of the study after completing a Methods of Teaching Science in Elementary Education course at a public university in New York City. The study results reveal that this set of pre-service elementary teachers is aware of many of the obstacles they will face in taking their students outdoors, and teaching science in general, as they describe their concerns related to school administration, testing, standards, and the narrowing of the curriculum. Students also discuss ways in which these obstacles can be overcome, for example by incorporating nature-based activities into other subject areas. The results raise important questions about what value our educational system is placing on nature-based education, and science education, in general.

Strand 15: Policy

Elementary Science Teaching: Intersection of Policy & Practice

8:30am-10:00am, Río Mar Salon 10

Presenter: Sarah J. Carrier

The Impact of the Principal in the Implementation of Promoting Science Among English Language Learners

Resma N. Chamadia, Corona Norco USD, drresma@gmail.com

Kimberly S. Lanier, University of Miami

Amy Cox-Petersen, California State University, Fullerton

ABSTRACT: This study sought to determine the impact of the school principal during the implementation of Promoting

Science among English language Learners (P-SELL), a professional development intervention. The intervention was implemented in a large, urban school district that is multicultural, multiethnic, and multilingual. Implemented in six elementary schools, the participants included all principals, and the third, fourth and fifth grade science teachers. Utilizing a case-study approach, interview and survey data were used to collect data over the three years of implementation. A multi-case analysis model was employed to identify themes and patterns across cases. The findings indicate that principals play a key role in the change process. In this influential role, principals must: (1) guide the change process by sharing a vision and mission for the school, (2) build leadership capacity and share the role of decision making, (3) know how to balance people and programs, (4) create time to cultivate nurturing relationships, (5) offer freedom so teachers can develop and learn from each other, and (6) provide resources in the form of materials that can enhance instruction. These are critical if change is to have a lasting effect on the science program and the scientific literacy of our children.

Principal Support: Does it Influence Teachers' Science Instructional Practices During a Science Intervention?

Kimberly S. Lanier, University of Miami, k.lanier@miami.edu

Marietta Suarez, University of Miami

Soyeon Ahn, University of Miami

Okhee Lee, New York University

Todd L. Hutner, The University of Texas at Austin

ABSTRACT: This study examined the affect of principal instructional support on teachers' science practices. As part of a three-year professional development intervention, the study examined the intervention's effect on teachers' perceptions after their first-year of participation. The study involved 117 fifth grade teachers from 32 schools participating in the intervention and 107 fifth grade teachers from 32 control schools. The teachers completed a questionnaire in the beginning and at the end of the first year of the three-year intervention. From the questionnaire a principal support scale was developed to determine the effect on teacher practice. Through the use of quantitative and qualitative methodology, the findings indicate that as principal support of science instruction increases, teacher use of reform-based practice increases.

An Exploration of Science Teaching Practices Among Elementary Teachers Implementing Three Comprehensive School Reform Models

Jessica Gale, Georgia Institute of Technology - CEISMC, jessica.gale@ceismc.gatech.edu

ABSTRACT: Although the marginalization of science at the elementary level likely results from a complex set of interrelated factors, recent scholarship suggests that tensions exist between science education reform and the reform agendas that predominate in urban school districts. This study examined the relationship between the implementation of comprehensive school reform models, one widespread approach to urban school reform, and elementary science teaching practices. Utilizing survey data, focus groups, interviews, and classroom observations, this study documents the observed and reported science teaching practices of elementary teachers implementing three comprehensive school reform models: Core Knowledge, Direct Instruction, International Baccalaureate. Findings suggest variation in the degree to which teachers engaged in reform oriented science teaching practices across reform models. Specifically, practices that tended to vary across reform models were 1) the integration of science with other subject areas, 2) the degree to which science is student versus teacher centered, and 3) the extent to which science instruction focuses on traditional science learning goals such as mastering "science facts" and vocabulary versus attaining conceptual understanding.

School Organization Factors Associated with Reducing Science Achievement Inequities: Instrument Development to Support Large-Scale Comparisons

Regina Suriel, University of Connecticut, regina.suriel@uconn.edu

John Settlage, University of Connecticut

ABSTRACT: Although uncommon within science education, large-scale studies of reading and mathematics offer valuable insights into school reform. More specifically, informed by organizational studies, school leadership and additional schoolwide factors, we direct our attention at science achievement using an ecological perspective. Drawing on other researchers' success with longitudinal, district-wide research of Chicago schools, our multi-year project makes use mixed methods to uncover explanations for disparate performance across schools by their culturally and

linguistically diverse student populations. Here we report on the results of our instrument development process. Using a rigorous validation process followed by factor analysis, we have developed a teacher survey with strong reliability and groups responses into 9 distinct organizational categories. Factors include: teacher-to-teacher trust, science instructional leadership, family involvement, workplace satisfaction, and commitments to equity. The process and results of the instrument's development will be the focus of the presentation as well as discussion about various practical and research purposes to which this tool can now be applied.

Concurrent Session #4**10:15am – 11:45am****Awards Committee Sponsored Session*****Symposium - NARST Outstanding Doctoral Research Award***

10:15am-11:45am, El Morro 1 and 2

Presiders:

Judith Lederman, Illinois Institute of Technology, ledermanj@iit.edu

Meg Blanchard, North Carolina State University

ABSTRACT: Interested in learning more about the NARST Outstanding Doctoral Research Award? Who is eligible for this award? What materials are needed for the application? In this informal session, members of the selection committee will share information about the award, including the details of the application process and the criteria for selection. We will review the mostly commonly asked questions related to the application process, and be available to answer any other questions.

Equity and Ethics Committee Sponsored Session***Symposium - New Scholar Symposium: STEM Education - Social, Cultural, Epistemological, and Pedagogical Issues***

10:15am-11:45am, Caribbean Salon 1

Presiders:

Felicia Moore Mensah, Teachers College

Maria S. Rivera Maulucci, Barnard College

Lisa Martin-Hansen, Georgia State University

Geeta Varma, University of Colorado, Denver

Deb Morrision, University of Colorado, Boulder

Scholars:

Nancy Albrecht, University of Minnesota-Twin Cities

Geraldine L. Cochran, Florida International University

David T. Brookes, Florida International University

Laird H. Kramer, Florida International University

Eric Brewe, Florida International University

Yeni Violeta Garcia, University of Northern Colorado

Salina Gray, Stanford University

Mary H. Hoelscher, University of Minnesota

Natasha Johnson, University of Georgia

Tamecia Jones, Purdue University

Andrea Motto, Virginia Tech

Alexis Patterson, Stanford University

Cassie Quigley, Clemson University

Patrick Womac, Clemson University

Kristina Maruyama Tank, University of Minnesota

Alicia M. Trotman, Mercy College

ABSTRACT: Recipients of the Jhumki Basu Scholars Award present compelling investigations in science education research. The scholars bring diverse perspectives that have shaped science education from various contexts.

Strand 1: Science Learning, Understanding and Conceptual Change***Disciplinary Features and Challenges in Biology Education***

10:15am-11:45am, Río Mar Salon 1

Presider: Michelle P. Cook*Elementary Students' Explanation Construction of Seed Structure and Function: A Concurrent Mixed Methods Study*

Laura Zangori, University of Iowa , laura-zangori@uiowa.edu

Cory T. Forbes, University of Iowa

Mandy Biggers, University of Iowa

ABSTRACT: Elementary science standards (K – 4) emphasize that students should develop conceptual understanding of characteristics and life cycles of plants (NRC, 2012), yet few studies have focused on early learners' reasoning about plant biology, particularly seed structure and function. The purpose of this study is to examine third grade students' (n=59) explanation construction about seed structure and function within a reform-oriented, kit-based elementary science unit. We purposively sampled three elementary teachers who enacted this set of curriculum materials over the same three month period of time for this study. Data collection and analysis focused on students' written artifacts (n = 177) and episodes of teacher-student exchanges for each enacted lesson (n = 9). We used the [instrument name withheld for blind review] (Authors, in press) to quantitatively score and qualitatively characterize classroom discourse and students' written explanations. Our findings indicate that there was wide variation in the quality and accuracy of students' explanations about seed structure and function, even when students' explanations were grounded in evidence. Variation in instructional scaffolding provided to support students' explanation construction was consistent with differences observed in students' explanations across classes.

Exploring Younger Students' Understanding of Biological Inheritance

Joi Merritt, Michigan State University, jmerritt@msu.edu

Kyle Erlenbeck, Michigan State University

Michelle Williams, Michigan State University

ABSTRACT: There is a need for research related to younger students' understanding of inheritance (Duncan, Rogat, & Yarden, 2009). This study explores fifth grade students' understanding of biological inheritance before and after experiencing the technology-based WISE Case of Audrey module, which was designed to help students understand inheritance and how the environment can affect trait inheritance. Five teachers and their 209 fifth-grade students at the two upper-elementary school located in a Midwestern suburban school district participated in the study. Identical pre/posttests comprised of 22 items were administered to all fifth-grade students. Overall, students participating in the fifth grade heredity curriculum experienced large and significant learning gains from pretest to posttest. Further analyses of students' understanding prior to instruction indicate that students recognize in organisms, both parents contribute genetic information to offspring, but they associate visible traits with the parent that visibly expresses that trait. After instruction, most students recognized that both parents contribute genetic information to offspring, that traits are passed down through generations and that traits that aren't phenotypically expressed are still present and can be inherited. This study reveals younger students' understanding of biological inheritance and has implications for the development of future heredity curricula.

Informing a Learning Progression in Genetics: Which Should be Taught First Mendel or DNA?

Ravit G. Duncan, Rutgers University, ravit.duncan@gse.rutgers.edu

Moraima Castro, Rutgers University

Madhavi Bhojraj, Rutgers University

ABSTRACT: The recently released Framework for Science Education and the Next Generation Science Standards emphasize learning progressions (LPs) that support conceptual coherence and the gradual building of knowledge over time. In the domain of genetics there are two independently developed alternative LPs. The discrepancies between the learning paths proposed by the two progressions stem from gaps in the research base, particularly regarding students' ability to reason about molecular genetics concepts and to relate them to concepts in classical genetics. In essence the difference between the two progressions hinges on conjectures regarding the accessibility of classical versus molecular genetics and the conceptual dependencies between them. To address the question of whether learning one aspect of

genetics, classical or molecular, supports the learning of the other, we analyzed correlations between students' test scores on item subsets for classical and molecular genetics on written pre-post assessments. We found that students' pretest scores on the molecular items were moderately correlated to their posttest scores on the classical genetics item set (but not the other way around). This suggests that molecular genetics understandings may bootstrap the learning of classical genetics, and implies that (in contrast to prevalent practice) molecular genetics should be taught before classical genetics.

The Effect of College Major and Biological Knowledge on Students' Acceptance of Common Health Misconceptions

Alla Keselman, National Library of Medicine, keselmana@mail.nih.gov

Savreen Hundal, Center for Public Service Communication

Yulia Chentsova-Dutton, Georgetown University

Jay A. Edelman, City College of New York

ABSTRACT: As educators, we are interested in delivering science education that all students see as relevant, and that provides useful knowledge and skills for their well-being. This study is concerned with how formal biological knowledge impacts thinking about health-related issues that are relevant to daily living, investigating the relationship among college major, types of knowledge used in reasoning about common health beliefs, and judgment accuracy about those beliefs. Seventy four college students, advanced biology and non-science majors, indicated their agreement or disagreement with commonly believed, but often inaccurate health facts, and explain their reasoning. The analysis distinguishes between advanced biological, simple (superficial) biological, experiential, and culture/media-based reasoning about the health facts. Findings indicate that while there is no direct relationship between participants' college major and judgment accuracy, biology major increases reliance on advanced biological reasoning, which mediates judgment accuracy. The findings also suggest that while some health-situations may benefit from reasonably deep biological knowledge, many are too complex for conclusive biology-based judgments by lay people.

Strand 2: Science Learning: Contexts, Characteristics and Interactions

Symposium - Reading, Writing, and Communicating Science: Exploring the Intersections of Science and Literacy Education

10:15am-11:45am, Caribbean Salon 2

President: Leah A. Bricker, University of Michigan, lbricker@umich.edu

Discussant: Kim Gomez, University of California Los Angeles

Presenters:

Megan Bang, University of Washington

Jasmine Alfonso, Northwestern University

Lori Faber, Northwestern University

Ananda Marin, Northwestern University

Michael Marin, American Indian Center of Chicago

Sandra Waxman, Northwestern University

Jennifer Woodring, Northwestern University

Douglas Medin, Northwestern University

Tiffany R. Lee, Teaching Channel

Katie Van Horne, University of Washington

Philip Bell, University of Washington

Elaine Klein, University of Washington

Joseph L. Polman, University of Colorado Boulder

Cathy Farrar, Rockwood School District

Jennifer M.G. Hope, McKendree University

ABSTRACT: The purpose of this symposium is to explore the intersections of literacy and science ideas, practices, and common themes. The Framework for K-12 Science Education and the forthcoming Next Generation Science Standards place unprecedented focus on specific scientific practices, such as analyzing and interpreting data, constructing explanations and engaging in evidence-based argumentation, and obtaining, critiquing, and communicating information.

Many, if not all, of these practices demand that students effectively utilize the languages of the sciences. The analyses described in this proposal involve children and youth, ranging from pre-kindergarteners to high schoolers, who participate in activities taking place in contexts in- and out-of-school. Constructs utilized in these analyses include multiliteracies, meanings of “pre-literate,” psychological distance and perspective taking, symbol systems in the sciences, the roles of language and other symbol systems in learning, and science journalism as science literacy. In this symposium, we argue that no exploration of “The S in STEM Education” is complete without analyses of the roles that language, literacy, and text play in learning about and participating in scientific work.

Strand 3: Science Teaching--Primary School (Grades preK-6): Characteristics and Strategies
Engineering and Careers in Elementary Science

10:15am-11:45am, Río Mar Salon 3

Presider: Deborah C. Smith, Pennsylvania State University

Exploring Engineering with Diverse Learners: A Mixed Methods Study Examining Variables Affecting Learning and Attitudes

Maya Israel, University of Illinois at Urbana Champaign, misrael@illinois.edu

Shelly Micham, University of Cincinnati

Kathie Maynard, University of Cincinnati

ABSTRACT: Engineering design offers promise for fostering science literacy for all students, including underrepresented populations. This presentation highlights findings from a study examining the impact of engineering education on 5th grade students’ engineering content knowledge and attitudes toward science and engineering. Four teachers and 117 students participated. Students were coded into three groups (struggling, average, and high-achieving) based on teacher input and qualification for special education and/or gifted services. All participants used the Engineering is Elementary curriculum related to electricity and circuits. Quantitative data revealed that students in all subgroups improved in both content knowledge and attitudes about science and engineering. Group differences were found on content pre- and posttest between struggling learners and their peers. Differences in attitudes existed at pretest, with struggling learners scoring lower on the attitude measures than students classified as average or high achieving. These differences dissipated after the engineering instruction, showing that struggling learners improved their attitude towards science and engineering to the level of their peers. Differences emerged between the four teachers, with students in one teacher’s group out-performing the other students. Qualitative data revealed this teacher included more modeling, connections to students’ lives, and explicit connections between engineering and scientific literacy.

Engineering Design as an Instructional Strategy in the Elementary Science Classroom

Kathie Maynard, University Of Cincinnati, kathie.maynard@uc.edu

Shelly Micham, University of Cincinnati

ABSTRACT: The current U.S. educational agenda positions scientific literacy as critical for individual success in the 21st Century. Engineering design integrated into the science classroom is a new instructional strategy being suggested to meet the demand for the scientific literacy of K-12 students. There is little educational research on teachers’ enactment of engineering design in the science classroom. The research questions answered in this qualitative research study were: What does engineering design, used as an instructional strategy, look like in the 5th grade science classroom in terms of: 1) How do teachers make explicit connections to science content during engineering design activities; 2) How do teachers make the practices of science and engineering design explicit for students; and 3) How do teachers deal with and support the “open-endedness” of engineering design activities? This study was situated in a high-needs suburban elementary school. The findings showed that teachers generally lacked explicitness in science content connections as well as science & engineering practices. The most typical connection to science made by the teachers was through the use of science vocabulary. Results revealed many missed opportunities to use the engineering design activity to teach science concepts, big ideas, and relevant connections to student’s lives.

STEM Career Signals: What Influences 5th Grade Children's Aspirations?

Julie A. Thomas, Oklahoma State University, julie.thomas@okstate.edu

Melissa Hulings, Oklahoma State University

Cynthia Orona, Oklahoma State University

ABSTRACT: This case study employs qualitative research methods to gather insight into rural, low SES and American Indian (AI) 5th graders' career aspirations. Namely, researchers wondered how home, school and community influenced children's thinking about STEM careers in these remote, rural areas. Data included gender-alike focus group discussions and field notes wherein randomly selected boys and girls (n=63 with 4-6 children in each group) talked about the science and mathematics they were learning in school, the work they expected they would do as adults, and the science and mathematics skills they would need in these jobs. Results point to fifth graders who aspire to science or math related careers; children's inspiration came from television (19%), family/community (70%) and school (11%). Clearly the long-view of elementary science education is to encourage and inspire young children to consider STEM careers. However, these research results point to limited career aspirations and science and mathematics instruction that neither allows nor encourages children to make explicit connections between school curricula and real-world applications. Researchers will suggest appropriate ways in which science teacher educators can help preservice and inservice elementary science teachers make explicit connections between in-school science learning and potential STEM career possibilities.

Strand 4: Science Teaching--Middle and High School (Grades 5-12): Characteristics and Strategies***Related Paper Set - Communication for Learning in K-12 Engineering Education***

10:15am-11:45am, Pelican Room

President: Christine Schnittka, Auburn University**Discussant:** Senay Purzer, Purdue University*Communication for Learning in K-12 Engineering Education*

Christine Schnittka, Auburn University, schnittka@auburn.edu

ABSTRACT: The new Framework for K-12 Science Education highlights the importance of teaching engineering in K-12 classrooms. Research in this area has been ongoing in engineering education organizations such as the American Society for Engineering Education, and is becoming by necessity a burgeoning field in science education circles. Researchers in these two fields are beginning to come together in an organized manner. This paper set on engineering education is part of a NARST paper set series that was begun in 2010 and aims to build a community to organize research efforts between engineering and science education. This collaborative paper set specifically focus on addressing the following research questions about communication for learning in K-12 engineering education: (1) How does CAD software enhance design skills? (2) How does communicating in research teams impact middle school teachers collaborating on engineering curriculum? (3) How do argumentation skills help students involved in robotics design? and (4) How can a curriculum that is based on both scientific inquiry and engineering design communicate effectively with teachers who use it? The paper set aims to address issues of communication in engineering education and promote discussion on how to infuse and improve engineering in K-12 classrooms.

An Efficacy Study of Computer-Aided Design Learning Tools in High School Engineering Classrooms

Charles Xie, The Concord Consortium, qxie@concord.org

Edmund Hazzard, The Concord Consortium

Rachel Kay, The Concord Consortium

Saeid Nourian, The Concord Consortium

Amy Pallant, The Concord Consortium

Middle Level Math and Science Teacher Perceptions from a University Research Experience

Karen A. High, Oklahoma State University, karen.high@okstate.edu

Juliana Utley, Oklahoma State University

Julie Angle, Oklahoma State University

Characterizing Argumentation Structures in High School Engineering Design

William McKenna, University of Texas Austin, william@math.utexas.edu

Innovating Science Curricula with Engineering: A Balancing Act

Marion Usselman, Georgia Tech

Mike Ryan, Georgia Tech, mike.ryan@gatech.edu

Brian Gane, Georgia Tech

Sabrina Grossman, Georgia Institute of Technology/CEISMC

Strand 5: College Science Teaching and Learning (Grades 13-20)***Effect of Models on Student Understanding***

10:15am-11:45am, Parrot Room

President: Stephen B. Witzig

Effect of Plastic Models, Organ Dissections, and Virtual Dissections on Learning, Retention, and Science Perceptions

Sara A. Lombardi, University of Maryland, slombar1@umd.edu

Reimi E. Hicks, University of Maryland

Katerina V. Thompson, University of Maryland

Gili Marbach-Ad, University of Maryland

ABSTRACT: This study aims to determine the effectiveness of three commonly used model-assisted activities (organ dissections, virtual dissections, and plastic models) on student learning as well as attitude and perspective towards science. After randomly assigning volunteers to experimental classrooms, each student received a 15 minute lesson followed by a 45 minute activity with one of the treatments. Students were tested on anatomy and physiology content and filled out a likert-style survey. Two months later, students were retested. Students who used plastic models earned significantly higher scores on both the initial and follow-up exams than students who performed organ or virtual dissections. In the initial exam, plastic model and organ dissection students scored statistically higher on anatomy questions than students who performed virtual dissections. On the follow-up exam, students in the plastic model group outperformed both virtual and organ dissection students on anatomy questions. Further, students in organ dissection agreed that "science was fun" three times more often than those who performed virtual dissection and 25% more often than students who used plastic models, suggesting organ dissections may promote positive attitudes towards science. This research may be used in curriculum development and the organization of laboratories at schools and higher education institutions.

2D/3D: Exploring How Students Use Models to Solve Representational Translation Tasks in Organic Chemistry

Jeffrey T. Olimpo, University of Maryland, College Park, jeolimpo@umd.edu

Bonnie L. Dixon, University of Maryland

ABSTRACT: Representations are used extensively in chemistry to describe the micromolecular world. While experts are adept at understanding and manipulating these representations, novices often are not. Research suggests that the use of 3D, physical models may facilitate novice's ability to comprehend and translate between chemical representations. However, these studies have traditionally explored students' use of models only in conjunction with 2D representations. Therefore, less is known about how students use 3D models to translate between diagrams when 2D representations are not present. In this study, we address this question by adopting a quantitative approach to explore how students translate between common representations (Dash-Wedge, Newman, and Fischer diagram) when presented only with a 2D diagram or a 3D model, and not both. Results suggest that students having access to only 3D models perform significantly better on translation tasks than those who see only the 2D diagrams ($p = 0.018$). This difference was attributed to students' purposeful use of models to solve the tasks, specifically the ability to align the model to the target representation prior to solving the problem on pencil-and-paper. Together, these results highlight the potential value of models in teaching chemistry.

A Novel Typology for Alternative Conceptions in Postsecondary Chemistry Identified by a Two-Tier Diagnostic Instrument
Caroline Cormier, Universite De Montreal, carocorm@hotmail.com

ABSTRACT: Alternative conceptions are a challenge for science education because they can cause barriers to learning by constituting a framework that is not in line with accepted scientific definitions (Driver & Easley, 1978). Alternative conceptions are recognized as difficult to detect and resistant to change under normal class conditions (Osborne & Cosgrove, 1983). Their identification therefore requires the researcher to deploy specific methods for diagnosis. One of these methods, the two-tier diagnostic instrument (Treagust, 1988), was applied to develop a diagnostic tool in chemistry. The topics covered in this study were molecular geometry and compound polarity, and the relationship between these theories and the observable phenomena they can explain. Results obtained for 277 students at the college level are presented and the most common alternative conceptions are discussed. The reasoning errors leading to the diagnosis of these alternative conceptions are also identified and classified in a new typology, of which four types of reasoning errors (overgeneralisation, fallacy of affirming the consequent, misconnection and one-reason decision-making) are presented here.

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

Diverse Approaches to Course Specific Pedagogy

10:15am-11:45am, San Cristobal

Presider: Huseyin Colak

Shifting College Students' Epistemological Framing Using Hypothetical Debate Problems

Dehui Hu, Kansas State University, dehuihu@gmail.com

N. Sanjay Rebello, Kansas State University

ABSTRACT: Developing expertise in physics problem solving requires the use of mathematics effectively in physical scenarios. Novices and experts often perceive the use of mathematics in physics differently. Students' perceptions or framings about mathematics use in physics play an important role in their problem solving. In this study, we examined students' framing about math use in physics in two types of problems: conventional problem and debate problem. We found that when working on conventional problem, students tend to frame problem solving in physics as plugging in quantities into a memorized physics equation (i.e., rote equation chasing); whereas in hypothetical debate problems, students are more likely to be involved in quantitative or qualitative sense-making. We conclude that debate problems might be used as instructional tool for shifting students into a sense-making frame. Thus, it might be potentially useful for developing more expert-like problem solving expertise.

The Effectiveness of the Cross-Age Peer Tutoring Program in Comparison to the Problem Solving Program in Introductory Physics Class

Kevin Insik Hahn, Ewha Womans University, ishahn@ewha.ac.kr

Shin Young Lee, Ewha Womans University

Jung Sook Yoo, Ewha Womans University

Eun Hee Kim, Ewha Womans University

ABSTRACT: This research on cross-age tutoring emphasizes programs in physics and suggests that such programs have positive academic outcomes for students who participate as tutees. Such programs also appear to have a positive impact on a variety of attitudinal outcomes, such as students' interests towards physics, confidence, ability to perform tasks and communication skills. Students took the midterm, final exam and attitudinal survey. Grades of tutees (4 groups ; n=12) were compared to the grades of the students that attended the problem solving group (1 group ; n=32). This study demonstrates that cross-age tutoring program on physics can enhance the achievement and attitudinal outcomes of tutees. It is therefore recommended that cross-age tutoring is adopted as an effective teaching and learning method for the development of students' physics academic and attitudinal outcomes.

New Ideas for Preparing University Teaching Assistants: Drawing from Secondary Science Teacher Education

Terry Lin, McGill University, terrylin.ca@gmail.com

Gale A. Seiler, McGill University

ABSTRACT: In response to reoccurring calls for reform in how science is taught in colleges and universities, active learning has been gaining attention, and teaching assistants are often expected to carry out innovative, active learning approaches and activities—a task for which they are frequently ill-prepared. Responding to a relative lack of research on effective professional development for teaching assistants in higher education, this research builds a model of teacher preparation that is based on key principles for learning to teach and a vision of ambitious science teaching that have emerged from the K-12 teacher education literature. An intervention will be described that leads science TAs in the development of core instructional practices through an ongoing Critical Friends Group and video study of in-class interactions. Constraints and affordances experienced by the TAs as they worked to transform their teaching practice are used to assess the usefulness of this model.

Development of Undergraduate Teaching Assistants as Effective Peer Mentors in STEM Courses

Stephanie B. Philipp, University of Louisville, stephanie.philipp@louisville.edu

Thomas R. Tretter, University of Louisville

Christine Rich, University of Louisville

ABSTRACT: In this study we examined the development of peer mentoring skills and deepening of content knowledge of trained and supported undergraduate teaching assistants (UTAs) working with undergraduate students in entry-level STEM courses. Through a mixed-methods research design, data were collected from multiple sources: an end of semester survey with 5-point Likert scale and open-ended items, reflections written throughout the semester by the UTAs for their required pedagogy seminars, and content knowledge test scores. Principal components analysis revealed that the survey items measured three factors about the UTAs: disciplinary content knowledge, internal focus on teaching skills; and peer mentoring communication and collaboration skills. UTAs felt confident about their content knowledge and communication skills as a peer mentor, with many UTAs reporting a strengthening of their own content knowledge as a result of their UTA experience. UTAs felt less sure about their teaching skills, realizing they had areas in which they wished to improve. UTAs demonstrated that they were more aware of pedagogical strategies and the learning needs of their students, experienced positive interactions with their students, and strongly recommended the UTA experience to other undergraduates.

Strand 6: Science Learning in Informal Contexts***Critical Design Elements of Informal Contexts***

10:15am-11:45am, Sea Gull Room

A Case Study of Understanding the Seasons in Informal Learning

Mi Song Kim, NTU, misong.kim@gmail.com

Wei Ching Lee, NTU

ABSTRACT: A growing body of research on embodied cognition supports the theory that the body is integrated with conscious cognitive processes. However, there is no fully articulated epistemology of embodied cognition in the field of education compared with other fields. Hence, we have designed an Embodied Modeling Mediated Activity (EMMA) to facilitate young adults' learning astronomy through multimodal modeling in informal learning. This case study aims to examine how embodied cognition can support one group of two young adults' understanding of the concepts of the seasons through participating in four EMMA workshops in informal learning. In order to explore their lived experiences, we collected multiple data sources such as observation, collected multimodal artifacts, video- and audio-taped recording, Facebook posts, interviews, surveys, field notes and reflective journals. The finding shows that (1) embodied engagements with multimodal models support representations of their understanding of the tilt of Earth's axis and its consistent pointing direction; (2) the limitation of 2D model triggers the development of 3D perspectives of the spring and autumn through body embodiment; (3) embodied engagement using 3D models often reveals their misunderstanding; and (4) embodied engagement allows them to develop visual and spatial reasoning. Implication will be discussed.

Using Visual Thinking Strategies and Live Animals in Natural Science Teaching in Museums

Jacqueline Genovesi, Drexel University, genovesi@ansp.org

ABSTRACT: Museums are important contributors to individuals' scientific literacy. One of the tools that many free-choice learning institutions use is live animals. The purpose of this case study was to better understand the characteristics of a new method of using live animals in museums that combines live animals with Visual Thinking Strategies (LA/VTs). This new method was explored through the roles of choice and control, personal motivation and social interaction in the learning processes of adults. It was also examined taking the National Research Council's (2009) six Strands of Informal Learning into consideration. Five major conclusions emerged: 1. Active participation in the "process of science" can be seen during LA/VTs presentations. 2. Emotional connections between participants and the animals were demonstrated during the presentations. This may sometimes lead to conservation attitudes. 3. There is a difference in the VTs experience at a science museum compared to the typical art museum experience. This difference might stem from the participants differing expectations between art and science. 4. The LA/VTs method sometimes facilitates the learning experience through social learning. 5. Observation skills, demonstrated during the LA/VTs presentation, were an important component of the characteristics of this new method of teaching with live animals.

The Role of the Physical Environment in Contextualizing Science Learning

Michael Giamellaro, Oregon State University- Cascades, michael.giamellaro@ucdenver.edu

ABSTRACT: Outdoor learning environments present opportunities to highlight the contextualized and interdisciplinary nature of STEM education but little is known about how the physical, outdoor aspects affect learning. This paper reports on a study of four high school science immersion trips, the resultant student learning, and the ways in which the physical environment contributed to that learning. Through a pre/post assessment of concept knowledge and a follow-up interviews with students, it was determined that significant learning was a result of these immersion experiences and that the physical environment directly contributed to the learning by providing the students with examples of the concepts, geographical indexing of the knowledge, and embodied experiences of the science concepts.

Strand 7: Pre-service Science Teacher Education***Symposium - Looking Past 2061: Visions of Science Teacher Education for the Next Century***

10:15am-11:45am, Canary Room

Discussant: Melissa Braaten, University of Wisconsin-Madison**Presenters:**

Douglas B. Larkin, Montclair State University, larkind@mail.montclair.edu

Gillian Roehrig, University of Minnesota

Christopher Emdin, Teachers College Columbia University

Vicky K. Pilitsis, Rutgers University

Melissa Braaten, University of Wisconsin-Madison

ABSTRACT: This symposium is designed to look across a variety of science education and teacher education reforms and to theorize about the promise and challenges of science teacher education in the coming decades, particularly in light of the Next Generation Science Standards. The first paper uses a framework of understanding learning progressions in science to address the issue of working with preservice science teachers to work productively with student ideas. The second paper examines the inclusion of engineering as part of the standards, and explores the implications for science teacher preparation and professional development. The third paper examines the substantive differences from five science teacher preparation pathways, and points to ways in which the field of science teacher education might productively respond to the shifting terrain of teacher education policy on state and national levels. The final presentation examines the preparation of science teachers through the lens of "reality pedagogy," and offers suggestions for providing science teachers with the tools to become effective.

Strand 7: Pre-service Science Teacher Education***Developing Content Knowledge and PCK***

10:15am-11:45am, Río Mar Salon 9

Presider: Patricia J. Friedrichsen*Unintended Consequences: Pre-Service Science Teachers' Immersion In Modeling-Based Inquiry in Tropical Ecology*

Sarah J. Adumat, UW-Madison, sjadumat@wisc.edu

Jana L. Bouwma-Gearhart, University of Kentucky

Rebecca L. McNall, University of Kentucky

Allyson Rogan-Klyve, Oregon State University

ABSTRACT: Learning modeling-based scientific inquiry can be a challenge for educators and students alike. Teacher educators have used various approaches, experiences, and tools to aid in preparing future science teachers to use modeling-based inquiry in the classroom. However, this ambitious vision of practice remains elusive for most science teachers. This qualitative case study investigates the following research questions: (a) What and how do participants learn from immersion in an authentic modeling-based ecology experience that is intended to be both a science experience and a science teaching experience? and (b) What are the unintended consequences of learning that is situated in modeling-based inquiry for pre-service teachers? Findings from this study indicate that authentic inquiry experiences, if too far-removed from teachers' prior or future classroom practice, will not transfer easily to a teacher's practice. Furthermore, a short-term experience with scientists might emphasize science content and obscure the instructor's focus on science teaching practices. Findings from this study can inform science teacher educators about the affordances and limitations of situating learning in a modeling-based inquiry community of practice.

What Role Does Content Knowledge Play in Learning to Teach Science?

Gail Richmond, Michigan State University, gailr@msu.edu

ABSTRACT: There has been little examination of ways content knowledge (CK) might facilitate the acquisition of high-leverage teaching practices (HLPs), particularly in light of growing numbers of alternative programs where CK is often privileged. In this study, the extent to which deep CK makes it possible to engage in HLPs was examined. These HLPs include the development of plans grounded in significant scientific ideas; selection of activities addressing core learning objectives; orchestration of productive scientific discussions; and identification of conceptual difficulties through analysis of student work. Participants included nine individuals enrolled in a masters-level certification program; data were collected across the 15-month program. Data sources included measures of CK and content knowledge for teaching, and assessments of HLPs that required both kinds of knowledge. Participants varied in the depth of their content understanding, and this understanding was related to their ability to recognize and design reform-based instruction. While strong CK was linked to its privileging in participants' vision, design, and enactment of teaching, results also suggest an individual's professional identity is critical in shaping HLP enactment. This work can inform our understanding of HLP development and design of experiences to better prepare teachers to serve children with the greatest need.

Developing Pre-Service Science Teachers' PCK for Model-Based Instruction

Mehmet Aydeniz, The University of Tennessee, maydeniz@utk.edu

Monica C. Mobley, The University of Tennessee

Bennett A. Adkinson, University of Tennessee

ABSTRACT: The purpose of this study was to enhance pre-service science teachers' pedagogical content knowledge (PCK) for model-based instruction through reflective learning experiences. Participants consist of 7 pre-service science teachers from a southeastern university. Data consists of participants' reflection papers on weekly readings, their model-based lesson plans, field notes from their teaching of their lessons and their self-reflection papers post-lesson implementation. Findings indicate that these reflective learning experiences enhanced pre-service science teachers' PCK for model-based instruction as measured by 14 criteria related to model-based teaching and learning. Our discussion focuses on the importance of pre-service science teachers' PCK for model-based instruction and ways to enhance such knowledge.

Providing Meaningful Experience to Pre-Service Teachers: Mentoring Enriched PCK Based Practicum Course

Aysegul Tarkin, Yuzuncu Yil University, atarkin@metu.edu.tr

Betul Demirdogen, Middle East Technical University

Sevgi AYDIN, Yuzuncu Yil University

Betul Ekiz, Middle East Technical University

Elif Selcan Kutucu, Middle East Technical University

Fatma N. Akin, Middle East Technical University

Mustafa TUYSUZ, Middle East Technical University

Esen Uzuntiryaki, Middle East Technical University

ABSTRACT: This study examined how pre-service teachers' (PTs) pedagogical content knowledge (PCK) with respect to a specific topic (i.e. rate of reaction) developed within the context of mentoring enriched PCK based practicum course. Action research, providing a way to discover a specific educational problem, and find solution to this problem to improve teaching and learning activities, design was used. Participants were three pre-service chemistry teachers, information rich cases and volunteers (two females and one male), enrolled in the mentoring enriched PCK based practicum course. Data were collected through the use of content representation (CoRe), semi-structured interviews, and reflection papers. Data were analyzed deductively by the use of existent categories. Although all participants developed themselves regarding all PCK components (science teaching orientation, knowledge of learner, assessment, instructional strategy, and curriculum) and integration of components, each participant's PCK development showed a particular pathway, which was an evidence for idiosyncrasy. Moreover, PTs explicitly started to utilize and view PCK construct as a professional knowledge for planning and teaching science through the end of the 14-week long practicum. Implications for science teacher education and research are discussed.

Strand 8: In-service Science Teacher Education***Promoting Professional Growth through Lesson Study***

10:15am-11:45am, Río Mar Salon 4

Presenter: Leslie Keiler

Developing Trust to Improve Elementary Science Teaching Through Lesson Study

Sharon Dotger, Syracuse University, sdotger@syr.edu

Kevin Moquin, Willow Field Elementary

Kathy Hammond, Willow Field Elementary School

ABSTRACT: School-university partnerships, particularly those focusing on elementary science, face a number of barriers in order to improve teaching and learning. In an effort to explicitly address these barriers, a university researcher and a group of elementary teachers engaged in lesson study over a two-year period. This paper reports on the development of that relationship, emphasizing events that are indicative of deepening of relationships among the participants. Using an analytical framework based on trust (Tshannen-Moran & Hoy, 2000), the events are described and then explanations of the contribution of the event to the development of trust is discussed.

Engaging Professional Development for High School Physics Teachers

Morten Lundsgaard, University of Illinois at Urbana Champaign, mlundsga@illinois.edu

Christopher P. Cunnings, College of Education

ABSTRACT: Next Generation Science standards conceive laboratory activities as a fundamental and integral part of science curriculum. In this paper we describe the study of a lesson study inspired professional development project for in-service high school physics teachers who were given the task of developing two laboratory-centered units in a two-week long summer workshop. The laboratory activities take advantage of a new multi-probe hardware that leans itself towards integrated laboratory instruction. Teachers' classroom implementations of the units were observed and followed up by study group sessions with the teachers. In these sessions, video clips of the classroom implementations were used as starting points for the review of the units. In the paper we report findings on the importance of collaboration between teachers, and on how teachers make connections between laboratory instructions and other classroom instructions. The findings are based on the analysis of the video recordings of the summer workshop,

classroom implementations, and study group sessions. The video recordings were parsed into intervals, with the borders of intervals being defined by changes in actions of the participants in the videos.

A Shift Towards Professional Learning from Professional Development: A Case of Bangladeshi Secondary Science Teachers

Hafizur Rahman, University of Dhaka, smhrahman9@yahoo.com

ABSTRACT: An orientation toward professional learning requires thinking differently about where learning takes place. It differs from that of traditional views of professional development. This paper explores how secondary science teachers' engaged in job-embedded professional learning rather process of additional training or workshops related to policy guidelines or imposed change. This study followed a qualitative research design and data has been collected from 14 secondary science teachers from seven nearby schools. The findings reveal that participant teachers found opportunities to support each other's practice through observing each other's classrooms, discussing observed practice with colleagues within and across the schools. These issues then may well impact on how they learnt more from colleagues and raised their issues about their needs through this process of job-embedded training.

Strand 9: Reflective Practice

Professional Support / Development

10:15am-11:45am, Heron Room

Presider: Lyn Carter

Engaging in Inquiry as Professional Development: Reconstructing Understandings of Research, Teaching, and Learning

Jeffrey S. Carver, West Virginia University, jeffrey.carver@mail.wvu.edu

Sharon B. Hayes, West Virginia University

Nadira I. Ghattas, West Virginia University

ABSTRACT: This paper explores what practicing secondary science teachers discovered about research and teaching as they learned about and engaged in action research. Through the analysis of action research reports, surveys, and interviews, the researchers examined the knowledge and perspectives constructed by practicing secondary science teachers as they participated in an action research course. Teachers began to develop broader understandings of the nature of research, its place in their classroom and their role in the research as both consumer and producer of knowledge. They also began to draw connections between a summer science research experiences and action research noting that the inquiry process is similar across disciplines of study.

Digging Deeper Into Formative Assessment: Reflections from a Middle School Earth Science Teacher and Co-Designer

Yves Beauvineau, Denver Public Schools, beauvineau.yves@gmail.com

Angela H. DeBarger, SRI International

William R. Penuel, University of Colorado Boulder

Savitha Moorthy, SRI International

ABSTRACT: This reflection describes a middle school science teacher's implementation of Contingent Pedagogies, a NSF funded study aiming to support effective formative assessment practices within two units of the Investigating Earth Systems curriculum. The project involved classroom response systems technology and a suite of tools including pedagogical patterns, decision rules, talk moves, and classroom norms. Examples drawn from classroom videos illustrate how the teacher elicits and responds to his students' ideas of Earth science phenomena and attempts to engage his students in deeper thinking and reasoning during whole class discussions. The findings show that a teacher's coherent use and appropriation of the tools designed to support effective formative assessment practices can have a positive impact on students' understanding of Earth science concepts.

Making Your Own Role: Narrative Positioning Analysis of Science Department Chair Instructional Leadership Practice

Jeremy S. Peacock, University of Georgia & Monroe Area High School, peacock.jeremy@gmail.com

ABSTRACT: For more than 80 years, authors in educational leadership have argued that high school department chairs are in a prime position to provide instructional leadership within their departments. However, department chairs' ability

to provide such leadership is limited by lack of line authority, time, role conflict, and role ambiguity. Beyond these general issues, science department chairs face unique concerns related to ongoing science curriculum reforms. Yet the literature and practical experience indicate that department chairs can exert a positive influence on instruction and learning within a high school science department. The current study employs narrative positioning analysis of research interviews with exemplary department chairs to contribute to our understanding of how chairs enact instructional leadership within the high school science context. This interactionist analytic approach moves the research on department chair leadership beyond its roots in role theory. General findings of this analysis indicate that narrative positioning analysis of research interviews can reveal new professional knowledge regarding chairs' professional practice. Specific findings indicate that chairs engage in a variety of interconnected practices in support of improving teaching and learning in the high school science classroom.

Strand 10: Curriculum, Evaluation, and Assessment

Curriculum and Assessment for Student Learning: Approaches in Secondary and Undergraduate Science

10:15am-11:45am, Río Mar Salon 2

Presenter: Mei-Hung Chiu

An Investigation of the Relationship Between High School Science Courses and First-Year College Outcomes

Pamela Kaliski, The College Board, pkaliski@collegeboard.org

Kelly Godfrey, The College Board

ABSTRACT: The focus of this research is to evaluate the relationship between advanced science high school courses and college outcomes, with a focus on the benefit of Advanced Placement® participation. Multilevel modeling was employed to account for the nested structure of the data (i.e., students nested within schools), and several student-level and school-level covariates were included in the model to provide a stringent test of these relationships. Results indicated positive relationships between advanced science coursework participation and college outcomes. For example, students who take AP Chemistry and score at least a 2 on the exam, AP Biology and score at least a 3 on the exam, or AP Physics B or Environmental Science and score at least a 4 on the exam have higher science GPAs than students who took Regular science courses, or students who did not take these science courses at all, when controlling for many student-level and school-level covariates. This suggests that participating in advanced science coursework in high school is beneficial for students in college; as such, teachers should encourage students to participate in advanced high school science course work when planning their curriculum for science learning.

Visualization-Based Collaboration and Transactional Distance Among Students in a Mini-Project in Industrial Engineering Course

Niva Wengrowicz, Bar Ilan university, nivawen@gmail.com

Dov Dori, Technion-Israel Institute Of Technology

Yehudit J. Dori, Technion-Israel Institute Of Technology

ABSTRACT: Our study is of a pioneering nature, in which we develop assessment techniques, based on Transactional Distance (TD) theory to assess the distance among peer students who participated and collaborated in a PBL- and visualization-based undergraduate course. About 20 students, who participated in a Mini-Project course in Industrial Engineering, constructed conceptual models, expressed in terms of an Object Process Methodology (OPM) for analysis of real projects. The students worked in two groups and had to collaborate with their peers and with an international project team. We used a mixed method and research tools included web-based questionnaires, semi-structured interviews, reflection reports and project summary reports. The findings confirm and reinforce the choice of TD as a theoretical framework for constructing assessment techniques for collaborative project base learning (PBL) involving advanced visualization and distance technologies. Additionally, our undergraduate students expressed high satisfaction from being exposed to and experiencing work in a visualization-rich, project-based environment in a very early stage of their learning. expressed high satisfaction from being exposed to and experiencing work in a visualization-rich, project-based environment in a very early stage of their learning.

Using Laboratory Centered Analogies to Enhance Student Understanding of Chemical Concepts at the Molecular Level

Mitchell R. Bruce, University of Maine, mbruce@maine.edu

Shirly Avargil, University of Maine

Jonathan T. Shemwell, University of Maine

François G. Amar, University of Maine

Alice E. Bruce, University of Maine

ABSTRACT: Many novice chemistry students have difficulty in thinking about “invisible” chemical processes while making observations and gathering evidence in lab. This is a critical aspect of learning chemistry. We examine the use of structured analogy activities in conjunction with lab work, and their effect on students’ analogical reasoning, connection of macro- to submicroscopic levels, and learning outcomes. This is done using a new instructional strategy that incorporates small group activities involving analogies during lab activities. The project is part of a NSF-MSP project involving University STEM reform in introductory chemistry courses. Data were collected through students’ answers to open-ended questions and pre-lab post-lab multiple-choice questions. A validated rubric was established in order to analyze students’ answers to the open-ended questions. Our findings suggest that students can use the analogy to connect the macroscopic and sub-micro levels; this approach helps students to think about the invisible chemistry through reasoning about the analogy. The learning gains observed in the present study are much higher than traditional lab instruction and are indicative of active learning strategies. This research addresses the importance of learning through analogies and connecting the macroscopic analogy and lab activities while engaging students in understanding **ABSTRACT** concepts.

Development and Validation of a Student's Competence Test for Upper Secondary Physics Education

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Andreas Borowski, Aachen University

Hans E. Fischer, University Duisburg-Essen

ABSTRACT: Standardized performance tests require empirically secured models of student abilities. This paper describes the model-based development and validation of a competence test for students of upper secondary physics education. The focus is on the concept of energy. By using empirically secured evidence from secondary science education and considering upper secondary physics requirements, a structure of competence was developed and evaluated on 66 test items. The model distinguishes between the dimensions Complexity, Cognitive Processes, and Mathematization. The validation shows that the dimension Complexity has a significant influence on the items’ difficulty. The explained variance is in the range of 34% whereas Cognitive Processes and Mathematization do not show significant influence. For external validity, the measured student abilities were compared with other variables of physics competence. The abilities gathered by the developed test correlate very highly (.902**) with students’ performance in a content knowledge test (TIMSS III). The correlations with school grades in physics (.713**), math (.551**), and German (.393**) show a meaningful order. Concerning the covered magnitude of students’ abilities, the test can be used to monitor students’ abilities on the concept of energy.

Stemming the HIV/AIDS Tide: Linking Science Education to Critical World Issues

Gregory Vogt, Baylor College of Medicine, vogt@bcm.edu

Barbara Tharp, Baylor College of Medicine

Alana Newell, Baylor College of Medicine

James Denk, Baylor College of Medicine

Nancy Moreno, Baylor College of Medicine

ABSTRACT: In spite of recent improvements in the worldwide HIV infection rate and the treatment of AIDS, Human Immunodeficiency Virus and the resulting Acquired Immunodeficiency Syndrome will continue to be a tragic domestic and world-wide problem for years to come. HIV infection, in itself, is completely preventable through safe life practices. Building wide-spread knowledge of the basic science of HIV/AIDS and its prevention is as important as creating new medicines for stopping HIV transmission and for treatment of AIDS itself. A new HIV/AIDS curriculum, suitable for middle and high school students, has been created and found highly effective through a cross-curricular pilot test (science, mathematics, history, geography). The curriculum is available free online. This session will report on the findings of the

pilot test evaluation as to the effectiveness of a STEM education approach to providing education about a critical world problem. It will be shown that the approach employed fostered acquisition of new STEM knowledge and skills, and an openness to examine intense associated societal issues. In fact, our HIV/AIDS curriculum pilot test evaluation demonstrated that providing science activities and content relating to critical local, national, and world issues, creates new opportunities for motivating students to learn, encouragement for self-directed research, and opportunities for thoughtful discussion.

Strand 11: Cultural, Social, and Gender Issues

Post-Secondary Minority Student Perception of STEM Majors and Careers

10:15am-11:45am, Río Mar Salon 8

President: Eileen C. Parsons, University of North Carolina at Chapel Hill

Evaluation of Students' First-Year Experience After a Summer Bridge Program Designed to Promote Diversity

Stanley M. Lo, Northwestern University, stanley-lo@northwestern.edu

Su Swarat, Northwestern University

Luke C. Flores, Northwestern University

Denise Drane, Northwestern University

Greg Light, Northwestern University

ABSTRACT: This paper reports a new summer bridge program designed for incoming students interested in biology from under-represented groups at a private, research university. Features of the program include a broader definition of diversity and a focus on community building, leadership development, biological research, and challenging academic coursework. Two cohorts of students (n=38) have participated in the program to date. Evaluation data center on the first-year experience, cognitive and affective learning outcomes, and retention. Survey and focus group data suggest that participants connect with faculty, establish social networks, reduce anxiety, become part of the university community, increase help-seeking behaviors, adjust to college life, learn about the variety and process of research, refresh their chemistry and calculus knowledge, and are satisfied with the program. Participants have higher retention rates (91.7%) than a historical cohort (29.6%) in General Chemistry, the gateway course sequence to other STEM disciplines including biology. In contrast to traditional summer bridge programs, this program expands the definition of diversity to include a variety of measures for under-representation, creating a program environment that is heterogeneous. Furthermore, the evaluation of this program fills a literature gap in students' first-year experience in college after attending summer bridge programs.

Science Majors and Non-Science Majors: Black College Students' Perceptions of Scientists

Crystall S. Gomillion, Eisenhower Middle School, crystall_gomillion@hotmail.com

Eileen C. Parsons, University of North Carolina at Chapel Hill

ABSTRACT: The research objective was to discover the perceptions of scientists possessed by Black college students. Forty-eight participants, 17 science majors and 31 non-science majors, volunteered for the study. All individuals completed the Draw-a-Scientist Test (DAST) and 14 individuals participated in one-on-one, semi-structured interviews with the researcher. DAST images were analyzed using the Draw-a-Scientist Test Checklist (DAST-C) to determine the number of stereotypical images depicted in the drawings. Verbatim interview transcripts were analyzed to expound upon participants' perceptions of scientists as revealed by the DAST. Results from an independent samples test for DAST scores indicated that science majors and non-science majors did not differ in the number of stereotypical elements illustrated. Both groups averaged four of the 16 elements. However, findings did expose that divergences existed in racial and gender representations of the scientists illustrated.

Supporting Future Scientists: Predicting Minority Student Participation in the STEM Opportunity Structure in Higher Education

Sylvia Hurtado, UCLA, sylvia.hurtado@gmail.com

Tanya Figueroa, UCLA

Bryce E. Hughes, University of California, Los Angeles

ABSTRACT: Using longitudinal data from the UCLA Cooperative Institutional Research Program (CIRP)'s 2004 Freshman Survey (TFS) and 2008 College Senior Survey (CSS), this study examines the predictors of participation in a number of educational opportunities that have been identified in the higher education research as being key in promoting academic success for STEM students. Engagement in such experiences is especially important for underrepresented minority (URM) students, as these students are most vulnerable to a number of unique barriers that deter them from successful STEM degree completion. Findings reveal that URM students have disparate access to faculty support, such as receiving letters of recommendation, but participate in undergraduate research at rates similar to their White and Asian American counterparts. Results inform institutional efforts to orient students, particularly underrepresented minorities, toward activities that will support their academic success and best position them for a career in STEM.

Occupying the E in STEM and Science: Rethinking the New Engineering Focus

Matthew Weinstein, UW Tacoma Education Program, mattheww@u.washington.edu

Karen Tonso, Wayne State University

ABSTRACT: This paper first explores the problems vis-à-vis equity that the injection of engineering logics into the practices of science education brings. These include problems of gender inequity, colonialism, hierarchical social and governance relationships. The bulk of the paper explores contesting visions of design and engineering that could serve as resources for engineering projects that promote democratic and social justice struggles. These visions emerge from multiple literatures and social movements including democratic design movements that emerged in the 1970s, cyborg feminist theorizing of resistance within technical systems, feminist and postcolonial critiques of engineering as a technical-social field, the engineering designs of people in resistance movements (e.g., the occupy camps of 2011), and the political activism of engineers reorienting their work for social justice. From these disparate threads we frame alternative standards that teachers and researchers need to engage with if their engineering work within science education is going to promote rather than disrupt democratic and social justice oriented STEM education.

Strand 12: Educational Technology

Teachers, TPACK and Using Technology to Support Instruction

10:15am-11:45am, Río Mar Salon 7

Presider: Victoria Costa

Preservice Teachers' TPACK: Using Technology To Support Inquiry Instruction

Jennifer L. Maeng, University of Virginia, jlc7d@virginia.edu

Bridget K. Mulvey, Kent State University

Lara K. Smetana, Loyola University Chicago

Randy L. Bell, Oregon State University

ABSTRACT: The purpose of this investigation was to describe how preservice science teachers 1) demonstrate their TPACK through technology-enhanced inquiry instruction and 2) use educational technologies to support students' investigations. Of the 27 preservice teachers enrolled in a two-year Master of Teaching program, 26 were purposively selected as participants based on their use of educational technology to support inquiry instruction during their student teaching semester. Prior to student teaching, preservice teachers were introduced to general guidelines for integrating technology to support reform-based science instruction. A variety of data sources allowed for characterization of participants' instructional practices with technology including classroom observations, lesson plans, interviews, and written reflections. Data analysis sought to characterize the manner in which participants used various technologies specifically to support inquiry instruction during their student teaching semester. Results indicated that participants incorporated technologies appropriate to the content and context to facilitate both non-experimental (e.g. observational and correlational investigations) and experimental inquiry experiences for their students. Results of this investigation may inform science teacher educators' development of content-specific, technology-enhanced learning opportunities that support preservice teachers' TPACK development and prepare them for the responsibility of supporting inquiry instruction with technology.

Changes In Pre-Service Science Teachers' Self-Efficacy Toward Technological Pedagogical Content Knowledge (TPACK)

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Havva Yamak, Gazi University

Nusret Kavak, Gazi University

Selcen Guzey, University of Minnesota

ABSTRACT: The purpose of this study was to evaluate changes in pre-service science teachers' self-efficacy level toward technological pedagogical content knowledge (TPACK) during one academic year. In this study, a science methods course was developed by modifying Magnusson, Krajcik and Borko's (1999) PCK model. 27 pre-service science teachers took the course toward the end of their four-year teacher education program. Data from these 27 teachers were gathered by the Technological Pedagogical Content Knowledge Self-Efficacy Scale (TPACK-SeS). TPACK-SeS was administered three times: at the beginning of the course (pre), at the end of the course (post), and 5 months after the end of the course (follow-up). A paired sample t-test was used to analyze the difference between pre and post test means. Also, one-way analysis of variance (ANOVA) for repeated measures was used to determine whether there were any difference between self-efficacy scores of the three time points (pre-test, post-test, 5-month follow up). The results show that the TPACK-based science methods course that focused on TPACK components provided opportunities for teachers to develop their self-efficacy beliefs toward TPACK.

Exploring the Use of ICT Tools and TPACK of Taiwanese Middle Science Teachers

Syh-Jong Jang, Chung-Yuan Christian University, jang@cycu.edu.tw

Meng-Fang Tsai, Chung-Yuan Christian University

ABSTRACT: Existing research on TPACK shows little about the relations between in-service middle school science teachers' most used information and communication technology (ICT) and their TPACK of ICT. This study aims to build a new TPACK model and use a newly developed questionnaire in a different context to verify whether the TPACK model could be adopted in the context of middle school science teachers. Factor analysis was conducted with the questionnaire data collected from 770 middle school science teachers, resulting in four TPACK components in the new model. The analytical results indicated that middle school science teachers' TPACK were statistically significant in relation to different types of ICT, whereas science teachers' TPACK were found to be insignificantly different according to gender and teaching experience. Among the four groups of the most used ICT, multimedia was the most used ICT, followed by PowerPoint, Internet, and Interactive whiteboards. Within the group of science teachers who reported their most used ICT to be multimedia (e.g., animation, videos), their TPACK showed no significant differences according to gender and teaching experience. The research implications of this study are provided along with suggestions.

An Exploratory Study of Science Teachers' Conceptions of the Nature of Technology

Noemi Waight, University at Buffalo, nwaight@buffalo.edu

ABSTRACT: The current exploratory study offered insight into the validity of Nature of Technology (NoT) as a guide to examine and theorize science teachers' conceptions of technology. In specific, what do teachers know and understand about technologies, the technological process and how it functions in cultural spheres in society and locally in the science classroom? Thirty high school science teachers' conceptions of technology and by extension, how these conceptions reflected dimensions of NoT were examined. In-depth interviews guided by video elicitations explored teachers' definitions of technology; knowledge of development, deployment and purpose of technologies (i.e. both everyday and classroom tools); and teachers' reflections of major historical changes in technological development. Definitions of technology and reactions to video scenario revealed overwhelming focus on the nature of the artefact and positive effects of technology. Perhaps most astounding in these findings was the stark absence (only 2 teachers) of science-technology references. At best, how do we explain these findings when the major impetus and associated arguments for technological implementation is driven by technological advancement in scientific practice? The implications of this study suggest expansion beyond traditional, instrumentalist perspectives to include a new repertoire of questions that engage the totality of the technological enterprise.

Strand 15: Policy***The Influence of Federal Policy on Science Teaching and Research***

10:15am-11:45am, Río Mar Salon 10

President: Jonathan F. Osborne*Challenges of Implementing the Next Generation Science Standards (NGSS) in Local-Control States*

Jacob Foster, Massachusetts Department of Education, jfoster@doe.mass.edu

Hannah Sevia, University of Massachusetts Boston

Allison Scheff, University of Massachusetts Boston

ABSTRACT: The release of the NGSS are anticipated in Spring, 2013, with some States planning for implementation in Fall, 2013. Implementing such a change across a State requires significant planning and support, including adjustments to State and district policies and coordination of resources. This study is concerned with understanding implementation of new Standards at the scale of entire States within a context of local-control State policy environments that has previously not been well studied. The primary goal of the study is to understand ways and conditions in which different stakeholders in two local-control States - teachers, district administrators, and State agencies - intersect in the relationship between top-down and bottom-up initiatives to implement new Standards. A new theoretical base, Design-Based Implementation Research, is directly relevant to this work, both in providing guidance for a smooth transition to new Standards and in how to measure progress toward and impacts of large-scale change. Findings of the study are anticipated to shed light on how to support change in local-control policy environments, and provide implications for how to develop, align or coordinate policy changes and organizational capacities of States and districts to support large-scale implementation and address implementation challenges.

College Science and Mathematics Faculty's Responses to a Statewide Policy of Scholarship of Teaching and Learning

Abdulkadir Demir, Georgia State University, abdulcadir_d@yahoo.com

Lisa M. Martin-Hansen, Georgia State University

Chad Ellett, CDE Research

Mehmet Fatih Tasar, Gazi Universitesi

ABSTRACT: The purpose of this case study was to investigate the roles that institutional culture plays in implementing, sustaining, or impeding a new statewide, Work in the Schools Policy (WISP), rewarding math and science faculty's educational research/activities in K-16 settings. This study focused on 1) participating institutions enactment of WISP; 2) S/M faculty, Tenure and Promotion chairs and/or members, and department chairs awareness of WISP and its implications; and 3) the constraints and barriers associated with the enactment of WISP. The fidelity of implementation of new, top down policies in these are filtered through multiple layers of personal and organizational characteristics. The paper has implications for policy, practice, and future research on innovations and faculty change in higher education.

The Semantic Relationship Between Teachers Beliefs about Pedagogy and Policy

Todd L. Hutner, The University of Texas at Austin, thutner@gmail.com

Arthur B. Markman, The University of Texas at Austin

ABSTRACT: Teacher beliefs are often cited to be the driving force in determining the enacted pedagogy of science teachers in the classrooms. Recent research had added a caveat: beliefs with respect to policy inputs shape classroom practice. Thus, it is not isolated beliefs that require examination, but the relationship between beliefs that becomes important. This study surveyed 15 science teachers in one high school to examine the relationship—or semantic structure—between beliefs. Drawing on work from cognitive science, teachers were asked to provide similarity rankings of various pedagogical and policy concepts relating to science teaching. Multi-dimensional scaling techniques were used to plot the similarity of these concepts in real space. Findings indicate that for the teachers in the school under study, pedagogical concepts such as inquiry were strongly dissimilar from policy concepts such as accountability. Thus, when teachers in this school are involved in cognitive processes driven by accountability policy, there is a small likelihood of their including concepts such as, and relating to, inquiry during said processes. Implications of our research for teacher education include the need to make accountability policy a part, and not target of, teacher education.

Investigating Publication Bias for Recent Causal Effects Studies in Science Education

Joseph A. Taylor, Biological Science Curriculum Study, jtaylor@bscs.org

Susan M. Kowalski, BSCS

Molly Stuhlsatz, BSCS

Christopher Wilson, BSCS

ABSTRACT: This study sought to explore publication bias in recent causal effect studies of science education interventions (2010-11). Specifically, bias against studies with small effect sizes and small sample sizes was examined. Publication bias was examined intuitively using a Funnel plot and a Galbraith plot. Publication bias was tested empirically using Egger's test of Asymmetry. The results of this study suggest a slight publication bias against small effect-small sample studies but this bias was not statistically significant. The recent trend away from bias is important as it will broaden the literature to include studies of programs with small but important effects. This trend will also contribute to more valid meta-analyses of science education interventions.

Conducting Studies of Causal Effects in Science Education: Considering Trade-Offs to Accommodate Methodological Requirements and the Policy Constraints Affecting Research in Schools

Janet Carlson, BSCS, jcarlson@bscs.org

Joseph A. Taylor, Biological Science Curriculum Study

Susan M. Kowalski, BSCS

Christopher Wilson, BSCS

Stephen Getty, BSCS

ABSTRACT: Over the last 15 years, federal agencies have advocated and supported efforts that align with evidence-based reform. This movement promotes the use of programs for which there exists causal evidence of effectiveness. Evidence-based reform in education has often been described as a response to a) a general lack of evidence regarding what programs or practices are effective; b) the adoption of programs or practices based on ideology or trends; and consequently c) the absence of evolution in the field in which more effective programs or practices displace those that are less effective. A range of legislation heralded this effort, most notably the NCLB, which famously mentions scientifically based research more than 100 times. While federal legislation has had significant impacts on considerations of research evidence and research design, these same documents also had significant impacts on what happens in schools via parallel accountability mandates. We therefore have a dilemma. While federal policies are advocating for causal effects research on science education programs and practices, the same family of policies has created barriers to conducting such research studies within schools. In this paper we will explore approaches to mitigating these challenges, and discuss trade-offs associated with each approach.

Concurrent Session #5**1:15pm – 2:45pm****Strand 1: Science Learning, Understanding and Conceptual Change*****Epistemic Aspects of Science Teaching and Learning***

1:15pm-2:45pm, Río Mar Salon 1

President: Fouad Abd-El-Khalick*Borrowing Structure from a Clearer Analogue to Overcome a Misconception About Boiling*

Brandon R. Emig, North Carolina State University, bremig@ncsu.edu

ABSTRACT: This pilot research analyzes what happens when student small groups are invited to do analogical (structure) mapping in order to overcome a misconception about boiling. Sixteen of nineteen participants initially stated that boiling is a warming process; it is actually a cooling process. To address this misconception students were given a liquid with a very low boiling point of -10°C , 'canned air' (actually 1,1,1,2 tetrachloroethane; available for about \$4US for the purposes of cleaning keyboards and the like), and invited to make it boil in their hand (inverting can, squirting liquid into a clear plastic bag); simply touching the bag with the liquid in the corner sufficed. The extremely low temperature of the boiling liquid felt cold; this was quite foreign to all participants. Afterwards, the groups were invited to do an analogical map between two scenarios: a beaker of water boiling openly on a hot plate (which they also had at their lab-desks) and the boiling 'canned air.' Results show that in spite of utterances indicating accurate scientific understandings, the misconceptions persisted. Discourse analysis sheds light on how this occurred.

The Impact of Explicit and Reflective NOS Instruction on Students' Epistemological Beliefs

Tiffany M. Roby, Drake University, tiffany.roby@drake.edu

Jerrid W. Kruse, Drake University

Jesse Wilcox, Iowa State University

ABSTRACT: This study seeks to build upon such studies by exploring how a particular aspect of reforms-based teaching, nature of science instruction, impacts students' broader epistemological beliefs. A total of 93 eighth graders were given both the nature of science and epistemological beliefs assessment before and after receiving three weeks of explicit and reflective nature of science instruction. A paired-samples *t* test showed that the mean post-test score ($M = 159.56$, $SD = 19.10$) was significantly lower than the mean pre-test score ($M = 165.86$, $SD = 17.52$), $t(92) = 4.323$, $p < 0.001$, and the standardized effect size index, *d*, was 0.48. The lower score indicates an increase in the sophistication of epistemological beliefs. This finding brings renewed emphasis on the nature of science in science education and highlights the manner in which science education including a strong nature of science component can contribute to the education of all students.

High School Students' Argumentation of Energy Consumption Issues

Hui Jin, Ohio State University, hjin@ehe.osu.edu

ABSTRACT: The purpose of this interview study is to investigate high school students' argumentation of an important socio-scientific issue—the impact of human energy consumption on global climate. In particular, I focus on two dimensions of argumentation: the logical dimension (constructing discipline-based monological arguments) and the dialogical dimension (co-constructing dialogical arguments). One-on-one clinical interviews were conducted to collect monological arguments. Focus group interviews were carried out to collect dialogical arguments. Fifty students from an urban high school participated the study. Based on the analyses of 20 monological arguments and 10 dialogical arguments, I developed two frameworks, each describing students' achievement levels on one dimension of argumentation. Regarding the logical dimension, the results indicate that students have difficulty constructing arguments with scientific mechanisms (matter/energy transformation in processes and chemical energy of organic molecules). Regarding the dialogical dimension, results show that students have difficulty constructing goal-directed argumentative conversations. The findings suggest that it is important to explicitly teach argumentation in high school science classrooms.

Analyzing Epistemic Utility: How Students Evaluate and Coordinate Scientific Research Questions

Eric Berson, UC Berkeley, eberson@berkeley.edu

ABSTRACT: While encouraging students to ask scientific questions is a goal of science education, challenges remain about how best to support students in understanding the epistemic utility of scientific research questions for advancing the goals of science. This paper reports on findings from an empirical study using a novel task to assess how students evaluate and coordinate scientific research questions to investigate phenomena. The analysis focuses on the extent to which students consider the epistemic utility of scientific research questions and how they leverage multiple research questions to test a theory. Findings highlight particular forms of epistemic utility and patterns in how students in different grade cohorts (elementary and high school) evaluate the utility of scientific research questions. This study has implications for the design of inquiry-based science instruction and for the assessment of students' practical epistemological beliefs.

Strand 2: Science Learning: Contexts, Characteristics and Interactions***Symposium - Controversy in an AP Biology Class: Looking Beyond Content Knowledge and Religiosity***

1:15pm-2:45pm, Caribbean Salon 2

President: Minjung Ryu, University of Maryland

Presenters:

Minjung Ryu, University of Maryland

Tiffanyrose Sikorski, University of Maryland, College Park

Jennifer Richards, University of Maryland, College Park

Lama Jaber, University Of Maryland, College Park

Janet Coffey, University of Maryland, College Park

ABSTRACT: This symposium takes an in-depth look at a controversial moment in a science classroom, in which a student, Yun Ho, poses questions about evidence supporting the theory of evolution. Despite his attempts to engage his classmates, his peers largely fail to engage with Yun Ho's questions. Drawing on four different analytical perspectives, namely affect, coherence seeking, expectations, and identity, we aim to make sense of this controversial exchange. Rather than bringing normative stances on what science learning and the learning of evolution should look like, we try to understand this interactional moment from learners' perspectives. Finally, we conclude with an interactive discussion reflecting on how these four perspectives help us understand the focal moment, and implications for science teaching and learning.

Strand 2: Science Learning: Contexts, Characteristics and Interactions***Science Learning within Chemistry Domains***

1:15pm-2:45pm, Río Mar Salon 10

President: Vashti Sawtelle

Conceptual Understanding of Chemical Reactions and Energy: An Investigation through Context-Based Approach

Ceyhan Cigdemoglu, Atilim University, ccigdemoglu@atilim.edu.tr

Omer Geban, Middle East Technical University

ABSTRACT: The aim of this study was to delve into the effect of context-based approach (CBA) over traditional instruction (TI) on students' understanding of chemical reactions and energy concepts. Additionally, the effect of treatment on gender was investigated. Six eleventh grade classes with 187 students taught by three teachers from two public high schools in 2011 fall semester were enrolled in this particular study. Each teacher had an experimental and a control group. These classes were assigned randomly as experimental and control groups. The experimental groups were treated with CBA, control groups were treated TI. Chemical reactions and energy concept test was administered as pre- and post-test to the groups. Analysis of Variance (ANOVA) was used for the analysis of data. The results revealed that CBA was superior to TI on students' conceptual understanding regarding the chemical reactions and energy unit. Additionally, the treatment did not favor males or females. The findings imply that CBA, as discussion platform of

concepts through real-life experiences, have potential to increase students' conceptual understanding in **ABSTRACT** and difficult concepts.

Investigating the Effects of Problem-orientation and Interconnectedness in Context-based Learning Tasks

Elke Sumfleth, University of Duisburg-Essen, elke.sumfleth@uni-due.de

Andrea Harbach, University of Duisburg-Essen, Chemistry Education

Sabine Fechner, Leibniz University Hannover

ABSTRACT: Context-based learning is a widespread and popular learning approach in chemistry education. Important characteristics of context-based learning are problem-orientation and the interconnectedness of everyday life contexts (e.g., fruit juice and teeth) and chemistry-related content (e.g., acids and bases). However, there are few studies investigating this approach and results are inconsistent. Moreover, most studies are faced with methodological problems. Therefore, a more detailed analysis is necessary. This project investigates the influence of problem-orientation and interconnectedness as design principles of context-based learning material. First, hypotheses of the effects on learning are derived from different theoretical considerations. Then, the study is presented being conducted with secondary school students in a controlled setting. Learning tasks are provided on textual basis in order to test the hypotheses. Learning outcomes confirm the assumption that problem-oriented learning tasks might overstrain the learners' cognitive load and thus decrease student situational interest, while interconnectedness raises interest levels and decreases cognitive load. The fact that no achievement effect could be found in the study is discussed in the presentation.

Subject as Context Level in Biology and Chemistry Courses

Vanessa Pfeiffer, University of Duisburg Essen, vanessa.pfeiffer@uni-due.de

Eva Kölbach, University of Duisburg-Essen

Elke Sumfleth, Universität Duisburg-Essen

Angela Sandmann, University Of Duisburg Essen

ABSTRACT: This study compared learning and motivation across two different context levels, i.e. subject (biology vs. chemistry) and explanatory example (adventure vs. subject-specific). Students learnt with worked examples about hormonal control systems and salt and solubility either in chemical or biological courses. Thus, each experimental group learnt about content outside subject area and content corresponding with the curriculum of the course. Worked examples in each course varied in the example used to explain the content (adventure vs. subject specific). Students' level of knowledge was measured before learning with the worked examples and once again afterwards. Before learning students specified expectancy beliefs and academic self-concept. After learning with the worked examples students were asked to report their intrinsic motivation. Our results indicate subject seems to be a superior context compared to explanatory examples in biology and chemistry courses. A relation between learning performance concerning content outside the subject and expectancy beliefs / academic self-concept was found; however, this was not the case for content corresponding with the regular curriculum.

Evaluating Characteristics of Real-life Contexts for the Chemistry Classroom

Sabine Fechner, Leibniz University Hannover, fechner@idn.uni-hannover.de

Helena Van Vorst, University of Duisburg-Essen

Elke Sumfleth, University of Duisburg-Essen

ABSTRACT: Over the last decades, context-based learning has become a popular teaching approach and has been advocated by science educators as a way to innovate chemistry learning. Research on the approach is multi-faceted with studies mostly focusing on teacher professional development, student interest as well as learning. However, evidence in some areas is still inconsistent while other areas suffer from the lack of a research-driven approach by making decisions on an intuitive basis. With regard to its effects on interest, evidence generally shows positive effects but varies according to the contexts selected for the learning environment. Scrutinizing the selection process of the respective real-life contexts it becomes obvious that characteristics for an effective learning environment have rather been defined on an intuitive and unfounded way. Thus, the present study aims at defining relevant characteristics that constitute real-life contexts on the basis of an in-depth literature review, validating the characteristics by means of a questionnaire and evaluating its effects on student interest. By this, the authors intend to further elucidate the factors

that make real-life contexts potentially valuable for successful student learning and hope to give purposeful advice to teachers being engaged in context-based courses.

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

Related Paper Set - Engaging Experienced and Preservice K-6 Teachers In Scientific Practices of Argumentation and Explanation Building

1:15pm-2:45pm, Río Mar Salon 3

Presider: Carla Zembal-Saul, Penn State University

ABSTRACT: Contemporary perspectives on proficiency in science place increasing emphasis on integrating scientific practices into school science. While recent research in science education has focused on students' explanation construction and scientific argumentation, very little has specifically focused on understanding and supporting teachers with these complex scientific practices. In this related paper set, the authors directly address the gap with their focus on scientific discourse and practices among elementary teachers. The work presented here balances essential research on teachers and teaching science with the informed approaches of teacher educators who are committed to crafting supportive contexts for teacher learning. Collectively, these five papers make important contributions to the field in terms of what we understand about elementary teachers' beliefs and practices related to classroom discourse/argumentation, the ways in which teachers take-up aspects of explanation and argument in their teaching, and the role of carefully crafted teacher learning experiences focused on scientific discourse. The paper set is of general interest to the NARST membership, particularly those scholars interested in research on elementary science teaching, scientific practices in elementary classrooms, and argumentation.

Teachers' Beliefs and Practices Around Argumentation During a Curriculum Enactment

Katherine L. McNeill, Boston College, kmcneill@bc.edu

Maria Gonzalez-Howard, Boston College

Rebecca Katsh-Singer, Boston College

Jeremy F. Price, University of California Berkeley

Suzanna Loper, University of California Berkeley

Elementary Teachers' Uptake of Aspects of a Framework for Constructing Explanations in Science

Mark Merritt, Penn State University, mdm35@psu.edu

Carla Zembal-Saul, Penn State University

Alicia McDyre, Penn State University

Promoting Explanation-Based Reasoning Through Teacher Questioning Practices

Kari Shutt, University of Washington, shuttk@uw.edu

Nancy Vye, University of Washington

Pre-Service Teachers Arguing About Science Teaching Methods

Kathleen Crucet-Villavicencio, University of Wisconsin, Madison, kathleen.crucet@gmail.com

Leema Berland, University of Wisconsin, Madison

A Discursive Model for Engaging Pre-Service Elementary Teachers with Teaching Science as Argument

Elisebeth Boyer, Penn State University, eboyer@psu.edu

Carla Zembal-Saul, Penn State University

Strand 4: Science Teaching--Middle and High School (Grades 5-12): Characteristics and Strategies***Assessing Students' Science Understandings***

1:15pm-2:45pm, Pelican Room

Presider: Huseyin Colak*Investigating the Development and Influence of Particle-Oriented and Two-Stage Teaching Module Via Conceptual Evolutionary Approach*

Wen-Lung Wu, National Taiwan Normal University, ntnu.wl.wu@gmail.com

Mei-Hung Chiu, National Taiwan Normal University

Hongming Liaw, National Taiwan Normal University

ABSTRACT: This study adopted multiple research methods to investigate the mental model of phase transitions and developmental processes. The research purposes were: (1) to investigate student's conceptual development via a survey of fourth through twelfth grades (n=832); (2) to construct the conceptual evolutionary tree with Phylogenetic technique; (3) to develop the teaching module for primary school (n=110). Instruments employed included "Questionnaire of Particle Nature and Phase Transitions (QPP)" and "PAUP* 4.0". The "Particle-Oriented and Two-Stage Teaching Module (PTTM) of Phase Transitions," consisted of two stages (particle nature and phase transitions) and role-play, was used for the experimental teaching program. The results were shown as below: (1) a majority of primary school students held correct macroscopic concepts and did not construct particulate concepts until high school; (2) Based on the software generated "Conceptual Evolutionary Tree," the Scientific Model developed after constructing particle view was located in Area C (out of four areas); (3) PTTM significantly improved student's learning in primary school even with only partial participation in the experimental teaching module. In conclusion, by employing three research methods, the current study was strengthened in its validity and reliability and thus should be considered for future curriculum studies.

Understanding Korean High School Students' Conception of Climate Change Using Issue Concept-Map (IC-Map)

Jinhee Kim, Ewha Womans University, kkjjeneb@hotmail.com

Kongju Mun, Ewha Womans University

Sung-Won Kim, Ewha Womans University

Joseph Krajcik, Michigan State University

Jiyoung Jang, Ewha Womans University

Hyo-Suk RYU, Ewha Womans University

ABSTRACT: We explored high school students' conceptions related to climate change. 155 high school students participated. The researchers developed the Issue Concept-map(IC-map) for evaluating student's personal conceptual understanding. The IC-map is a structured concept-map for exploring students' understanding of various issues. The accompanying worksheet is divided by context (personal, societal, global) and occurrence (cause, effect and countermeasure). The IC-map allows students to consider what are causes, effect and countermeasures of climate change at the personal, societal, and global level. Students expressed what they knew about climate change on their IC-map worksheet and individually completed it for 50 minutes. We found four trends related to students' understanding. First, the global effect (GEf) cell presented the most number of students' answers. Second, student confused climate change with other environmental issues such as ozone layer depletion, exhaustion of energy. Third, students drew connections from personal context to societal and global context and connections from cause to effect and countermeasure forthly. Therefore we suggest that educators and researchers who develop science education materials need to consider students' conceptual understanding of climate change. We also suggest that researchers and science educators need to further work with students to gain in depth of their understanding of socio-scientific issues such as climate change.

A Comparative Study of the Development of Science Proficiency in High School Chemistry

Jonathon Grooms, The Florida State University, jgrooms@fsu.edu

Patrick J. Enderle, The Florida State University

Victor D. Sampson, Florida State University

ABSTRACT: This study explores students' development in several aspects of science proficiency in the context of two instructional models for laboratory investigations implemented in high school chemistry. Students experienced either a

traditional model of laboratory instruction that can be generally described as teacher-centered, while students at a different institution experienced the argument-driven inquiry instructional model. Learning gains were measured using four different assessments, which each target a specific aspect of science proficiency. Results from this study indicate that both groups achieved statistically significant learning gains with respect to various aspects of science proficiency. However, the impact of the ADI instructional model, as measured by the effect size for the learning gains, was far greater than the impact of the traditional model of instruction. For example the ADI model had nearly twice the effect of the traditional model in terms of students' knowledge of scientific explanations and nearly 35% more effect on students' ability to use scientific explanations to explain phenomena. Furthermore the treatment group demonstrated small to moderate effects in their ability to communicate in writing and design investigations, but the traditional instruction engendered no effect in those areas.

Gender and Levels of Attainment of Scientific Literacy Among Students Under Constructivist Instructional Model

Apollonia A. Nwosu, University of Nigeria, apoanaelenwosu@yahoo.com

Ebere Ibe, University of Nigeria

ABSTRACT: The study investigated gender and levels of attainment of scientific literacy by 8th grade students. The design of the study was quasi-experimental. 162 grade 8/junior secondary school students in four intact classes randomly selected from twenty two such schools in Abia State in Nigeria constituted the sample for the study. These four selected schools were randomly assigned (two each) to the experimental and control groups. Data were collected using an instrument – Test of Scientific Literacy (TOSL). This instrument was face and content validated. After trial testing, the Reliability Coefficients were 0.69 for part A (multiple objective test items) and 0.72 for the practical test items (part B). Findings showed that constructivist instructional strategy increased students' attainment of scientific literacy. Also girls performed slightly better than boys when exposed to the inquiry and activity based constructivist instructional strategy although this difference is not significant. Constructivist instructional strategy was found to be superior to gender in attainment of scientific. These findings support literature on the efficacy of inquiry based methods for effective STEM education as well as authenticate the learning propositions of Piaget and Vygotsky's that emphasize inquiry based and interactive pedagogical practices for effective science education.

Why Do Students Struggle With the Idea of Conservation of Matter?

Ingrid M. Sanchez-Tapia, University of Michigan, ingridsa@umich.edu

Joseph S. Krajcik, Michigan State University

Namsoo Shin, University of Michigan

ABSTRACT: Conservation of matter is a core scientific concept that students must understand because its explanatory power across virtually all areas of science and engineering. However, our preliminary results show that middle school students struggle to understand conservation of mass during physical and chemical changes. We use a mixed methods approach to understand the sources of difficulty that students experience when faced with items focused on the conservation of matter. We performed Item Analysis with nine items and conducted Constant Comparative Analysis on students' responses and teachers' interviews to better characterize and explain students' difficulties. We found that the most difficult items for middle school students before and after instruction were those focused on assessing students' understanding of conservation of mass in the context of phase change and chemical reactions. Students' difficulties might stem from not understanding that gases have mass, not perceiving the role of gases in combustion nor their connection with weight and volume changes, over-reliance on perceptual information, and a tendency to perceive gases, liquids and solids as different types of matter. We propose the ideas of accuracy, precision, and substance as stepping-stones to help students improve their understanding of conservation of matter during transformations of matter.

Strand 5: College Science Teaching and Learning (Grades 13-20)
Focusing on Conceptual Understanding in College Science Teaching

1:15pm-2:45pm, Parrot Room

President: Meghan Rector Federer, The Ohio State University

Demon Facilitated Understanding of Entropy: A Cognitive and Community Approach

Sissi L. Li, California State University Fullerton, sili@fullerton.edu

Michael E. Loverude, California State University Fullerton

ABSTRACT: This research is part of a broader and ongoing project to investigate student learning and develop curricular materials for upper-division courses in thermal physics. We have investigated student learning of entropy and developed and tested curricular materials on entropy, engines, and the second law of thermodynamics. Entropy is a core idea of thermodynamics and statistical physics. Entropy is also a fundamental concept that spans the physical and biological sciences. However, two features of entropy make it challenge to understand—entropy is often a more **ABSTRACT** concept than those students have encountered previously, and entropy is articulated differently by discipline. As a result, students draw on ideas and experiences for making sense of entropy which may not always be productive. In this study, we present interview and class observation data to examine how students in a thermal physics course make sense of entropy using ideas from within and beyond the course. In addition, we study the practices of the classroom community that play a role in student sense making. Together, these findings allow us to construct a model for thinking about entropy learning that is both cognitive and social.

Effects of Problem-Based Learning on Biology Students' Conceptual Understandings About Animal Physiology and Student Perceptions

Lin Xiang, University of Kentucky, lin.xiang@uky.edu

Jeffrey L. Osborn, University of Kentucky

Jana L. Bouwma-Gearhart, University of Kentucky

ABSTRACT: The present study sought to investigate the effects of a problem-based learning (PBL) instructional model designed to suit biology undergraduates' learning about animal physiology and student's perception about the model. An experimental design was used to compare PBL students' understandings to that of their counterparts attending the conventional lecture class. ANOVA analyses suggest that the PBL model implementing in this study had a positive effect on student higher level cognitive learning and in the meantime did not result in shortcomings in students' grasp of basic conceptions. Student responses to survey question indicate that these students valued the key components of the PBL model but still expected some direct instruction and explanations.

Do We Emphasize Too Much on Conceptual Understanding Over Algorithmic Problem Solving in Introductory Physics, or Vice Versa?

Shin Young Lee, Ewha Womans University, 1017lee@hanmail.net

Jung Sook Yoo, Ewha Womans University

Kevin Insik Hahn, Ewha Womans University

ABSTRACT: The purpose of this study is to determine the relationship between conceptual understanding and algorithmic problem solving ability in students' physics performances. Sixty university students were involved in this study. In order to assess students' performance, two tests on conceptual and algorithmic questions were utilized. Students' performances in each test were analyzed statistically. The analyses were conducted to compare two types of question score by assessing the Pearson correlation coefficient and comparing each level. Students were categorized by their performance on algorithmic problems and by their understanding of conceptual questions. The results of this study were as follows: First, the algorithmic mean score was higher than the conceptual mean score. The mean difference was not significant. Second, the Pearson correlation was 0.690. This means that there was positive correlation between two types of question scores. Third, after comparing the two types of question scores individually, there were some big score gaps. Fourth, when the students were divided into the three groups by performance level, the students in the same algorithmic and conceptual group (HAHC, MAMC, LALC) were just on half of all students. From these comparisons, there is a weak positive relation between conceptual understanding and algorithmic performance.

Moving Students to a Better Understanding of Enzyme Specificity

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Kristy Halverson, University of Southern Mississippi

Brian Gearity, University of Southern Mississippi

ABSTRACT: Students often struggle with understanding enzymatic reactions. One reason for students' confusion stems from the traditional instruction of the inaccurate "Lock and Key" model of enzyme specificity. However, a proper understanding of enzyme specificity is connected to the students' understandings of other biological concepts. To address this problem, we developed a lesson based on a more scientifically accurate model; the "Induced Fit" model. We also supported this lesson with either of the two visual representations, static or dynamic, to compare the influence of each representation on understanding the concept. We used pre/post-tests, interviews, artifacts, and administered a follow-up content exam from eight senior students of the School of Human Performance and Recreation and compared them to a control group of fifteen students at a research-intensive university. Upon analysis, we identified a positive influence of both representations on developing knowledge about the "Induced Fit" model. Both representations as well helped students retain more information about this concept as compared to controls. Students exposed to dynamic representations demonstrated a deeper understanding of the "Induced Fit" model. Therefore, instructors should consider teaching the "Induced Fit" model of enzyme specificity. More research is needed before reaching conclusions about the best representation of this model.

Strand 6: Science Learning in Informal Contexts***The Value of Connecting Informal and Formal Educational Systems***

1:15pm-2:45pm, Sea Gull Room

Presider: Amy Cox-Petersen

Characterizing the UK Science Education Community

Matthew C. Wenger, Oregon State University, mwenger1701@gmail.com

John H. Falk, Oregon State University

Jonathan F. Osborne, Stanford University

Lynn D. Dierking, Oregon State University

Emily Dawson, King's College London

Billy Wong, King's College London

ABSTRACT: This paper presents the findings of a recent research effort to characterize the science education system in the United Kingdom and understand the value of informal science education to science learning in the U.K. Prior research has focused on identifying the major contributors to informal science education and attempting to document their individual efforts and outcomes. This research effort was aimed at constructing a more holistic view of the system that supports STEM education, identifying the major agents/resources in that system engaged in the provision of both informal and formal STEM learning experiences and evaluating how well the system functions. We collected data from four sources: A review of the academic literature to identify the main findings and theoretical perspectives in the literature, Interviews with 51 purposefully-selected participants drawn from 18 distinct "sectors" of providers of educational experiences in science, survey data from 200 participants representing these 18 sectors from across the country, and two symposia of purposefully selected participants representing major contributors from these representative sectors.

A Comparative Study of the Normative Scientific Practices in Herpetological Summer Programs for Children

Catherine M. Scott, Coastal Carolina University, cmkowole@uncg.edu

ABSTRACT: A purpose of this study was to examine the normative scientific practices in which elementary-aged participants in two different week long herpetology programs engaged and to describe how these experiences differed across each of the programs. The structures of the Herpetology and Reptiles programs were compared to determine how each herpetology program's activities and methodologies impacted participants' perceptions of authentic science and normative scientific practices. This study was conducted and the data analyzed using an interpretative case study, mixed

methods approach. For participants, the structure of the programs directly influenced participants' opportunities to participate in normative scientific practices. For one program, normative scientific practices aligned with more familiar scientific practices such as supporting ideas with evidence; in the other program, normative scientific practices provided a more rigid perspective of science. If science educators are to respond to the needs of students and to challenge their students to engage in authentic science, they must take into consideration how they want their students to define authenticity in science. Participants were able to pinpoint what made them feel like scientists and to identify the normative practices reinforced within each program – something that educators must consider when working with students of their own.

How to Support Students to Apply Knowledge Learned in the Classroom to a Field Setting

Kari Beate Remmen, University of Oslo, k.b.remmen@naturfagsenteret.no

Merethe Frøyland, University of Oslo

ABSTRACT: This study focuses on how teachers can support students to apply knowledge learned in the classroom to the real phenomena in the field. Through video observation of one teacher and seventeen senior high school students in Norway, we contrast the process of teaching and learning of two concepts - rocks and relative dating - in the classroom preparation and in the field. We analyzed the type of knowledge-in-use and the extent of students' understanding of this knowledge. The findings indicate that the students had difficulties with applying knowledge without bridging clues (i.e., in the case of rocks). In contrast, they managed to apply knowledge with bridging clues when the bridging clues were unambiguous, explicated, and practiced in the classroom preparation (i.e., in the case of relative dating). Additionally, a post-test of four students one year after the fieldwork revealed understanding of relative dating but not of rocks. The study concludes with recommendations for how teachers can support beginning students to apply knowledge in the field: focus on knowledge with relevant bridging clues, reduce the amount of factual knowledge that cannot be connected to physical features in the field, and ensure overlap between the classroom preparation and the field tasks.

Strand 7: Pre-service Science Teacher Education

Learning to Create Culturally-Responsive Science Classrooms

1:15pm-2:45pm, Canary Room

President: Sara E. Tolbert

How Do I Make it Relevant? Preservice Science Teachers Contextualizing Instruction in Underserved Classrooms

Sara E. Tolbert, University of Arizona, saratolbert@email.arizona.edu

ABSTRACT: This paper describes results from a qualitative study in which I investigated the practices of preservice science teachers learning to contextualize instruction in underserved placement classrooms, where contextualizing instruction is defined as facilitating authentic connections between science learning and relevant personal and sociocultural contexts for all students. Data sources include three 1.5-hour audio-recorded classroom observations and field notes with each of four student teachers (12 observations total), debrief interviews for each lesson, and 2 focus group interviews with all four participants, as well as participants' written and videotaped state performance assessments for teachers. Results show that participants actively attempted to contextualize science instruction in their placement classrooms. Success at those attempts varied among participants, with performance assessment lessons being the most contextualized. Participants identified challenges to successful contextualization as limited autonomy from cooperating teachers and insufficient lesson planning time. Participants identified supporting factors as engaging in hands-on contextualized inquiry lessons and viewing videotaped segments of contextualized science activities in methods courses. Although the activities they implemented represented a diversity of approaches to contextualization, they struggled to create and facilitate activities that were authentically student-centered, dialogic, and inquiry-based. Implications for how teacher educators can address these challenges are discussed.

Learning to Teach Elementary Science in an Experiential, Informal Context: Culture, Learning and Identity

Carolyn S. Wallace, Indiana State University, carolyn.wallace@indstate.edu

ABSTRACT: Learning to teach elementary science through clinical classroom experiences is often problematic in the

United States, because in the current climate of testing for reading and math, time for science is minimized. The purpose of this qualitative study was to investigate how the culture of a methods class located in the experiential, informal learning context of a summer science camp impacted preservice teachers' understandings of science teaching, learning and their science identities. The research design was an ethnography with embedded case studies of three preservice teachers. Findings indicated that key cultural aspects of the learning environment included: (a) giving the preservice teachers autonomy in planning, management and teaching; (b) distributing the instructional burden through peer collaboration; and (c) developing close interpersonal relationships with both children and mentor teachers. Students learned how to view and implement science teaching as exploration and inquiry through reflection on their lessons. All three case study participants developed their identities as enthusiastic teachers of science, including evidence that they have developed a stronger personal interest and confidence in teaching science.

Reflecting on Contrasts: Productive Reflection by Pre-Service Teachers Inspired by Multiple Field Placements

Daniel K. Capps, University of Maine, daniel.capps@maine.edu

Shirly Avargil, University of Maine

Jonathan Shemwell, University of Maine

Tao Mason, Yale University

MacKenzie R. Stetzer, University of Maine

Michelle K. Smith, University of Maine

ABSTRACT: Supporting pre-service teachers in becoming reflective practitioners has been an important aim of teacher education programs for the last several decades. The idea that supporting pre-service teachers in reflecting on teaching and learning experiences can promote continued growth and development through induction and beyond is quite powerful. This study examined the experience of pre-service teachers during a semester-long field placement. Aspiring teachers were placed with between one and three practicing teachers who were enacting the same set of instructional resources in their classrooms for the first time. We used a qualitative approach consisting of multiple data sources to investigate the nature and change of pre-service teachers' reflective comments throughout the semester. Then, through a case study of one pre-service teacher, we looked for evidence that reflection may have resulted from contrasts the aspiring teacher observed during her placements. Results indicate an increase in reflective comments throughout the semester for pre-service teachers who had multiple placements. Moreover, we argue that the placement of pre-service teachers in multiple classrooms has the potential to support deep reflection and the concomitant understanding of teaching and learning in a more sophisticated manner. Results highlight the potential benefit of placing early pre-service teachers in multiple classrooms.

Can We Prepare Teachers for Culturally Responsive Teaching Without Protracted Field Experiences in High-Need Settings?

Kevin Goff, College of William & Mary, kdgoff@email.wm.edu

Juanita J. Matkins, College of William & Mary

Jacqueline T. McDonnough, Virginia Commonwealth University

ABSTRACT: Special initiatives which aim to prepare preservice science teachers for careers in high-need schools must typically do so within the context and confines of the wider teacher education program and surrounding K-12 setting. This ongoing study compares two such initiatives (both Noyce Scholars programs), each using a distinct, locally adaptive approach. One university provides preservice teachers with protracted immersive field placements in high-need schools under the guidance of a specially trained, proven veteran of such environments. The other university instead provides supplemental (but non-immersive) field experiences in high-need schools, coupled with explicit exercises to provoke reflection, cultural self-awareness, and cross-cultural consciousness and commitment. Although the first university's prolonged and authentic field experiences have been a more effective strategy for cultivating good habits of culturally responsive STEM instruction, the second university's Noyce program has in each of its first three years responded both to its research findings and to feedback from its preservice teachers by making strategic changes to its program elements. As a result it has been increasingly successful at building the desired skills and dispositions. More than one strategy may be able to support the development of culturally responsive science teachers.

Strand 7: Pre-service Science Teacher Education***Methods to Improve Preservice Teachers' Practices***

1:15pm-2:45pm, Río Mar Salon 9

Presider: Stacey Britton*Developing Practical Wisdom for Teaching Science in Initial Teacher Preparation: Adopting Electronic Portfolios*

Karen Goodnough, Memorial University, kareng@mun.ca

ABSTRACT: In this study, electronic portfolios (e-portfolios) were adopted as a tool to examine the development of science teacher candidates' practical wisdom during a three-semester teacher preparation program. More specifically, the study was guided by the following research questions: a) How does teacher candidates' practical wisdom change or develop during initial teacher preparation? b) How can the processes/activities adopted during the creation of e-portfolios support the development of teacher identity in initial teacher preparation? Outcomes of this qualitative study focus on three broad themes: teacher candidates' understanding of the complexities of teaching, teacher candidates' practical wisdom and future goals, and the value of e-portfolios.

Helping Pre-Service Elementary Teachers Enact Strong Lesson Planning Practices

Jennifer L. Cartier, University of Pittsburgh, jcartier@pitt.edu

Elaine M. Lucas-Evans, University of Pittsburgh

Danielle Ross, University of Pittsburgh

Ellice A. Forman, University of Pittsburgh

ABSTRACT: In earlier work related to this longitudinal study, we reported that the Learning Cycle is an effective framework for helping pre-service elementary teachers (PSETs) select and sequence learning tasks provided in curriculum materials. While important, these skills are clearly not sufficient to enable teachers to enact ambitious science instruction. Teachers must also be able to anticipate how learning activities will unfold in their particular classrooms and be prepared to draw upon a variety of instructional tools to support students' discursive engagement in those activities. Thus study builds on our early work by looking more in depth at PSETs' use of specific microplanning practices designed to support student engagement in the Engage, Explore, and Explain portions of the Learning Cycle. A group of 51 PSETs planned for, enacted, and created artifact packets to document their instruction of a science Learning Cycle. Analysis of their lesson plans revealed that they found planning for questioning more difficult than planning for tools. While all PSETs incorporated a variety of tools into their lessons, they struggled most to implement, adapt, or design tools to support students' development of explanations and to support students' overall engagement with second-hand data.

Strand 8: In-service Science Teacher Education***What Should Mentoring Look Like during the Induction Years?***

1:15pm-2:45pm, Río Mar Salon 4

Presider: Samina Naseem, Michigan State University*Personas of Novice Science Teacher Mentors*

Samina Naseem, Michigan State University, naseemsa@msu.edu

ABSTRACT: The purpose of the study was to understand how professional identity influence novice science mentors' mentoring practices. This study was conducted with three novice science mentors who were mentoring for the first or the second time at secondary level. The primary data sources included interviews with novice science mentors and their interns. In this paper, I argue that mentors may communicate or model their own practices adequately; however, these practices may not be aligned with the ones that are valued by the teacher preparation programs. This non-alignment, results in a significant tension between all three parties involved (the teacher preparation program, the teacher candidate, and the mentor). I also argue that science mentors position themselves according to what they value as experts. That is, values of teacher education programs may not be a part of mentor's professional identity. The preliminary results show that the three novice science mentors valued "egalitarian" relationship with interns but positioned themselves as role models and maintained the "expert" stance, rather than as an "educative" companion.

Furthermore, with limited understanding of their role as a mentor, the participants associated mentoring with teaching, i.e., they taught student teachers rather than helping them to solve problems themselves.

Opportunities for Change: The Noticings and Self Reflections of a Cooperating Secondary Science Teacher

Shelly R. Rodriguez, University of Texas, shelly.rodriguez@austin.utexas.edu

James P. Barufaldi, The University of Texas at Austin

ABSTRACT: During a typical early field experience, cooperating science teachers interact with preservice teachers to observe and provide feedback on their lessons. While research has shown that cooperating teachers are highly influential in determining the kinds of practices that preservice teachers ultimately adopt little attention has been paid to their professional growth. This case study focuses one secondary science cooperating teacher working with a nationally recognized STEM teacher preparation program. The study asks the following questions: 1) What does the secondary science cooperating teacher notice as he observes preservice teachers enacting lessons in his classroom? 2) Does the act of noticing stimulate reflection and pedagogical reasoning in the cooperating teacher? 3) Does the teacher draw connections between what he notices and his own teaching practices? The findings show that the cooperating teacher primarily attended to student understanding of science concepts and student participation. Additionally, the act of observation stimulated reflection and pedagogical reasoning. Finally, data revealed that the teacher made connections to his own teaching which led him to inquire into his own practice. Findings from this study will be useful for in-service teachers, teacher educators, researchers, and others interested in creating field experiences that benefit both preservice and classroom teachers.

Teachers' Experiences in Professional Development: A Comparison of Face-To-Face, Online, and Hybrid Delivery Models

Ya-Wen Cheng, University of Missouri, yck86@mizzou.edu

Deborah L. Hanuscin, University of Missouri-Columbia

Mark J. Volkmann, University of Missouri

ABSTRACT: In teacher education, mentoring as a supportive mechanism is broadly used to assist teachers to develop content knowledge and pedagogical skills. In this qualitative case study, we examined the essential elements of effective mentoring from teachers' perspectives and how different environments (face-to-face, online, and hybrid) afford learning opportunities for the PD participants. Data sources included interviews, coach observation forms, mentor reflection forms, as well as artifacts and field notes over a six-month period were used in this study. The result suggested that the essential elements for effective mentoring include being able to reflect, receiving feedback, building a trust relationship, sharing experience/understanding and accountability. Regardless which delivery model was used for mentoring, they all provide teachers an opportunity to step back from being in the moment of teaching and reflect on practice and forces them to make this a part of their learning. Face-to-face delivery model provides real-time feedback, an opportunity to address immediate concerns regarding their teaching or student learning and hold teacher more accountable of their teaching. An online delivery model enables coach/mentor and teachers to meet more frequently with less time and location constraints. Hybrid delivery model delivers a more flexible learning environment and increase collegiality.

On the Nature of Induction: Case Studies of Four Beginning Secondary Science Teachers' Induction Experiences

Angela W. Webb, Louisiana State University, awwebb@lsu.edu

ABSTRACT: As one of the top five areas experiencing teacher shortages (Keller, 2003), the need to produce high-quality science teachers and keep them in the classroom is quite pressing and the successful induction of beginning secondary science teachers is crucial. Induction programs have been shown to positively impact the retention of beginning secondary science teachers; however, little is known about the nature of induction supports and the ways beginning science teachers experience such supports. Given this, the purpose of this study is to describe beginning science teachers' induction supports and the ways they experienced such supports. The data collected in this multi-case study focusing on induction experiences of four first-year secondary science teachers can be used to make the following arguments: First, not only is there variation among different induction programs, but there is also variation within a single school district's induction program. Second, in providing myriad supports, the district and schools took for granted that they knew what participants needed, leading to a top-down approach to support. Third, despite the multitude of provided supports, beginning science teachers most greatly valued school-based supports that privileged agency and flexibility.

Strand 9: Reflective Practice***Related Paper Set - Affordances and Limitations of Video Clubs in Promoting Science Teacher Thinking, Learning, and Practice***

1:15pm-2:45pm, Heron Room

ABSTRACT: In this related paper set, we explore how video clubs with a variety of designs, purposes, settings, and approaches can promote science teacher learning. We argue that video clubs can be useful at any stage of teacher learning – from preservice to inservice, elementary to secondary – with goals adapted to specific needs. Video clubs provide an approach to supporting teacher learning that is situated in teachers' own practice and creates an authentic space for teachers to reflect on their practice, observe other models of practice, and attend to details often overlooked in the moment of teaching. During club, teachers can leverage records of practice to reason about teaching and learning and have opportunities to replay and rehearse classroom events with colleagues. Video clubs can also push teachers to extend their specialized content knowledge for teaching and attend to specific aspects of practice, such as student thinking or scientific representations. However, video clubs also present challenges that may impact teacher learning, including heterogeneous grouping of teachers and a unique professional learning culture that can create tensions for teachers. Throughout this collection of studies, we discuss the affordances and limitations of teacher participation in video clubs and the potential implications for classroom practice.

Developing Preservice Teachers' Knowledge for Teaching through Video Clubs

Heather J. Johnson, Vanderbilt University, heather.j.johnson@vanderbilt.edu

Michelle Cotterman, Vanderbilt University

Video Clubs as Productive Sites for Preservice Science Teachers to Interrogate Instructional Representations

Michelle Cotterman, Vanderbilt University, michelle.e.cotterman@vanderbilt.edu

Heather J. Johnson, Vanderbilt University

Promises and Limitations of Video Clubs for Supporting Ambitious Science Teaching

Melissa Braaten, University of Wisconsin, mbraaten@wisc.edu

Supporting Teachers' Ability to Attend to Student Thinking in Science

Melissa J. Luna, West Virginia University, melissa.luna@mail.wvu.edu

Miriam Sherin, Northwestern University

Strand 10: Curriculum, Evaluation, and Assessment***Symposium - Understanding Inquiry Classroom Practice through Measurement of Teacher Inquiry Skills***

1:15pm-2:45pm, El Morro 1 & 2

Presider: Jon E. Pedersen, University of Nebraska-Lincoln**Presenters:**

Gwen Nugent, University of Nebraska, gnugent@unl.edu

Jon E. Pedersen, University of Nebraska-Lincoln

Jeff C. Marshall, Clemson University

Daphne D. Minner, Abt Associates

Jacqueline DeLisi, Education Development Center, Inc

Gina Kunz, University of Nebraska

ABSTRACT: Planning and implementing inquiry-based instruction is a demanding task for teachers, requiring several kinds of knowledge and pedagogy. As a first step in better understanding how such skills are enacted in the classroom and impact students' learning, it is important to have valid and reliable measurement tools. This symposium features developers of observation instruments for measuring teacher inquiry skills and practice. These protocols encompass a broad range of inquiry and measurement features, including different types of lesson events (instruction, discussion, presentation, etc.), instructional strategies (modeling, demonstrating, field study, etc.), and teacher behaviors. They

were designed to be used for a variety of purposes -- both formative and summative. They represent documentation at different time intervals (15-second, 5-minute, entire lesson) and at different levels of assessment (individual indicator, construct, lesson). They can be used with a variety of instructional models and science content and can assess inquiry-related practices from both a quantitative (how much) and qualitative (how effective) standpoint. Symposium panelists will provide background information on the instruments and will engage in a moderated discussion of issues and nuances associated with the development and use of these instruments as a means to better understand teacher inquiry practice.

Strand 10: Curriculum, Evaluation, and Assessment

Models and Applications of Research and Evaluation on Student and Teacher Outcomes

1:15pm-2:45pm, Río Mar Salon 2

Presider: Stephanie Sisk-Hilton, San Francisco State University

Improving Learning by Improving Classroom Assessment in Earth Science: Findings from the Contingent Pedagogies Project

William R. Penuel, University of Colorado Boulder, william.penuel@colorado.edu

Angela H. DeBarger, SRI International

Savitha Moorthy, SRI International

Yves Beauvineau, Denver Public Schools

Kate Allison, University of Colorado Boulder

ABSTRACT: Past research has documented many difficulties teachers face implementing effective classroom assessment practices, especially using assessment tools to help elicit and develop student thinking. The Contingent Pedagogies project is a professional development intervention aimed at supporting effective classroom assessment in middle school Earth science. Researchers and teachers co-designed a suite of tools to support elicitation and development of student thinking related to core ideas in Earth science. In this paper, we report on a study that was conducted with 12 treatment and 7 comparison group teachers, who taught two Earth science units to a total of 587 students. In the study, we compared the two groups with respect to gains they made on two assessments of student learning, and we also analyzed data from videotaped lessons provided by all teachers in the study. Treatment teachers were more likely to employ high leverage talk moves that effectively elicit reasoning, encourage exploration of ideas, and use a greater variety of tasks to engage students in developing their thinking. Findings support the perspective that effective classroom assessment involves the integration of disciplinary content in tools for formative assessment practices.

Formative Assessment to Improve Student Learning in High School Chemistry

Angela H. DeBarger, SRI International, angela.haydel@sri.com

Carlos Ayala, Sonoma State University

Jim E. Minstrell, FACET Innovations

Rachel Freed, Sonoma State University

Sara Vasquez, SRI International

ABSTRACT: This paper examines the effectiveness of a formative assessment system, Diagnoser Tools for Chemistry, for improving student learning in chemistry. Standards- and research-based facet clusters including learning goals and common problematic student ideas served as the conceptual framework that guided the design of diagnostic questions and lessons. Findings from a quasi-experiment with six high school chemistry teachers and their students indicate that student learning gains were greater when teachers used the facet-based tools and formative assessment practices. Results also provide insight into the nature of students' problematic thinking in these chemistry classes. The study contributes to the generalizability and instructional validity of facet-based perspectives for instruction and assessment.

Evaluating Student Understanding in Virtual Environment-Based Science Assessments: Comparative Measures for Content Knowledge and Inquiry

Angela Shelton, North Carolina State University, anshelto@ncsu.edu

Uma Natarajan, Temple University

Diane Jass Ketelhut, University of Maryland
Deb Felix, University of Maryland
Chris Teufel

ABSTRACT: Although the scientific inquiry process is highly emphasized in national science standards, many educators assess the process with a surface level application, partially due to the constraints of paper and pencil assessments. This proposal illustrates evaluation of students' science content knowledge and inquiry skills within a virtual environment-based assessment consisting of multiple choice and constructed response questions. In a multiple regression examination of 263 middle grade students' inquiry and content understanding, inquiry evidence was the most significant predictor for a student's overall score. When students were assessed for inquiry process skills, many were able to demonstrate accurate understanding even though their scientific content misconceptions had previously indicated an incorrect response. Thus, evaluating the process of inquiry without providing students an opportunity to participate in the iterative procedures may only illustrate content understanding in a repeated way. In order to illuminate understanding of more than declarative scientific content knowledge, providing an assessment within an authentic context- perhaps ideally a Virtual Environment- is necessary for some students to demonstrate their understanding. If assessments are the litmus test for scientific literacy, then they must include a way for students to engage in inquiry, not just define it.

The Use of Outcome Mapping in the Educational Context

Anna R. Lewis, University of South Florida, arlewis@usf.edu

ABSTRACT: Outcome Mapping is intended to measure the process by which change occurs, it shifts away from the products of the program to focus on changes in behaviors, relationships, actions, and/or activities of the people involved in the treatment program. This process-oriented methodology, most often used in designing and evaluating community development projects uses graduated progress markers to determine if the intervention is achieving the desired outcomes and forms the basis for additional monitoring and evaluation. This theoretical paper explores the use of Outcome Mapping as an alternative or a supportive method of research design and evaluation in teaching and learning contexts. This paper discusses the relevance of this method and compares and contrasts the functionality, use, and outcome measures utilized in current educational assessments methods.

Strand 10: Curriculum, Evaluation, and Assessment

Related Paper Set - Developing and Evaluating an Eighth Grade Curriculum Unit that Links Foundational Chemistry to Biological Growth

1:15pm-2:45pm, San Cristobal

ABSTRACT: In response to the direction of modern biology, which according to the National Research Council "has become increasingly chemical in character" (2003), we are developing a six-week curriculum unit for eighth grade that connects core chemistry and biology ideas to provide a foundation for high school biology. Learning goals from national standards were selected and clarified in an iterative process. Curriculum development employed a backward design approach to arrive at a coherent presentation of science ideas that engages students with a range of observable phenomena and makes use of physical models to guide sense making and address common misconceptions. Professional development also used backward design based on a framework laying out the science knowledge and pedagogical skills teachers would need to implement the unit effectively. Student assessments were designed to measure knowledge of the science ideas and showed that the unit has great promise: student understanding increased significantly from pre- to post-test. Teacher assessments were designed to measure teacher knowledge of the science content, common student misconceptions, and curriculum activities and showed that teachers made small gains following professional development and larger gains after teaching the unit. These results are informing revisions in student and teacher materials and professional development.

Selecting Core Ideas and Practices -- An Iterative Process

Jo Ellen Roseman, AAAS Project 2061, jroseman@aaas.org

Cari F. Herrmann Abell, AAAS Project 2061

Jean C. Flanagan, AAAS Project 2061

Rebecca Kruse, BSCS
 Elaine V. Howes, BSCS
 Janet Carlson, BSCS
 Kathleen Roth, BSCS
 Brooke Bourdelat-Parks, BSCS

Changing the Research-Based Curriculum

Elaine V. Howes, BSCS, ehowes@bscs.org
 Rebecca Kruse, BSCS
 Janet Carlson, BSCS
 Kathleen Roth, BSCS
 Brooke Bourdelat-Parks, BSCS
 Jo Ellen Roseman, AAAS Project 2061
 Cari F. Herrmann Abell, AAAS Project 2061
 Jean C. Flanagan, AAAS Project 2061

Designing Professional Development To Support Teaching

Rebecca Kruse, BSCS, rkruse@bscs.org
 Elaine V. Howes, BSCS
 Janet Carlson, BSCS
 Kathleen Roth, BSCS
 Brooke Bourdelat-Parks, BSCS

Using Student Measures to Evaluate the Promise of the Intervention

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 Jean C. Flanagan, AAAS Project 2061
 Jo Ellen Roseman, AAAS Project 2061

Using Teacher Measures to Evaluate the Promise of the Intervention

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 Cari F. Herrmann Abell, AAAS Project 2061
 Jo Ellen Roseman, AAAS Project 2061

Strand 11: Cultural, Social, and Gender Issues

Teacher Development: Attitudes, Perceptions, and Critical Pedagogy

1:15pm-2:45pm, Río Mar Salon 8

Presider: Gale Seiler, McGill University

Talking With Jesus about Darwin: Religion, Conceptual Vocabulary, and the Training of American Science Teachers

David E. Long, George Mason University, davidelong74@gmail.com
 Leslie S. Jones, Valdosta State University

ABSTRACT: When coming to the university, Creationist students are often challenged seriously for the first time regarding the stability and timelessness of their theological views—through encountering the liberal arts curriculum, an increasing diversity of students, and the associated belief systems they represent. During their time on campus, most students have precious little opportunity to collaboratively explore the extent and stakes of these differences. This paper reports results of study that embeds a researcher with science teachers in training to track their developing understanding of evolution. By using co-generative dialogue, we explored the extent to which students understand each other, and then dialectically pushed the limits of their conceptions of science, religious faith, and their interrelations—all things currently with scant representation in the science education literature.

Critical Pedagogy in the Pre-Service Teacher Curriculum, Teaching English Language Learners

Jessica R. Stephenson, Virginia Tech, jesteph3@vt.edu

George E. Glasson, Virginia Tech

Gresilda K. Tilley-Lubbs, Virginia Tech

Mythianne Shelton, Virginia Tech

ABSTRACT: The United States is continuing to become an ethnically and socioeconomically diverse population, while the teaching force remains largely middle-class, female, and white (Hollins & Guzman, 2005). How do we teach pre-service teachers to create classroom environments that are welcoming, nurturing, safe places to learn for students from diverse cultures, and particularly for those students who are English language learners (ELL)? This study examines the implementation of an early field experience for science pre-service teachers (PST) at a local ELL school center, in which science education PST students were paired with ELL education PST students for a collaborative learning and teaching experience. The PST teams completed classroom observations before collaboratively planning a science lesson, which they taught together at the afterschool program. This field experience was paired with readings and in-class discussions related to critical pedagogy, followed by critical self-reflections. Preliminary findings indicate that early field experiences and critical self-reflection increase awareness of critical pedagogy and differentiation of instruction, particularly related to ELL students.

Working with Inservice Science Teachers to Develop CPD: An Emergent, Responsive Approach to Teacher Professional Development

Christina Siry, University of Luxembourg, christina.siry@uni.lu

Sara Wilmes, University of Luxembourg

Andrea Teuchert, University of Luxembourg

ABSTRACT: Working with inservice science teachers to develop CPD: An emergent, responsive approach to teacher professional development This presentation explores the implementation of a primary school reform-based curriculum in science education in an European context and elaborates on the multiple outcomes of working towards professional development that is responsive to teachers' needs and interests. Grounded in sociocultural theoretical perspectives, this study provides a multi-layered perspective on the role of ongoing teacher workshops that correlate with newly mandated reform-based science curricula, in order to frame arguments about the needs for teacher education that is emergent and responsive. Specific questions that guided our work included: i) How do teachers progress through a process of curriculum implementation that is new to them? ii) What can teachers learn from one another about how to improve teaching and learning by engaging in collaborative curriculum implementation? iii) What do we learn by tuning in to teachers' needs for planning professional development at this level? In approaching these questions, we engaged in an ongoing, recursive approach to facilitating the professional development sessions, one that drew on the reported needs, expectations, and experiences of the teachers.

Pre-Service Teachers' Views about Teaching and Learning of Science by ELLs: A Case Study

Grace N. Orado, Syracuse University, gnorado@syr.edu

Jeffrey J. Rozelle, Syracuse University

ABSTRACT: This study describes pre-service teachers' views about teaching and learning science by English language learners (ELLs). It adopted a qualitative research design and involved pre-service teachers enrolled in a science methods course for elementary teachers at a private university in northeast USA. Data were collected from four participants through one-on-one semi-structured interviews. From the analyzed data, differences in pre-service teachers' views based on whether or not they had an experience of learning in a second language emerged. Learning in a second language as opposed to learning a second language emerged as a useful experience for pre-service teachers because it enabled a pre-service teacher to view ELLs as students who need to be accountable for their own learning rather than students who are deficient hence struggling to learn. Implications for instructional practice in teacher education are discussed. In addition to having possibilities of influencing instructional practice in teacher education, this study could also inform policy on experiences in teacher education programs such as study-abroad programs.

Strand 12: Educational Technology***Symposium - Technology-Enhanced Assessment: Implications for Science Education Policy***

1:15pm-2:45pm, Caribbean Salon 1

Presider: Philip Bell, University of Washington**Presenters:**

Nancy B. Songer, The University of Michigan

Edys S. Quellmalz, WestEd

Kihyun (Kelly) Ryoo, University of North Carolina

Douglas B. Clark, Vanderbilt University

Ji Shen, University of Georgia

Marcia C. Linn, University of California-Berkeley

ABSTRACT: Current high-stakes assessments drive science teachers, administrators, and curriculum designers away from inquiry-oriented instruction by emphasizing the recall of factual information over the development of conceptual understanding. As a result, students are often denied the benefits of meaningful inquiry learning, and teachers are often frustrated by the lack of alignment between effective science activities and typical assessments. Technology offers great promise for design of assessments embedded in inquiry activities that not only measure student outcomes but also serve as learning activities. This symposium brings together leaders in technology-enhanced learning and assessment to showcase six innovative approaches to technology-enhanced assessment. The approaches take advantage of simulations, models, and games to provide opportunities to explore and understand complex systems in contexts such as climate change and energy policy. All the assessments engage students in linking, connecting, integrating, or fusing ideas or processes. They offer students varied ways to display their understanding including by creating concept maps, drawing molecular interactions, succeeding at a game, or designing and justifying experiments. These rich formats have the potential to increase the equity of assessment by offering alternative paths for demonstrating success. Several of the presenters use automated scoring and investigate the power of online feedback.

Strand 12: Educational Technology***Assessment and Technology Rich Environments***

1:15pm-2:45pm, Río Mar Salon 7

Presider: Kevin J. White***Multi-Level Assessment of Science Learning in the Context of a Game-Based Curriculum***

Parker Stuart, University of Missouri, pes4kc@mail.missouri.edu

Troy Sadler, University of Missouri

William L. Romine, University of Missouri

Dominique Merle-Johnson, University of Missouri - Columbia

ABSTRACT: Given video games popularity and potential to support educational goals, many educators have advocated for the incorporation of gaming into classrooms. Critics, however, have cited concerns with their incorporation related to allocation of classroom time and their limited connection to standardized test scores as well as lack of supporting curriculum. This study explores these tensions by investigating the effects of a game-based curriculum on student learning of biological content knowledge. Using a multi-level assessment approach, 642 high school students grouped by ability level participated in the implementation of a game-based curriculum. Using a quasi-experimental, repeated measures multiple analysis of variance (MANOVA) design, proximal and distal assessment data were collected to measure the effect of the intervention on students' understanding of biological content knowledge. Results indicate that student content knowledge increased regardless of ability level on the both assessments. Students in the low ability group show the greatest improvement on the distal assessment with effect sizes almost two and a half times as great as their peers. This suggests that a video game based curriculum can support learning of science content knowledge among high school students and games can be used productively in formal science education.

Using Student-Generated Animations to Assess Student Understanding of the Particulate Nature of Matter

Jennifer L. Albert, NC State University, jennifer_albert@ncsu.edu

Margaret R. Blanchard, North Carolina State University

Eric N. Wiebe, North Carolina State University

ABSTRACT: Visualizations, mostly in the form of illustrations, are used liberally throughout chemistry textbooks with the goal of enhancing student understanding of the particulate nature of matter. There is promising research on active learning strategies, such as learner-generated drawing strategies, which may give students the opportunity to think more deeply about chemistry phenomena, enhance their conceptual learning, and address students' conceptual misunderstandings. This research investigates students as they construct or create digital animations, asking: Do student-generated computer animations enhance student conceptual understanding of atomic-molecular theory/conceptions? To what extent do student-generated animations relate to elements in a phase change learning progression and/or the provided text? Data analyses of pre/posttests, conceptual question responses, and student-created animations indicate that for students who cognitively engage, creation of digital animations can enhance conceptual learning, resonant with Van Meter and Garner's GTDC. Also, student understanding of aspects in a phase change learning progression related to motion seem to be most positively impacted by students creating digital animations.

Exploring the Efficacy of Machine Learning and Translation Software in International Comparison Studies

Minsu Ha, The Ohio State University, ha.101@osu.edu

Ross H. Nehm, The Ohio State University

ABSTRACT: Our study examined the potential uses of technology to address two central aspects of international comparison studies employing written assessments: (1) computerized translation of responses into a common language (English) and (2) machine-learning analyses (i.e., scoring) of translated responses. Two research questions guided our study: (1) What magnitudes of correspondence characterize human-translated (native-speaker to English) and computer translated (Google translator to English) written responses to science prompts? (2) To what extent do automated computer scoring models built using American human scoring data capture the evolutionary ideas of Indonesian and German participants? 371 Indonesian and 85 German pre-service biology students generated (respectively) 1484 and 340 written essays in response to the published ACORNS instrument. Essays were translated by native speakers and Google translator, and scored by content experts and automated scoring models. Our results indicated that automated scoring models built using American responses were successfully capable of capturing the concepts in human translations of Indonesian and German essays (> 0.81 kappa). The automated scoring of Google translation showed very promising results, with total score correlations > 0.9 . Our study suggests that free, automated machine scoring and computer translation tools may be useful for international studies investigating authentic scientific practices.

Using Blended Combinations of Physical and Virtual Manipulatives to Enhance Sixth-Graders Conceptual Understanding in Physics

Marios Michael, University of Cyprus, michaelm83@gmail.com

Zacharias C. Zacharia, University of Cyprus

Georgios Olympiou, University of Cyprus

Vasoula Papasozomenou, Acropolis Lyceum

ABSTRACT: The purpose of this study was to investigate the effect of experimenting with Physical Manipulatives (PM), Virtual Manipulatives (VM), and a blended combination of PM and VM on primary school students' understanding of concepts in the domain of Electric Circuits. A pre-post comparison study design was used for the purposes of this study that involved 55 participants assigned to three conditions. The first condition consisted of 18 students that used PM, the second condition consisted of 18 students that used VM, and the third condition consisted of 19 students that used the blended combination of PM and VM. In the case of the blended combination, the use of VM or PM are combined according to the framework developed by Olympiou and Zacharia (2012). This framework takes into consideration the PM and VM affordances and specifically targets the content of each lab experiment separately. All conditions used the same inquiry-oriented curriculum materials and procedures. A conceptual test was administered to assess students' understanding before and after teaching. Results revealed that the use of the blended combinations enhanced students' conceptual understanding in the domain of Electric Circuits more than the use of PM or VM alone.

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

Poster Session A
3:15pm – 4:15pm, Río Mar Ballroom 5

Strand 1: Science Learning, Understanding and Conceptual Change

Poster Session A

3:15pm – 4:15pm, Río Mar Ballroom 5

A1. Students' Framing of Digital Gaming Environments Designed to Teach Newtonian Mechanics

James M. Hughes, Vanderbilt University, jamesh53@gmail.com

Douglas B. Clark, Vanderbilt University

ABSTRACT: The focus of this study is a qualitative analysis of the frames that students take while interacting with a digital video game designed to teach an intuitive understanding of Newtonian Mechanics. We asked the research question, "What frames do students take while engaged in a digital video game designed to teach Newtonian Mechanics?" The concept of framing as we discuss it originates in sociolinguistics to describe the beliefs and views individuals adopt of situations and contexts that they encounter. In this qualitative analysis of a diverse suburban classroom, we observed students who formed frames along two differing spectrums. Their frames related to either elements of the game, specifically,, or elements of physics, specifically, and only one student who was observed showed a strong ability to relate the game and physics knowledge. This work is important to future research, and design of digital gaming environments geared at teaching students science concepts, because it gives insight into the kinds of thinking that takes place as students engage the context for learning.

A3. Reasoning about Mechanism: Children's Explanations of Pop-ups

Mayumi Shinohara, Vanderbilt University, mayumi.shinohara@vanderbilt.edu

Rob Rouse, Vanderbilt University

Rich Lehrer, Vanderbilt University

ABSTRACT: In order to investigate how children reason about mechanism, we presented 31 children from two third-grade classrooms with the task of constructing a pop-up book. Here we report the results of a qualitative analysis of 29 children's semi-structured interviews in which they answered questions about their pop-up books post-construction. We found that nearly all children exhibited some form of mechanistic reasoning, and that their attention to pop-up mechanisms varied. For example, children's mechanistic explanations differed in degree and type of connection (i.e., no mechanistic connections, empirical regularities, or mechanistic connections) as well as attention to aspects of mechanism (i.e., particular components, activities, or properties).

A5. Pathways of Learning Illuminated from 8th Grade Students' Mental Models of Magnetism

David Sederberg, Purdue University, dsederbe@purdue.edu

Lynn A. Bryan, Purdue University

ABSTRACT: In a design-based approach, we investigated pathways by which students in traditional 8th science (N = 63) constructed, critiqued, and revised their mental models of magnetism. Our goal was to construct an in-depth analysis of the dynamic nature, coherence, and explanatory power of students' mental models of related and interdependent concepts of magnetic phenomena and, using these criteria, define pathways in which students constructed knowledge. Two particularly meaningful aspects of students' mental model representations were the scale at which they placed characteristics of magnetic phenomena (macroscopic or microscopic features) and the relative status of those characteristics and their actions (static or dynamic). Building on a scheme identified by four levels of sophistication of mental models, we characterized six learning pathways. The pathways identified suggested that those students with

moderate scientific knowledge about magnets were less likely to construct more sophisticated explanatory mental models than those students with sparsely detailed and more fragmented models. Further findings suggested a positive relationship between students' ability to incorporate multiple aspects of scale into their mental models and the explanatory sophistication of the models they were able to construct.

A7. Supporting Chemistry Learners: Using Visual Scaffolds to Foster Comprehension in an Interactive Simulation

Ruth N. Schwartz, New York University, rns221@ynu.edu

Jan L. Plass, New York University

Bruce D. Homer, CUNY Graduate Center

Catherine E. Milne, New York University

Trace Jordan, New York University

Steven Yavner, New York University

ABSTRACT: Understanding and making connections among different levels of representation—the observable, the explanatory, and the symbolic—is considered key to understanding science. Dynamic computer-based visualizations, which can incorporate and integrate these levels of representation, can be a valuable tool for science learners. However, making connections between the different representations presented in such visualizations is not always easy or straightforward for learners. We report a study investigating the use of visual scaffolds to support students in making connections between explanatory and symbolic levels of representation in an interactive computer simulation on the Ideal Gas Laws. High school students from a public school in a large Northeastern city used an interactive simulation on the Ideal Gas Laws. Students were randomly assigned to a control group ($n=36$) using a version of the simulation with no visual scaffolds or an experimental group ($n = 38$) using a version that incorporated visual scaffolds. Preliminary results indicate that the use of the visual scaffolds improved students' performance on transfer items, which assess the ability to apply conceptual understanding in a new context. This is a particularly intriguing finding because transfer tasks are, by definition, more difficult and often more resistant to improvement through instruction.

A9. Research and Scientific Literacy: How does What you do Contribute to What you Understand?

Gail Richmond, Michigan State University, gailr@msu.edu

ABSTRACT: Research suggests that scientific understanding can be enhanced by involving students in scientific work, and understanding better the contributing aspects of this experience would be valuable in designing effective curriculum and orchestrating effective classroom-based activities. This study examined the relationship between 25 students' experiences in a research apprenticeship program on the depth of their scientific understanding. Pre/post-program questionnaires were analyzed to determine changes in understanding as a result of program experiences, areas in which changes occurred, and whether these changes were associated with the role that students played in guiding their research. Students developed an appreciation for the role of creativity, complexity, ambiguity, and to some degree, luck, in research; most also developed an understanding of how scientific communities support knowledge development and the motivating effect of recognizing one's limited knowledge. Students who identified their own research question understood earlier and more deeply the multiple paths to such questions, the usefulness of unexpected results and the logic of the experimental design, the value of challenges by members of one's scientific community, and of the limitations of data. The question's sophistication and complexity of the study's design also appear to matter less than the opportunities to author them.

A11. Explore the Visual-Spatial Abilities in Identifying 3D Chemical Structures

Chin-Fei Huang, National Kaohsiung Normal University, chinf1027@yahoo.com.tw

ChengHsieh Yu, National Kaohsiung Normal University

Houn-Lin Chiu, National Kaohsiung Normal University

Chia-Ju Liu, National Kaohsiung Normal University

ABSTRACT: This study aims to explore how visual-spatial abilities affect how well students identify 3D chemical structures. To collect data for this study, a chemical structure conceptual questionnaire, event-related potential experiments and interviews were administered to eighteen university students majoring in chemistry. The results showed that although most students used similar strategies to identify 3D figures and 3D chemical structures, the students with strong visual abilities which analyzed by event related potentials (ERPs) technology used more visual-

spatial strategies to identify 3D figures. This study suggests that ERPs technology could reflect the visual-spatial abilities of students and help further studies to explore the effects of visual-spatial abilities on science learning.

A13. *Development of a Learning Progression for the Formation of the Solar System*

Julia Plummer, Pennsylvania State University, jdp17@psu.edu

Alice Flarend, Pennsylvania State University

Christopher Palma, Pennsylvania State University

KeriAnn Rubin, Pennsylvania State University

Brandon Botzer, Pennsylvania State University

ABSTRACT: This study describes the process of defining a learning progression for astronomy around the big idea of solar system formation. At the most sophisticated level of the learning progression, students can explain how the formation process leads to the current solar system through chemistry and physics principles, such as chemical change, conservation of angular momentum, and the law of gravitation. In this first step towards understanding student progress in this domain, we interviewed middle school, high school, and college students (N=44), asking them to describe properties of the current solar system and to explain how the solar system was formed. Our analysis reveals potential levels of sophistication within the hypothetical learning progression while also revealing common barriers to progress; many students' understanding of solar system phenomena was limited by either alternative ideas about gravity or limited application of momentum in their explanations. Few students approached a scientific-level explanation, but their responses revealed possible stepping-stones that could be built upon with appropriate instruction. Our findings also point to critical deficiencies in how state and national standards address solar system astronomy. Future research that examines student progress across instruction will help clarify and validate this hypothetical learning progression.

A15. *On The Relationship between Physical Computation and Development of Mechanistic Reasoning In Physics & Ecology*

Gokul Krishnan, Vanderbilt University, gokul.krishnan@vanderbilt.edu

Pratim Sengupta, Vanderbilt University

ABSTRACT: In this study we investigated the substance of mechanistic reasoning by a group of elementary grade students as they engaged in an ecology and physics activity using physical computational manipulatives. The analysis of the activities of the two groups of students showed the importance of debugging. Students created programs by connecting command blocks within the program, which then wirelessly controlled the motion of a floor robot. Debugging was achieved by allowing the student to run their program in a step by step manner and using visual feedback from the robot to recognize and identify problems. While debugging is an activity central to computational modeling and programming, this study highlights its function and importance, and its relationship to chaining. Based upon the results from the study, we can suggest that debugging has an important role in activating chaining. This work has significant implications for educational practice. In particular, it highlights that even very young students can engage in substantive mechanistic reasoning when using physical computational manipulatives. Physical computational manipulatives such as LEGO Mindstorms provide students with subject matter rich with mechanistic possibilities so that students can practice using this kind of reasoning to productively make sense of the physical world.

A17. *Students' Energy Concepts in Biological Contexts – Towards a Holistic Energy Learning Progression*

Sebastian T. Opitz, Leibniz Institute (IPN) Kiel / Germany, opitz@ipn.uni-kiel.de

Ute Harms, Leibniz Institute (IPN) Kiel / Germany

Knut Neumann, Leibniz Institute (IPN) Kiel / Germany

ABSTRACT: Core concepts promote students' ability to merge concepts learned in different science subjects (Krajcik et al. 2012). An exemplary case is the energy concept, which students encounter from early childhood onwards in science- and everyday contexts (Boyes, 1990). This suggests an early start in the development of this concept and students developing it according to their requirements. Since young learners are likely to encounter the energy concept especially in biological contexts (e.g. nutrition, sports, growth), this study investigates energy concepts in biological contexts at the threshold between primary and lower secondary school (grade 3-6). In a quantitative, cross-sectional study (N=269), concepts were assessed through a newly developed instrument with multiple-choice items for biological concepts,

following a model of physics education research (Kauertz 2008). The model focuses on the four aspects forms / sources, transfer / transformation, degradation / dissipation and conservation. Results show an increase in energy scores by the factor 2 from grade 3 to 6. A development in all aspects of the energy concept was observed, even in the more difficult areas of dissipation and conservation, suggesting – at a basic level of understanding – a less differentiated and less hierarchical development than expected.

Strand 2: Science Learning: Contexts, Characteristics and Interactions

Poster Session A

3:15pm – 4:15pm, Río Mar Ballroom 5

A19. *Exploring the Usefulness of Science in Daily Life*

John Ruppert, jruppert@saintpeters.edu

Margaret A. Holzer, Rutgers University GSE

Nicole Shea, Rutgers University

Peter Cannon, Saint Peter's College

ABSTRACT: Claims about the usefulness of science are common when discussing the need for scientific literacy; however, there is a dearth of empirical research to support this claim. Given that not all citizens pursue scientific careers, we specifically consider science useful if it can help individuals when making everyday decisions. Using an anonymous survey, we asked individuals to describe meaningful decisions that they face in everyday life and whether they view science as relevant to those decisions. Our results indicate that most people find healthcare, exercise, diet and environmental impacts of products to be the most important decisions that they make. They also commonly recognized that scientific information was relevant to their decision-making process. However, they often did not consider multiple scientific perspectives that are present in scientific literature, embracing an epistemology of certainty. Our results provide empirical evidence that science education should focus on increasing individual's awareness of multiple viewpoints around these central topics- healthcare, exercise, diet, and environmental impacts.

A21. *Haptic Worlds: New Learning Environments for Teaching Students with Visual Impairments about Particulate Motion*

Gina Childers, North Carolina State University, childers.gina@gmail.com

Gail M. Jones, North Carolina State University

Brandon Emig, North Carolina State University

Vanessa Stevens, North Carolina State University

Joel Chevrier

Hong Tan

Jonathan List, North Carolina State University

ABSTRACT: This exploratory study investigated the use of haptic feedback technology for teaching students with visual impairments concepts related to particle movement. The haptic device allows participants to experience collisions of particles under different settings (high to low temperature; high to low pressure). The participants, who were elementary and secondary students with visual impairments, used a haptic device and a computer simulation to explore the relationship of particle movement to temperature and pressure. A pre-assessment and post-assessment was administered before and after the students used haptic device. The results showed a statistically significant difference in scores on pre and post assessment indicating the haptic device was effective in teaching students with visual impairments these **ABSTRACT** science concepts.

A23. *Characterizing Teacher Effect on Student Progress Along a Learning Progression*

Deborah C. Peek-Brown, University of Michigan, dpbrown@umich.edu

Shawn Stevens, University Of Michigan

Sung-Youn Choi, Michigan State University

Ingrid Sánchez, University of Michigan

Namsu Shin, University of Michigan

Joseph S. Krajcik, Michigan State University

ABSTRACT: Characterizing Teacher Effect on Student Progress Along a Learning Progression **ABSTRACT** The Framework for K-12 Science Education employs a learning progressions approach to outline a coherent path that students can follow to build understanding of core ideas of science. In order to support students in progressing along these paths, research is needed. This study is part of a larger project that involves developing and empirically testing a learning progression for secondary students for the transformations of matter. In order to quantitatively measure gains in learning assessments were designed specifically to test our LP. This poster will focus on characterizing the teacher effect in measured student progress using surveys, interviews and classroom observations to characterize teachers' background and practice. Our study included seventeen science teachers from eight middle schools. Trends that emerged showed differences in teachers' orientation to teaching inquiry science and levels of PCK that can affect the instruction students experience in the classroom as well as student gains. Using multiple data sources in order to characterize teachers and their practice and linking it to student progress will add knowledge needed to support students in progressing along coherent learning paths.

A25. Exploring an Approach to Raising Students' Intrinsic Motivation in Learning Chemistry

Katrin Vaino, University of Tartu, katrin.vaino@ut.ee

Miia Rannikmäe, University of Tartu

Jack Holbrook, University of Tartu

ABSTRACT: This paper introduces a research project in which five chemistry teachers, working in cooperation with university researchers, implemented a new teaching approach using context-based modules specially designed to stimulate the intrinsic motivation of students. The intention was to induce change in chemistry teachers' teaching approach from more traditional, extrinsically motivational teaching styles, into student centred approaches stimulating students' intrinsic motivation. Evaluation of the approach was by means of student pre- and post questionnaires, in part adapted from the intrinsic motivation instruments developed by Deci and Ryan based on indicators of autonomy, competence and relatedness, but also encompassing items of interest and value in the eyes of students. The questionnaire was validated after translation for use in the Estonian secondary and high school situation. Based on the questionnaire responses, it was found that students' (N = 416) motivation was significantly higher related to the lessons based on the modules compared to their previous chemistry lessons. While significant differences existed in questionnaire responses between the schools (teachers) before the intervention, there was no significant differences in post-questionnaire results. Implications of this are discussed.

A27. The Effect of an Argument-Based Inquiry Approach on Students' Critical Thinking Skills: A Two-year Study

Jeong-Yoon Jang, University of Iowa, jeongyoon-jang@uiowa.edu

Brian M. Hand, University of Iowa

Kyong Mi Choi, University of Iowa

ABSTRACT: This study examined the effects of an argument-based inquiry approach known as the Science Writing Heuristic (SWH) on student critical thinking skills over the two years. Effect size was used to examine the magnitude of the effect due to either the SWH treatment or the effect of longer exposure to the SWH i.e. two years as opposed to one. The results indicated that as the exposure in years of the SWH increases that critical thinking diminishes. The results imply that the first year of exposure to the SWH is related to the greatest increase in critical thinking. While more exposure is better, it cannot compete with the initial increase in the beginning.

A29. Seeing Difference across Time and Space: Implications of Ecological Spatiotemporal Variation for Students' Field Practice

Michelle Cotterman, Vanderbilt University, michelle.e.cotterman@vanderbilt.edu

Richard Lehrer, Vanderbilt University

Leona Schauble, Vanderbilt University/Peabody College

ABSTRACT: Though students are often initiated into ecological fieldwork by observing a site over time, they are rarely encouraged to wrestle with the issues of space and sampling fundamental to ecological practice. Consequently, educators know little about which of students' observations might be most conducive for developing such practice. This study uses middle level students' observations of difference while studying a local river to examine how questions of

time and space might impact students' field practice. We found that though students' observations primarily evoked seasonal change, students also recruited space to reason about change and partitioned spaces when exploring organism distributions and river dynamics. This focus on space seemed important in advancing data-driven, rather than narrative, research. A comparative study of two student research questions indicated that a focus on temporal change led to narrative explanations that were unable to be substantiated due to their reliance on past states, while a focus on spatial difference afforded access in the moment to critical variables needed for empirical investigation. These findings suggest that if we want students to understand how sampling and data modeling drive ecological explanations, then it seems profitable to focus fieldwork on comparisons across space, rather than just time.

A31. *The Impact of Resident Scientist Graduate Students on Middle School Teaching and Learning*

Mika Munakata, Montclair State University, munakatam@mail.montclair.edu

Sumi Hagiwara, Montclair State University

ABSTRACT: The GK-12 Fellows in the Middle program is a five-year NSF-funded grant project that partners middle school science and mathematics teachers with STEM research graduate students (fellows). The authors present findings from four years of interview data gathered from 22 fellows, 24 teachers, and about 75 middle school students. Program goals are to: 1) equip fellows with skills necessary to excel in science, technology, engineering, and mathematics (STEM) careers, 2) strengthen teachers' knowledge of science and mathematics content and research, 3) increase middle school students' interest and achievement in science and mathematics, and 4) institutionalize project activities at XXXX University. The paper focuses on the impact of the program on graduate students' communication skills, teachers' practices, and middle school students' attitudes and beliefs about STEM.

A33. *Co-construction of Knowledge in a Modeling-based Teaching Context*

Rosaria Justi, Univ Federal de Minas Gerais, Brazil, rosariajusti@gmail.com

Paula P. Costa, Univ Federal de Minas Gerais, Brazil

ABSTRACT: In this study, our aim is to characterize the process of co-construction of knowledge in a modeling-based teaching context. The data were collected in a regular chemistry class, when 15-16 year-old students were taught about ionic bonding from a modeling-based teaching sequence that was previously validated in other teaching and research contexts. All the lessons were video-recorded and transcribed. From the transcriptions, we identified 18 episodes in which the co-construction took place. The detailed analysis of such moments supported the development of an analytic framework based on both teachers' actions and skills showed by students. Our results show that the co-construction process cannot be categorized into specific types (as occurred previously in the literature) due to both its dynamic nature and distinctions concerning the specific stage of the modeling process associated with the analyzed context.

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

Poster Session A

3:15pm – 4:15pm, Río Mar Ballroom 5

A35. *School Leadership and Science Education: A Case Study of how a Preschool Principal Frames and Promotes Teaching and Learning in Preschool Science Education*

Loucas T. Louca, European University-Cyprus, Louca.L@cytanet.com.cy

Anna Papaloizou, European University-Cyprus

ABSTRACT: Although inquiry-based teaching is not a new endeavor in science education, numerous difficulties are still slowing down the establishment of this agenda in the everyday teaching of science. This has motivated various efforts for supporting teachers towards teaching and learning in science through inquiry-based approaches. The role of the school principal in sustaining teachers in these efforts has been rather understudied. In this case study we seek to describe the role of a pre-school principal in supporting her schoolteachers to teach science effectively. Using a series of interviews with a school principal and schoolteachers we describe in detail how the principal perceives and understands teaching and learning in science, and how she translates that understanding into efforts for promoting teaching and learning science through her ways of school management and organization. Findings suggest that the study's principal held a view of scientific literacy mostly focused on helping students develop abilities for the scientific method and gain

everyday experiences from natural phenomena. Findings also suggest that this was a school principal who worked both as a teacher and as an administrator, and she seemed to be torn between these roles.

A37. *Capturing the Dialectical Aspect of a Classroom SSI Discussion: An Expanded Analytic Scheme*

Chrystalla Lymbouridou, Ministry of Education & Culture, Cyprus, L.Louca@euc.ac.cy

Loucas T. Louca, European University-Cyprus

ABSTRACT: Socioscientific controversial issues (SSCI) are regarded as a context in which science education may help students develop epistemological awareness, abilities for thoughtful decision making, whereas the science curriculum can be humanized with the infusion of ethics, political, emotional and social factors. The description of morals, emotions and evidence emerging within the context of a SSCI discussion suggests a need for methodological tools that can be used to describe the dialectical aspect of the discussion, in which argumentation plays a central role. The purpose of this study was to develop an analytical scheme for describing the dialectical aspect of an SSCI discussion in science classrooms. Using Walton's and Krabbe's (1995) typology of argumentative dialogues as a starting point, we developed the scheme by analyzing five 80-minute classroom discussions about SSCI through the application of open coding techniques. Our analytic scheme differentiates between discussions focusing on the issue, holding an argumentative, deliberative, informative and inquiry character, on the agents (people) involved, holding an initial informative and explanatory character, and on the decision making process related to the logistics of the discussion.

A39. *Challenges and Support: Dynamic Relationships between Inquiry and Literacy in Elementary Science Education*

Marianne Odegaard, University Of Oslo, marianne.odegaard@naturfagsenteret.no

Sonja M. Mork, University of Oslo

Berit S. Haug, University of Oslo

Gard Ove Sorvik, University of Oslo

Jonathan Francis Osborne, Stanford University

ABSTRACT: We wish to present related studies that illuminate dynamic relationships in science classrooms during an integrated science inquiry and literacy approach. We will present four papers that all explore relationships of inquiry and literacy, but with different foci. However, all papers use the same research material as basis for their analysis. The first paper presents an overall video analysis of our material showing patterns of inquiry and literacy activities. It suggests that handling data is a valuable force for linking literacy to science content. The next paper that focuses on learning science concepts through inquiry, informs us how multimodality makes students' thinking visible and supports teachers in their assessment. The third paper scrutinizes how texts support processes of science inquiry, and reminds us of the need to develop a sense of text genre sensibility in the teaching of integrated approaches. Finally, the fourth paper investigates teachers' different approaches to reading in science inquiry. It points to how general education teachers have a need for instructions and guidance in how to do this.

A41. *Understanding Immersive Argument-Based Inquiry: A Critical Review of Thesis Studies on the Science Writing Heuristic Approach*

Jee Kyung Suh, University of Iowa, jeekyung-suh@uiowa.edu

Ying-Chih Chen, University of Minnesota

Brian M. Hand, University of Iowa

ABSTRACT: This study is a critical review of nineteen thesis studies that formed part of an ongoing research project focused on examining benefits and nature of the Science Writing Heuristic (SWH) approach in science classroom. Given limitations related to sample sizes, topics, and classroom contexts of individual study, the study is an attempt to make broader generalizations. The results indicated that using the SWH, an immersion oriented Argument-Based Inquiry approach, was beneficial for student to develop knowledge of science concepts and knowledge of argumentation. The SWH provides scaffolds to enable students to engage in constructing arguments by using language as a learning tool. Additionally, the results suggest that teachers' pedagogical skills and understandings for questioning and dialogical interaction can be improved through implementation of the SWH. At the presentation, several theoretical and practical issues regarding learning science through immersive ABI approach will be discussed.

A43. *Thinking Like a Butterfly: Leveraging Students' Embodied Intuitions in Elementary Ecology Classrooms*

Amanda C. Dickes, Vanderbilt University, amanda.c.dickes@vanderbilt.edu

Pratim Sengupta, Vanderbilt University

Gokul Krishnan, Vanderbilt University

Kara Krinks, Vanderbilt University

Amy V. Farris, Vanderbilt University

ABSTRACT: Embodied modeling is a particular form of modeling in which students themselves act as individual agents in a complex system. Such a pedagogical approach connects scientific phenomena directly to students' lived experiences and enables them to deepen their understanding of the phenomena. Embodiment – in both real and virtual environments – allows the learner to be both the source and processor of information as they experience first hand the complex aggregate-level outcomes that emerge from simple agent-level decisions (Colella, 2000; Wilensky & Stroup, 1999). The present study is an investigation in the field of elementary ecology education and reports findings from a study conducted in a 3rd grade classroom. This study is grounded in a science as practice perspective (Lehrer & Schauble, 2006) in which the concepts and tools of science are deeply intertwined. The goal of the study was to design a learning environment that successfully integrated embodied modeling and MABMs through the generation of mathematical representations that are common to both forms of modeling. Specifically, the study investigated the following research question: How do students develop understandings of structure-function relationships through the generation of mathematical representations of embodied modeling activities?

A45. *Elementary Teachers' Use of Science Curriculum Materials to Foster Explanation Construction*

Laura Zangori, University of Iowa, laura-zangori@uiowa.edu

Cory T. Forbes, University of Iowa

Mandy Biggers, University of Iowa

ABSTRACT: Science curriculum materials – lesson plans, student worksheets, and other material resources through which students are afforded opportunities to engage in classroom science – are essential resources through which elementary (K-5) teachers cultivate effective science learning environments. Despite evidence that early learners can effectively engage in explanation construction when provided instructional support, curricular resources frequently do not afford them the opportunity to do so. Further, the choices elementary teachers make about whether to modify curriculum to include explanation construction are dependent on their knowledge, beliefs, and other personal resources. This longitudinal qualitative multiple-case study examines how three third grade teachers' interactions with their curricular materials regarding explanation construction changed from the first year of curriculum adoption to their second year of implementation. Our findings indicate that, while the teachers' curricular modifications increased in year two, their emphasis on explanation construction decreased. Each was an experienced classroom teacher yet did not have a firm grasp on how to support their students in explanation construction. Our findings reinforce and extend results from past research on inservice elementary teachers' professional knowledge and practices for science teaching and learning.

Strand 4: Science Teaching--Middle and High School (Grades 5-12): Characteristics and Strategies**Poster Session A**

3:15pm – 4:15pm, Río Mar Ballroom 5

A47. *Arguing for the Sake of Argument: STEM Career Changers' Experience and Beliefs Regarding Key Practices of Science*

Carrie-Anne Sherwood, University of Michigan, casher@umich.edu

ABSTRACT: One of the potential benefits of the recent economic recession is the enrollment of bench scientists, who have lost their jobs, in teacher education programs. This trend provides a unique opportunity to investigate how former scientists bring their experience and expertise into their preparation to become teachers. This is an especially propitious time to undertake this study since the Framework for K-12 Science Education (NRC, 2011) proposes that K-12 science education integrate the teaching of science content and practices. This requires that teachers engage students in understanding the nature of science and skills required to do science. It makes sense that individuals with deep content

knowledge and experience with the practices of science would be well-suited to this task. Because research into the work of actual scientists has demonstrated that the everyday use of scientific literacy practices is integral to the work they do, this study uses this lens through which to examine the knowledge, beliefs, and experiences of these former scientists prior to and at the conclusion of the first year of their alternative certification program.

A49. *Deep Conceptual Learning in Science and Mathematics: Perspectives of Educators and Educational Administrators*

Peter Rillero, Arizona State University, rillero@asu.edu

ABSTRACT: Research into deep learning emerged in the 1970s with Marton examining how college students responded to reading academic articles. Deep conceptual learning (DCL) and surface learning emerged as two distinct styles. DCLs sought to understand by (a) applying what they were reading and (b) by questioning and evaluating and this led to better recall and better understanding of the reading immediately and after several weeks. A questionnaire was developed and administered electronically to gain a better understanding of DCL in mathematics and science education at the middle school and high school levels. The questionnaire included questions assessing the importance of DCL, how DCL practices are implemented, the status of DCL, the extent to which DCL is put into practice, and the extent to which different instructional methods embody DCL. Survey results (n= 445) indicate respondents believe that DCL is very important for preparing students for careers and college. Both administrators and teachers generally believe that DCL is very important for mastering the Common Core State Standards and there was strong agreement that (a) the learning environment affects if students become DCLs and (b) DCLs are more likely to become lifelong learners.

A51. *Designing an Instructional Model for Promoting Scientific Argumentation: Exploring the Effectiveness*

Suna Ryu, UC Berkeley, sunaryu@ucla.edu

Yuhwa Han, Korea National University of Education

Seoung-Hey Paik, Korean National University of Education

ABSTRACT: 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:"Times New Roman"; mso-bidi-font-family:"Times New Roman"; mso-bidi-theme-font:minor-bidi;} In this paper, we develop an instructional model that coordinates laboratory activities and discursive practice from the perspective of learning progression. The model is also developed in response to teachers' needs identified from a survey and results of a curriculum content analysis. We explore how students' practice of argumentation evolves as they engage in this model. Our results show that many teachers did not recognize the importance of scientific argumentation. Moreover, even those who recognized the importance of argumentation felt that argumentation was important to improve science content knowledge and did not connect its importance to the epistemological understanding of scientific knowledge. Overall, teachers' answers indicate the need for a guide to pedagogical discourse use to balance teacher-talk and student-centered discussion and curricular materials. By increasing the complexity of engaging in scientific inquiry, we increased the chances of having multiple opinions and thus the chances of challenging others. In our model, teacher scaffolds and prompts are decreased over time, and student responsibility and freedom to make decisions are increased. Our findings indicate that this model helps students to engage in argumentation more often and actively, and their conversations became more scientific in nature.

A53. *Exploring Strategy for Improving Nigerian Students' Performance in Quantitative Electrolysis in Chemistry*

Adewale Adelayi, Lagos State University, Nigeria, walelayi@yahoo.com

Bolatito Danmole, Lagos State University, Nigeria

Peter A. Okebukola, Lagos State University, Nigeria

ABSTRACT: Over the past twenty years, there has been a flurry of efforts at determining concepts in chemistry that students find difficult to learn. The goal of these efforts is to document difficult concepts and thereafter, seek methods for assisting students to break barriers to learning such concepts. The literature has revealed that electrolysis and mole concept top the rank of such difficult topics. The contextualized guided-discovery method was explored in this study as one of such ways. Contextualized guided discovery (CGD) embeds the traditional guided-discovery technique with elements of the learning setting. The major hypothesis of the study was that there will be no significant difference in the

achievement in electrolysis of students who benefitted from the CDG approach and those exposed to the expository method. The study employed a mixed method design involving qualitative and quantitative techniques. Over a two-week period after pretesting, experimental students were treated using the contextualized guided discovery approach. The control class was taught in an expository manner without the CGD colouration. Experimental group students outperformed the control. ANCOVA was significant ($p < .001$). Qualitative data were gleaned through interviews. There was a general air of acceptance of the CGD approach by participants in the experimental classes.

A55. *Feeding the World: Writing about Socio-Scientific Issues in 7th Grade to Increase Decision-Making Skills*

Meena M. Balgopal, Colorado State University, Meena.Balgopal@colostate.edu

Lynn Gilbert, Conrad Ball Middle School

ABSTRACT: Students must be able to make scientifically informed decisions about their behavior, as this is the hallmark of being scientifically literate. Socioscientific issues (SSIs) are good prompts that encourage students to explore social consequences of scientific phenomena or research and writing activities are excellent in promoting thoughtful exploration. We integrated reading/writing activities into a 7th grade interdisciplinary life science-social studies unit. Of the 100 students recruited, 53 chose to participate in our study. Students engaged in a 6-week unit centered on the SSI of whether or not Earth has reached carrying capacity to support the world's human population. Important scientific concepts include population dynamics and limiting resources. Students participated in inquiry activities, discussions, reading, and writing assignments while collecting relevant data recorded using graphic organizers based on Toulmin's argumentation model. Our qualitative written discourse analysis revealed that students' decisions fell into three categories: individual-personal; individual-global; and systemic. The proportion of individual-personal decisions of total claims made on pre-unit essays was 0.33 and jumped to 0.67 on the post-unit essay; hence, students made more personal decisions about changing their behavior. We believe there is much merit to continuing our studies on graphic organizers to support writing in science activities.

A57. *Teachers' Pedagogical Design Capacity and Use of Educative Curriculum Materials when Implementing a Biophysics Curriculum*

Morgan L. Presley, University of Missouri, mlp446@mail.missouri.edu

Parker E. Stuart, University of Missouri-Columbia

Nilay Muslu, University of Missouri, Columbia

Deborah L. Hanuscin, University of Missouri-Columbia

ABSTRACT: In summer 2012, three middle-school teachers field tested a new biophysics curriculum supplement. The purpose of this study was to investigate how teacher and school characteristics affect teachers' use of and modifications they make to the curriculum, a perspective known as pedagogical design capacity. This study also explored how educative curriculum materials affect teacher learning. Preliminary data show that barriers within the school environment, such as pressures to align with standards, lack of resources, and shortage of time can affect teachers' use of curriculum. Teacher knowledge of classroom management can also affect the use of reform-based curriculum when hands-on activities are present. The results of this study also provide evidence for the claim that curriculum materials can be educative for teachers in terms of content knowledge and instructional decision-making.

A59. *Pedagogical Content Knowledge and the Gas Laws: A Multiple Case Study*

James M. Nyachwaya, North Dakota State University, James.Nyachwaya@ndsu.edu

Gillian H. Roehrig, University of Minnesota

Mary E. Sande, University of Minnesota

ABSTRACT: This study looks at In-service chemistry teachers' pedagogical content knowledge (PCK) of gas laws. Four chemistry teachers were given an assessment to determine their subject matter knowledge for teaching gas laws, and interviewed to find out their PCK, focusing on representations and student conceptions. Findings of this multiple case study indicate that the participants' subject matter knowledge for teaching, ability to move between representations, and understanding of student alternate conceptions regarding the gas laws and how to address those conceptions were limited

A61. *Impact of Administrative Support on K-12 Science Teachers' Job Satisfaction in Texas: Structural Equation Modeling*
Muhammet Mustafa Alpaslan, Texas A&M University, alpaslan27@tamu.edu
Carol L. Stuessy, Texas A&M University

ABSTRACT: Administrative support refers to the school's effectiveness in assisting teachers with issues such as student discipline, instructional methods, curriculum, and adjusting to the school environment. Job satisfaction refers the positive, potentially health promoting, aspects of relationships such as instrumental aid, emotional caring or concern, and information. The purpose of the study was to determine the impact of the level of four dimensions (emotional, instrumental, informational and appraisal) of administrative support defined by House (1981) on science teachers' job satisfaction in Texas. The results revealed that satisfaction with the administrative support influences the teachers' job satisfaction, attitude towards teaching, and therefore, their decision whether to retain at a school. Implications and future direction were discussed.

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

Poster Session A

3:15pm – 4:15pm, Río Mar Ballroom 5

A63. *Korean Female Undergraduate Students' Evaluation about Trustworthiness of Scientific Information*
Jiyeong Mun, Ewha Womans University, jiyeong86@gmail.com
Eunjin Kim, Ewha Womans University
Kongju Mun, Ewha Womans University
Hyo-Suk Ryu, Ewha Womans University
Sung-Won Kim, Ewha Womans University

ABSTRACT: 21st century is the information age. To be a future citizen and make decision in daily lives, it is important to students learn ability to evaluate critically scientific information in science education. The aim of this study was to understand Korean female undergraduate students' way of evaluating scientific information. Especially we were interested in that how do students examine trustworthiness of information. We investigated following research questions: (1) How do the Korean female undergraduate students examine the trustworthiness of scientific information? and (2) What are the differences of students' criteria between trustworthy information and untrustworthy information? For this, we asked fifty-eight undergraduate students to choose two pieces of scientific information (the trustworthy information and the untrustworthy one) and to examine each piece of information. Data was analyzed using criteria which suggested by Kolstø et al. Through an analysis, a total of 227 criteria made by students were identified. Results revealed that students used different kinds of criteria to make a thorough examination such as social and other aspects. From the results, we suggest that various criteria and critical thinking ability should be emphasized in science education explicitly.

A65. *Evolutionary Theory as an Advance Organizer in Introductory Biology*
Lawrence C. Scharmann, Florida State University, lscharmann@fsu.edu
Wilbert Butler, Tallahassee Community College
Miray Varol, Florida State University

ABSTRACT: Evolutionary theory was introduced as the advance organizer for a non-majors' biology course taught at a community college. Fourteen weeks of instruction were performed, each possessing a central theme, critical in-class activities, and a discussion to elucidate tentative conclusions based on evidence from in-class activities. Students (N=31) engaged in explicit and reflective writing (i.e., journaling) at four points during the semester providing responses to: a) what influence did the recent activity and class discussion have on your understanding of evolution; b) has your view changed? (Explain your response and provide support or examples of what influenced the change); and c) what aspects of the nature of science have you observed in recent lessons/activities? Journal entries were coded on a continuum as informed (I), somewhat informed (SWI), or not informed (NI) regarding the accuracy of evidence cited with respect to evolutionary theory. Initial journal entries were strongly negative toward evolution. Data analyses, however, indicated a statistically significant shift in student responses toward an informed view by the end of the course. Students noted an

appreciation for an assessment method that was respectful and nonjudgmental of their personal interpretation of scientific evidence.

A67. *Beyond Content Knowledge: Improving Postsecondary Learners' Metacognition, Felt Competencies and Affect Towards Inquiry Through Inquiry*

Jana L. Bouwma-Gearhart, Oregon State University, jlbo226@uky.edu

Sarah J. Adumat, UW-Madison

Rebecca McNall Krall, University of Kentucky

Andrew Bouwma-Gearhart, Oregon State University

Lin Xiang, University of Kentucky

Allyson Rogan-Klyve, Oregon State University

ABSTRACT: Because of a more traditional science education background, many postsecondary students, including science teachers, are ill prepared to engage in scientific inquiry of most varieties. How does a model-based inquiry (MBI) approach to teaching science impact postsecondary students' (1) scientific knowledge (2) understanding of science processes? (3) understanding of scientific inquiry, (4) engagement with scientific inquiry, and (5) felt competencies regarding scientific inquiry? This study analyzes a course specifically designed to engage students with authentic evolutionary ecology phenomena through MBI. Students demonstrated statistically significant gains in content knowledge concerning ecology, broadly, and evolutionary ecology specifically. In addition, they demonstrated statistically significant gains in understanding, felt competence, and affect regarding scientific processes commonly accepted as basis of science inquiry. Certain aspects of inquiry were most salient to students as per interviews, including using evidence to construct and evaluate models and connecting explanations to previous knowledge. Students were especially effective at encouraging their peers to mentally wrestle with ever more nuanced data and construct and revise accurate explanatory models in response. Of some surprise, there was increased interest among undergraduates, not already committed to a profession, to teaching science after participating in the MBI course.

A69. *Investigating Students' Understanding of Material Science Concepts by Reflecting on Confusing Points*

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Micheline T. H. Chi, Arizona State University

Stephen Krause, Arizona State University

ABSTRACT: This study investigated the effects of students' daily reflections on their learning of various introductory materials science and engineering concepts. The students were asked to reflect on the "muddiest points" at the end of each class for an entire semester. The students individually answered the question of "what was confusing or needed more detail" after each class. We collected students' daily reflections, pre and post concept tests about crystal structures and polymer structures, unit exams, and Materials Science Concept Inventory (MCI) as data resources. Students' daily reflections on "muddiest points" were coded based on the deepness and quality of their explanations. The analysis showed a significant correlation between the quality of students' daily reflections and learning gains based on the crystal structures pre and post concept tests. There was also a significant correlation between students' average muddiest point scores and their percentage correct of the polymer structures-related questions on the unit test.

A71. *A Hands-on Activity Incorporating the Three Levels of Representation and Its Impact in Students' Understanding about Redox Concepts*

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Jose Noel Caraballo, University of Puerto Rico at Cayey

Edgardo L. Ortiz Nieves, University of Puerto Rico at Cayey

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ABSTRACT: Science is a dynamic discipline that requires application of scientific concepts using multiple representations to solve problems. Traditionally, however, teaching and learning of scientific concepts occur in one representation. In chemistry, the most commonly used representation is the symbolic. Introductory chemistry students should learn how to connect and transfer between the three representations (macroscopic, sub-microscopic, and symbolic) to master chemistry concepts. In this study a hands-on activity incorporating the three representations was developed and implemented for the concept of redox reactions. The objective of the study was to investigate if the activity is a better

approach than traditional instruction helping students develop a better understanding of redox reactions, and making interconnections between the three representations. Students' understanding about redox reactions was evaluated using a developmental assessment instrument constructed in this study. The instrument centers on the idea of identifying an effective level of performance by ordering related sub-concepts in a hierarchical manner. The results suggest that the intervention incorporating the three representations had a positive impact in promoting students understanding of some of the concepts involved in redox reactions and interconnecting the three representations.

A73. *Problem-based Learning in the College Physics Classroom: Did They "Get It" or Not?*

Catherine M. Koehler, Southern Connecticut State University, sissianne@aol.com

Attila Elteto, University of New Haven

ABSTRACT: Problem-based Learning in the College Physics Classroom: Did They "Get It" or Not? In this study, we explore the research question, what effect does using 2 pedagogical strategies (peer-teaching and inquiry labs) have on students overall performance in a general physics college course? The context of this case study was a non-calculus based, general physics class in a 2-year community college in the northeastern U.S. The physic course used in this study was taught during a traditional 16-week semester and was designed in three phases: (Phase 1) traditional lecture and cookbook laboratories, (Phase 2) peer-instruction during lecture with cookbook laboratories, and (Phase 3) peer-instruction during lecture and inquiry laboratories. Results indicated that although students agreed that peer-instruction was preferred over traditional lecture-style, the class reinforced that notion that traditional-style "cook-book" laboratories were preferred over inquiry-based laboratories.

A75. *The Impact of Project-Based Group Work on Engineering College Students' Content Knowledge and Affect*

Anne Marie A. Casper, Colorado State University, aramaticasper@gmail.com

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Karen Rambo-Hernandez, Colorado State University

Rebecca Atadero, Colorado State University

Darrell Fontane, Colorado State University

ABSTRACT: This paper describes the results from a pilot study that incorporated Project Based Learning (PjBL) in an engineering statics course. Two sections on the course were taught by different instructors. One section was a control section with traditional lecture. The other was the treatment section where students were placed in groups of 4-5 and were assigned three projects with varying levels of structure during the course of the semester. The study hypothesizes that students who participate in a PjBL curriculum will have higher learning gains as measured by a statics concept inventory and higher scores in constructs of interest in social cognitive theory measured with an affect instrument developed by the authors. Furthermore, video analysis is used to explore how the nature of talk varies depending on the type of project task student groups are assigned. Results show that students in the PjBL class scored the same on the concept inventory as students in the control class but showed higher gains in self efficacy. Self-efficacy in turn was related to a stronger intention to remain in engineering. Video analysis results showed that more time was spent by groups in concept negotiation during a more structured project assignment.

A77. *Service Learning as a Strategy for Learning Basic Genetics Concepts*

Michelle L. Klosterman, University of Missouri, klostermanml@missouri.edu

Gloria Muday, Wake Forest University

Carole Browne, Wake Forest University

Stacey Lundy, Wake Forest University

ABSTRACT: Service learning has been increasingly popular on college campuses and provides benefits to students and teachers at both the pre-secondary and post-secondary level. However, unanswered questions still surround how we define and analyze the expectations and objectives of service learning and how it impacts subject matter learning. The primary goal of this study was to detail the experiential and educational outcomes of undergraduate student participants as a result of their engagement in a service learning experience. This study examined the outcomes associated with a service learning experience for non-science majors enrolled in an introductory Biology course. A survey was administered to all students to examine their perceptions of science, teaching, and learning. Three additional measures were used to compare the subject matter knowledge of the service learning and comparison groups. The final

paper will outline the process of designing, implementing, and researching this service learning experience. It is our hope that as a result of our paper, discussions will continue in the larger NARST community about how to design effective service learning experiences in the natural sciences for non-science majors – a current initiative of STEM education worldwide.

Strand 6: Science Learning in Informal Contexts

Poster Session A

3:15pm – 4:15pm, Río Mar Ballroom 5

A79. Informal Science Learning Experiences: Possible Contributions to Science Identity

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ABSTRACT: Knowing what common activities people already associate with science provides science education program and curriculum developers with tools to foster the growth of a pre-established understanding of science and the development of personal science identity. This research was conducted through a mixed methods approach involving a survey and supplemental drawings. Findings support that there are foundations for science identity development being established in informal environments such as the outdoors, and include activities such as fishing, and camping. These memorable experiences need to be tapped by the science education community in order for individuals to build a more robust understanding of science.

A81. Sharing Stories: Identity-Related Visitor Narratives from Body Worlds

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Susan Jagger, OISE/University of Toronto

Erminia G. Pedretti, University Of Toronto

ABSTRACT: Body Worlds is a travelling exhibition of human cadavers that has had over 35 million visitors from around the world. This study explores the visitor experience of Body Worlds, specifically considering occupation-related identities of: artists; students; medical practitioners; tradespeople; and service/clerical workers, and the role of these identities in meaning-making. Visitor responses are shared as narratives using fictional composite character vignettes – a form of representation unique to informal learning research. The distinct narratives presented speak to how occupation-related identity can inform the visitor experience and meaning-making of Body Worlds. These findings serve as a reminder to museum curators and exhibition designers to consider the role of occupation-related identity when designing exhibitions so as to optimize the potential for meaning-making.

A83. Examining Zoo Education and Visitor Interaction for Significant Knowledge Gains

Patrick Dawes, Syracuse University, pjdawes@syr.edu

ABSTRACT: Learning takes place in both the traditional classroom setting and at informal learning institutions like Zoos and Museums. The learning that occurs in these non-classroom settings has the ability to both enhance the everyday lives of the learners but also to supplement the learning that is occurring in the traditional classroom setting. Zoos present a variety of educational offerings including signage, educational volunteers, and staff presented materials. This study intended to examine what educational opportunities zoo visitors used as part of their learning process and how effective these opportunities are. Using a pre and post-test methodology changes in visitor knowledge were measured in combination with a self-report of which types of educational offerings visitors use. Thereby allowing for the examination of which offerings create the most educational gains. The results of this study clearly paint a picture of the zoological setting as a place where learning is occurring. The correlations as well as the ANOVA results show that zoo signage had the most effect on zoo visitor knowledge gains. This becomes important to the science education research community because it gives us insight into how science learning is occurring in a more varied learning community.

A85. Archaeology as a Means of Engaging Underserved Youth in STEM: Lessons from a Field School

Camellia Sanford, Rockman et al, camellia@rockman.com

ABSTRACT: Time Team America and the Science of Archaeology (TTASA) is an NSF-funded project implementing a series of archaeological field schools that provide underserved youth with real world experiences visiting dig sites and

meeting archaeologists. Potential outcomes of youth's field school participation include increased interest in and knowledge about archaeology and STEM concepts, activities, and careers. Researchers examined these impacts via pre-post surveys, focus groups, and participant-recorded interviews and images. After the field school, participants reported feeling more knowledgeable about archaeology and associated careers and confident in their research skills. Youth's interest in science and archaeology remained relatively high throughout the experience. The field school's hands-on, authentic research activities appeared to engage youth more than their previous self-reported classroom experiences.

A87. *Be a Scientist! Scaling Up a Hands-On Family Science Engineering Program*

Tara Chklovski, Iridescent, Founder & CEO, tara@iridescentlearning.org

Harouna Ba, Education Development Center's Center for Children and Technology

ABSTRACT: Be a Scientist! is a five-year longitudinal study, sponsored by the National Science Foundation, where engineering students in LA and NYC teach hands-on "Family Science" workshops (FSWs) to underserved families with children in grades one through five. Begun in 2010, the program aims to identify scalable methods of engaging minority audiences in STEM and keeping those audiences engaged for many years through a blend of online and face-to-face programs. This poster will share findings from two years of multi-method evaluations using both quantitative (surveys) and qualitative (observations, interviews, and instructor logs) methods. Preliminary results have found that the program is making significant impacts on the parents, children, and engineers. At the same time, the evaluations have found ways of continuously improving the program so that it can scale and impact more families cost-effectively. Be a Scientist! is a collaboration of a science education non-profit, university, two science museums, and an external evaluator.

Strand 7: Pre-service Science Teacher Education

Poster Session A

3:15pm – 4:15pm, Río Mar Ballroom 5

A89. *A Discursive Approach of Analyzing Preservice Teachers' Discourse on Becoming a Science Teacher*

Pei-Ling Hsu, University of Texas at El Paso

Tania Moreno, University of Texas at El Paso

ABSTRACT: One objective of many science educators is to recruit more science teachers. Researchers have investigated factors and influences that guide students to choose science teacher as a career. However, few investigations studied the forms of language makes available for articulating being a science teacher. The purpose of this study is to investigate ways of using language for supporting justifications of becoming a science teacher. Thirteen preservice teachers were interviewed about their career choices. Drawing on discursive psychology, we identify four interpretative repertoires that are deployed during the interviews: the (a) experiential, (b) inspirational, (c) consequent, and (d) historical repertoires. These repertoires do not merely characterize the discourse but also co-articulate different aspects of professional identities as a science teacher.

A91. *Learning to Teach Science: The Experience of a Preservice Teacher in a High Needs School*

Karen Rose, Florida State University, kr04@fsu.edu

ABSTRACT: This research follows a preservice teacher placed in a high needs school during the apprentice teaching (also known as student teaching) semester. In this case, a high needs is described as a school with a free and reduced lunch percentage greater than 50%. This phenomenological study explores the connections between a preservice teacher's emotions, identity and the implementation of inquiry-based science instruction during the participant's apprentice teaching experience. The findings describe how identity and emotions shape a novice teacher's efforts to enact inquiry during the apprentice teaching experience.

A93. *Preparing Pre-Service Teachers to Teach Science to English Language Learners: Preliminary Analyses of Impact on Student Learning*

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Edward G. Lyon, Arizona State University

Preetha K. Menon, UC Santa Cruz

Trish Stoddart, University of California - Santa Cruz

ABSTRACT: This paper presents student learning analyses conducted as part of the NSF-funded Effective Science Teaching for English Language Learners (ESTELL) project. Two groups of elementary pre-service teachers participated in the project: a treatment group (science methods course transformed to infuse a set of instructional practices known to be effective for teaching science to ELLs) and a control group (unmodified course). To explore the intervention's influence on student learning we gathered science achievement data from 7 case study teachers (4 treatment, 3 control) who taught a common science unit in their first year of teaching. Student science learning was measured pre and post by an assessment aligned with the common science unit. This assessment contained a mix of constructed and selected response items covering three main categories – science concepts, science vocabulary, and science writing. Descriptive analysis of gain scores show that students of both treatment and control teachers demonstrated improved learning across all categories. We also found patterns consistent with the ESTELL instructional practices. For example, students of the treatment teachers outgained the control teachers on items related to language and literacy. Similar analyses are underway for ELL and non-ELL students as well as tests for statistical significance.

A95. *Analysing Diagnostic Competencies of Pre-service Teachers by means of the Simulated Science Classroom*

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Jens Moeller, Christian Albrechts University Kiel - Germany

Anna Suedkamp, University of Bamberg - Germany

ABSTRACT: Pedagogical diagnostic competence (PDC) is one of the main professional skills of teachers. It is a fundamental precondition to identify students' difficulties in learning or their shortcomings in knowledge, which is fundamentally important precondition though a teacher will be able to select appropriate feedback and actions to support the students' learning. Beyond that, the teachers' PDC is the requirement necessary for the fair judgement of students' performances. However, it seems to be difficult to ascertain PDC in the context of teaching, because in authentic teaching situations the influence of confounding variables can hardly be controlled. By employing a specifically adapted computer program – the “Simulated Science Classroom (SSC)” – it is possible to create teaching-analogue situations in which parameters of achievement and motivation of “simulated students” can be controlled systematically. In experimental studies we investigated specific components of “chemistry related pedagogical diagnostic competence (CPDC)” of 80 pre-service chemistry teachers taking over the role of a chemistry teacher interacting with 12 simulated students. The analyses show that the testees were able to compose an approximately correct ranking of the simulated students' achievements, but the levels as well as the standard deviations of the simulated students' achievements were systematically underestimated by the testees in all of the four different experimental treatments.

A97. *Preparing Digital STEM Teachers and Teacher Educators*

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Kristen Shand, California State University, Fullerton

Debra DeCastro-Ambrosetti, California State University, Fullerton

Natalie Tran, California State University, Fullerton

ABSTRACT: Technology integration in K-12 schools has moved slowly forward, but could do better still. It is evident that university course instruction and fieldwork experiences as well as prior technology experience has a significant influence on pre-service teachers' ability to use technology to support teaching and learning (Lambert, Gong, and Cooper, 2008), but there has been little discussion on how to prepare the STEM teacher educators to effectively model technology use. What skills do STEM teacher educators need? What professional development programs are available? And just as important, what are the concerns, steps, and/or elements to successfully and systematically transforming STEM pre-service education programs to be technology-rich and 21st century-oriented? What are the elements to successfully and systematically transform STEM pre-service education programs to be technology-rich and 21st century-oriented? Beginning with an overview of the Fullerton Math/Science Digital Credential Program Pathway, this paper provides a model and theoretical framework for the transformation of STEM teacher preparation programs through development of STEM teacher educator technology skills and creation of digital-rich learning environments for preservice STEM teachers.

A99. Noyce Pathway to Science Scholars: Attracting and Training Future Science Teachers

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Andre M. Green, University Of South Alabama

ABSTRACT: Noyce Pathway to Science (PTS) is a collaborative program between a local university's College of Education, College of Arts & Sciences, and a public school system. Pathway to Science addresses the desperate need to increase the number of science teachers in the school system through enabling recent science bachelor's degree graduates to complete secondary science certification in an intensive four-semester program that culminates with certification and an earned master's degree. The study explores the effect of a redesigned alternative certification program that significantly increases clinical field experiences while shortening the time to complete the certification, thus putting more qualified science teachers into classrooms sooner. The PTS program will add to the body of knowledge by identifying factors that attract science majors to careers as secondary school teachers.

A101. Instrument Development for Measuring the Professional Dispositions of Pre-service Math and Science Teachers

Tonya D. Jeffery, University of Houston, tdjeffery@uh.edu

ABSTRACT: This study sought to pilot a survey instrument to measure and assess the professional dispositions of pre-service math and science teachers in an undergraduate teacher preparation program at an urban university. A 64-item instrument was created using expert and empirical validity to explore pre-service teacher dispositions. Forty-one participants completed the survey. The instrument was developed utilizing the NCATE and INTASC principles along with the university's professional attributes standards. The four constructs represented components of the above standards: (a) self as a professional (P); (b) self as impacting student learning (ISL); (c) self as a reflective practitioner (RP); and (d) self as interacting with school and community (ISC). Exploratory factor analysis was used to show empirical validation utilizing SPSS. Each domain subscale was measured for internal consistency by calculating Cronbach's coefficient alpha, which ranged from .73 to .83 for the four domains. The study's findings presented evidence that the survey is a valid and reliable instrument and it effectively measures the four identified constructs. Future research is needed to continue the validation of this instrument on a larger sample of pre-service teachers. However, findings in this study can inform policy, research and practice for math and science teacher preparation programs.

A103. Pre-service Teachers' Developing Understanding of Teaching and Learning across Formal and Informal Learning Contexts

Maritza Macdonald, American Museum of Natural History, mmacdonald@amnh.org

Alix Cotumaccio, American Museum of Natural History

Preeti Gupta, American Museum of Natural History

ABSTRACT: We are urged to consider innovative approaches to teacher preparation in order to meet the challenges of urban teaching, and to address what research tells us are difficulties that new teachers face. In this study, we describe the ways that pre-service teachers who are part of a newly designed clinically rich teacher preparation program housed in a museum develop their skills, knowledges and habits of mind over the course of one summer, where they are taking courses and working with youth in museum programs.

A105. Embedding Science Education Service Learning into a Preservice MAT Science Teacher Program: Candidates' Reflections

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Joanne Caniglia, Kent State University

ABSTRACT: A growing literature base supports a model of teacher education service learning that has four essential elements: service opportunities in diverse settings, academic links between preservice teacher education courses and service learning experiences, reciprocity between the service learning sites and preservice teachers, and opportunities for reflection. While service learning may offer new opportunities to support preservice science and math teachers, few studies examine service learning beyond isolated teaching events. Content-specific service learning is an important, innovative thread that unites the various components of this institution's Noyce Scholars program. In the current study, we attempt to improve upon this literature by following master of arts in teaching (MAT) students' views of their service learning experiences throughout their entire MAT year. Five Noyce scholars were interviewed following their service

learning experiences. These interviews targeted scholars' perceptions of their service learning teaching episodes, growth as educators, views on teaching in urban settings, and future professional goals. Data analysis produced several themes including frustration about service learning event structure, awareness of their own adaptability, and initial hesitance about urban school settings. Major findings are discussed and elaborated upon with suggestions for future MAT programs seeking to incorporate science/math education service learning tasks.

A107. Preservice Teachers' Understanding of an Argument-based Inquiry

Aeran Choi, Ewha Womans University, aeran-choi@hotmail.com

Eulsun Seung, Indiana State University

ABSTRACT: This study explored pre-service science teachers' views on scientific inquiry and ways how learning experiences in science teaching methods class influence on their views on argumentation and inquiry. Participants of this study were 28 pre-service science teachers in an university located in Seoul, Korea. The participants were involved in various activities designed to support their understanding of inquiry features in a science methods class for a semester. Major data sources included 28 pre-service teachers' surveys, interviews and written reflection. Data analysis indicated that the pre-service teachers 1) exhibited limited experiences and understanding of the inquiry features; 2) emphasized only some features, such as generating research questions, designing and implementing procedure and drawing conclusions as essential components of scientific inquiry; and 3) improved understanding of scientific inquiry through actual experiences of argumentation in scientific inquiry and discussions about their experiences with teacher perspectives.

Strand 8: In-service Science Teacher Education

Poster Session A

3:15pm – 4:15pm, Río Mar Ballroom 5

A109. Examining Science Teacher Self-efficacy, Beliefs about NOS, and Constructivist Practice in a Collaborative Graduate Program

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Gregory Hale, The University of Texas at Arlington

Kevin J. White, University of Texas at Arlington

ABSTRACT: This paper presents research on the Math, Science, Technology Teacher Prep Academy (MSTTPA) – a collaborative program for science teachers among the university's College of Education and Health Professions, College of Science, and area partner school districts. The MSTTPA program implemented a concerted design to promote teachers' self-efficacy through constructivist teaching and learning experiences along with a strong foundation of science content, and to foster understanding of NOS by providing experiences to explore science as a tentative, dynamic discipline. This research proposes that teachers who have high self-efficacy toward teaching science and view NOS as tentative and changing with new evidence hold a more constructivist philosophy of science teaching and use more inquiry-based teaching approaches. Thus, the research purposes were to: 1) examine possible shifts in self-efficacy toward teaching science, views of NOS, and primary teaching philosophy and practices from beginning to end of the program, and 2) investigate relationships among self-efficacy toward teaching science, views of NOS, and primary teaching philosophy and practices at the beginning and end of the program. Results indicated positive significant shifts in self-efficacy and in NOS toward more dynamic views, and significant increases in teachers' use of constructivist teaching practices including problem-solving and logic.

A111. Middle School Science and Mathematics Teachers' Knowledge of the Nature of Science

Sissy S. Wong, University of Houston, sissywong@uh.edu

ABSTRACT: This research study examined the nature of science (NOS) knowledge of middle school science and mathematics teachers (N=22) as they being an online masters program that focuses on integrating the two content areas. This study explored the initial NOS conceptions the teachers held prior to starting the program, whether the level of NOS knowledge differed between the science and math teachers, if years of classroom service is related to level of NOS understanding, and if participants responded consistently amongst three different NOS instruments. Findings show

that the teachers' views of NOS are moderate, with science teachers having more advanced understanding of NOS than math teachers. There is no relationship between years of classroom experience and NOS understanding, and participants' responses on three different NOS instruments were consistent overall. By understanding the NOS knowledge of practicing middle school science and math teachers, researchers and teacher educators may gain insight into how to foster and develop NOS understanding in preservice and practicing teachers.

A113. *Supporting Elementary Teachers' Learning to Use Formative Assessment for Science: The RAES-Iowa Professional Development Model*

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Kathy J. Long, University of California

Cathleen A. Kennedy, KAC Group

Jeanne Bancroft, Creative Connections, LLC

Christopher Soldat, Grant Wood Area Education Agency, Iowa

Mandy Biggers, University of Iowa

Jaime Sabel, University of Iowa

ABSTRACT: Elementary science learning environments should be designed to engage students in scientific practices and science as inquiry. Early learners are capable of participating productively in these scientific practices when provided appropriate scaffolding through curriculum and instruction. Formative assessment is a powerful form of scaffolding that allows elementary teachers to account for students' explanations and support students' sense-making about science. However, elementary teachers require support to learn to implement formative assessment strategies in the classroom. The purpose of this paper is to present a novel professional development model employed in a 3-year research and development project charged with engaging 40 grades 3-6 teachers in sustained professional development to learn to implement formative assessment for science. The project is grounded in a partnership involving university-based science education researchers and scientists, four high-needs partner school districts, and state educational agencies. We present tenets of the professional development model, findings from the literature review that ground its design, elements of the program evaluation and research design, as well as insights into fostering and maintaining the multi-institution partnership in which the project is based.

A115. *Mentoring, Reflection and Growth in Science and Mathematics Teachers Using Plus/Delta*

Sheryl McGlamery, University of Nebraska at Omaha, sherylmcglamery@gmail.com

Saundra L. Shillingstad, University of Nebraska at Omaha

ABSTRACT: This qualitative study of beginning science and mathematics teachers follows twelve teachers participating in an induction program. The study chronicles their growth in six areas of professional skill development. The Plus/Delta Instrument was used as a reflective tool to assist both the beginning teachers and their mentors reflect and evaluate pedagogy from the beginning teachers' and mentors' perspectives. Science and mathematics lessons were recorded and evaluated by both groups. Researchers coded the data and found differences in what each group identified as critical components of the lessons observed. A comparison was made between the responses of the mentors and the responses of the mentees in order to contrast what each group perceived as going well and as needing improvement.

A117. *Finding Time to Lead: High School Science Department Chairs as Instructional Leaders*

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ABSTRACT: High school department chairs are in prime position provide instructional leadership in science, but this role is not well understood and not well used within schools. Lack of time and authority and role conflict and ambiguity all limit chairs' effectiveness. Thus the current study presents the results of a survey focusing on the leadership contexts and instructional leadership practices of high school science department chairs. High school science department chairs (n = 146) from across the state of Georgia responded to a combination of selected- and open-response items examining to what extent and how chairs work within existing limitations to provide instructional leadership within their departments. Quantitative and thematic analysis of survey responses led to a conceptual model in which chairs define their role as instructional leaders as they negotiate a range of supporting and limiting factors within their school contexts and as they prioritize instructional leadership among other duties. Findings of this study underscore the potential value of providing chairs with sufficient time to complete important instructional duties. Further, the model of

instructional leadership presented provides a roadmap of how chairs build on supports and negotiate limitations to enact leadership within science education.

A119. *Elementary Education Pre-service Teachers' Performance on Context-based Science Process Skills*

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Erin Miles, Southern Illinois University

Vivien M. Chabalengula, Southern Illinois University Carbondale

ABSTRACT: Science process skills increase subject matter understanding and science content knowledge and provide the foundation for inquiry. As such, teachers' sufficient understanding of science processes, content knowledge and inquiry are essential elements for effective science teaching in K-12 classrooms. The research question that guided this study was how well do in-service elementary teachers perform on science process skills? A sample comprised 24 in-service elementary education teachers who were certified to teach K-8 students. Data was collected through a 48 item multiple choice test. Data was analyzed using descriptive statistics and non-parametric tests. Results show that teachers performed well on science process skills test. This result could be because context plays a part in cognitive tasks presented in a test, especially on multiple choice tests. The performance test in this study presented these skills in a real-world type situation, possibly assisting teachers in doing them because they were familiar with the contexts. These results offer some hope that teachers may teach the science process skills because they performed well on them, but only within given contexts and possibly with some misconceptions.

A121. *Establishing an Effective Programme for Developing Teachers' Self-Efficacy towards Motivational Inquiry-based Teaching*

Ana Valdmann, University of Tartu, anavaldmann@gmail.com

ABSTRACT: Establishing an Effective Programme for Developing Teachers' Self-Efficacy towards Motivational Inquiry-Based Science Teaching The purpose of this study is to establish an effective CPD programme to promote teacher's self-efficacy with respect to implementing motivational inquiry-based teaching based on a theoretical three-stage model. To this end, the professional needs of each teacher were identified by means of a validated teacher needs questionnaire covering identified pedagogical content knowledge expectations, plus follow up teacher interviews. The CPD focus was determined by interviewing teachers who had been through similar CPD programmes in the past. Findings suggest enactment of teaching and reflective feedback on classroom implementation as important components for raising teacher confidence in using the approach, while the course itself should relate to developing competence in covering theoretical education ideas. Key terms: continuous professional development, teachers' self-efficacy, inquiry-based teaching, three-stage model.

A123. *Supporting the Supporters: A Case Study of Professional Development for Science Coordinators*

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Jennifer Maeng, University Of Virginia

Randy L. Bell, Oregon State University

Amanda L. Gonczi, University of Virginia

ABSTRACT: We investigated changes in district science coordinators beliefs about science teaching and learning and supporting teachers' science instruction following participation in a state-wide professional development (PD) experience. Participants included 3 male and 10 female science coordinators from 12 different school districts in a mid-Atlantic state. Data included survey responses and follow-up interviews. From the participants, one science coordinator, Ann, was purposefully selected for in-depth case-study. Data for this case study included observations of Ann implementing PD in her district, interviews with teachers and principals in Ann's district. Data were analyzed using analytic induction. Analysis indicated that as a result of attending the PD, all participants valued developing and implementing a strategic plan for science, perceived inquiry as an effective pedagogical approach, and appreciated developing relationships with their peers. Additionally, participants supported teachers' science instruction by providing PD opportunities that emphasized problem-based learning, inquiry, and nature of science instruction. However, participants reported having little authority within their districts to change science instruction, which hindered their effectiveness in improving science instruction. These results suggest the ability of science coordinators to affect change

in the infrastructure within a district may be limited; therefore, PD efforts should be broadened to include other district stakeholders.

A125. *Understanding and Scaffolding Inquiry: A Tale of Three Teachers*

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Jennifer L. Maeng, University of Virginia

Randy L. Bell, Oregon State University

ABSTRACT: This investigation employed a social constructivist framework to explore 3 secondary science teachers' use of a tiered framework for inquiry instruction. Participants were secondary science teachers in their first years of teaching and were part of a larger professional development program that highlighted a scaffolded approach to inquiry instruction. These teachers were purposefully selected; each indicated they implemented the "levels of inquiry" framework emphasized in the PD. The researchers employed analytic induction to make meaning from the large data set, which included classroom observations, surveys, and interviews. Results indicated that the participants' understanding of inquiry became more aligned with the PD; however, these understandings were not aligned with their classroom instruction. Several factors appeared to mitigate participants' use of inquiry instruction including participants' ability to easily modify their own activities, coworker/coach support, content knowledge expertise, and school-wide policies. While students' in all participants' classes gathered and analyzed data during inquiry lessons; only students in one of the three participants' classes evaluated and communicated their results of their investigations. The present study has potential to inform how methods of scaffolding inquiry instruction and teaching scientific practices are taught to in-service teachers.

A127. *Taking the First Step: Understanding Teacher Perspectives of Inquiry-Based Professional Development in a University-School Partnership*

Krista E. Wood, University of Cincinnati, Krista.Wood@uc.edu

Kathie Maynard, University of Cincinnati

ABSTRACT: Many university-school partnerships aim to reform education and improve student achievement, but overlook what teachers think about the partnership, reform effort, and related professional development. This paper illustrates secondary science teachers' views of inquiry-based professional development in a university-school partnership. Five secondary science teachers were interviewed and transcripts were analyzed using the teacher-centered systemic reform model to understand teacher perspectives. Findings showed two themes: What Teachers Want and Teachers' Challenges. Teachers wanted more content knowledge, pedagogical content knowledge, implementation support to change their practices, and vertical collaboration across grades. Teachers perceived structural and cultural challenges in their reform efforts. A university-school partnership must consider teacher perspectives, including what teachers want and teachers' challenges, during implementation of professional development to effect change. By addressing the perspectives of teachers who will be enacting classroom reform, the findings can be used to improve the design of professional development in university-school partnerships.

A129. *Teachers' Beliefs of Technology Use to Teach Genetics*

Regina Wragg, University Of South Carolina, rewragg@gmail.com

Christine R. Lotter, University of South Carolina

ABSTRACT: In understanding that teachers' beliefs influence their practice, this study explored how teachers' beliefs change as they enact and influence how they enact technology-rich curriculum into their classroom as they receive support through professional development. Via a case analysis with triangulated data, our study supports research that suggests the best practice of supporting classroom teachers in their use of technology-rich inquiry curriculum is an extended professional development model that should allow the teachers to be engaged as learners. Our data also supports changes in teachers' beliefs regarding students ability to learn with technology-rich curriculum can be supported by providing teachers with access to technology for their classrooms and modeling classroom management skills that assist teachers in supervising students in the use of the technology.

A131. *Understanding Indian Teachers' Orientations in Relation to PCK and Curriculum Reform*

Vanashri Nargund-Joshi, University at Buffalo, SUNY, vanashri@buffalo.edu

Meredith A. Park Rogers, Indiana University

ABSTRACT: This study explores the concepts and behaviors, otherwise referred to as orientations, of six Indian science teachers and the alignment of these orientations to the 2005 Indian National Curriculum Framework (NCF-2005). To understand nature of teachers' orientations we examine (a) differences in teachers' orientations across grade bands (elementary [1-5], middle [6-8], and secondary [9-10]) and (b) teachers' science teaching orientations in relations with different components of Pedagogical Content Knowledge (PCK). We created profiles of teachers' science teaching orientations based on three interviews with each teacher and several classroom observations. By implementing inductive approach we developed profile of each teacher's science teaching orientation. This helped us understand similarities and differences between the nature of teacher's orientation(s) according to grade band level. Teachers' orientations ranged from traditional in nature to inquiry/constructivist in nature. Teachers displayed limited pedagogical content knowledge regarding students' scientific thinking, curriculum design, instructional strategies, and assessment. Inquiry/constructivist teachers' orientations, while more in line with reform, still have a few key areas of pedagogical content knowledge needing attention (e.g., knowledge of assessment and a variety of purposes for constructivist instructional strategies). Suggestions for shifting teachers' orientations towards more constructivist principles according to various stakeholders are discussed.

Strand 9: Reflective Practice**Poster Session A**

3:15pm – 4:15pm, Río Mar Ballroom 5

A133. *Leveraging Argumentation to Facilitate SMK Understanding among Students of A Middle School in China*

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ABSTRACT: Argumentation has become a significant issue. Its importance in science education lies in that it fosters the ability of making informed decisions regarding a scientific issue based on data analysis and reasoning. Research regarding argumentation has increased in numbers. A structure of argumentation has been well-structured by previous work in this domain. According to Toulmin's model, an informed argument is consisted of 5 key elements, claim, data, warrant, backing and rebuttal. However, most of these studies were conducted in a context of social-scientific issues. There were few studies concerning the relationship between an arguer's Subject Matter Knowledge (SMK) and his argumentation skills. SMK is crucial in argumentation in that it usually plays the role of warrant or backing, which determines the reliability and accuracy of an argument. Therefore, there is a need for studies that investigate how SMK leverages the development of argumentation. This project was a practical study of this concern. It was conducted in a Chinese middle school physics class where scientific content knowledge was highly emphasized. The result gave educators an insight into the role of SMK in argumentation, as well as how to implement argumentation in a class with heavy load of SMK.

A135. *Patterns of Reflection on Practice Through Professional Development with High School Science Teachers*

Nonyelum M. Alozie, Albion College, nonye.alozie@gmail.com

ABSTRACT: In this study, professional development sessions focused on supporting high school biology teachers as they reflect on their inquiry-based discussion practices. My research question was: What patterns of reflection do teachers exhibit during professional development workshops when using educative resources? I worked with 1 administrator and 3 high school teachers enacting a genetics and genomics curriculum. We met 4 times in 12 weeks in professional development workshops that used resources (criteria, video artifacts, strategies, curriculum materials and education research articles) to help us think about how to promote inquiry-based discussions in the classroom. I used Wade, Fauske, and Thompson's (2008) and Zeichner and Tabachnick's (2003) descriptions of reflective perspectives to understand the shift in conversations and the relationship to the professional development resources. Teacher conversations showed similarities to different types of reflection, indicating that the use of research articles and video observation has the potential to support a change in reflective perspectives on teaching, and thereby facilitate changes in teacher instruction. The study contributes to research in science education by showing how effective reflection can be

promoted by encouraging teachers to use their experiences in the classroom to inform professional development and promote changes in reflective perspectives on teaching.

A137. *Supporting Reflection on Co-teaching Practices that can Improve Science Teaching in Linguistically Diverse Classrooms*

Sonya N. Martin, Seoul National University, sm655@snu.ac.kr

Jennifer C. Park, Seoul National University

ABSTRACT: With the increased number of English Language Learners (ELL) in the U.S. that are mainstreamed in K-12 classrooms, the need for all teachers to have the knowledge, skills and dispositions to effectively teach ELL students is greater than ever. Although a variety of professional development, training and intervention models for teachers have emerged in recent years, there is still a dearth of research on preparing science teachers to work with ELLs. This poster presents findings from a larger grant-funded study in which observation, video analysis, and cogenerative dialogues were used to examine the practices of science and English support (ESOL) teachers in classrooms with linguistically diverse middle school students. In this presentation, we discuss the benefits of cogenerative dialogues as a tool to support coteaching between science and ESOL teachers. Analysis of quantitative and qualitative data sources indicate that (1) observations supported teachers to identify significant challenges in teaching ELL students science; (2) teachers reported shifts in awareness about needs of ELLs based on video reflections; and (3) cogenerative dialogues provided a valuable social space for science and ESOL teachers to share perspectives, foster positive relationships, and develop new scaffolding strategies to promote science and language proficiency.

A139. *Pre-service Science Teachers' Implementation of Assessment for Students' Learning and their Beliefs*

Hye-Eun Chu, Nanyang Technological University, hyeeun.chu@gmail.com

ABSTRACT: The aim of this research is to investigate how pre-service science teachers implement Assessment for Learning (AfL) during their practicum teaching and how their beliefs on assessment influence practicum teaching. A total of sixty pre-service science/physics teachers in PGDE (Post Graduate Diploma in Education) program participated in this research. Student teachers' answers from open-ended questionnaire in each group, a total 15 groups, was collected to investigate student teachers prior understanding related to Assessment for Learning (AforL) and individual reflection writing during practicum teaching were analyzed to identify student teachers AforL implementation in their teaching practices and their beliefs on AforL strategies. The findings indicated that student teachers prefer to implement AforL strategies related to constructive and inquiry based teaching approach. However, they showed more negative beliefs on AforL when the teaching approach embedded with AFL include classroom discourse.

A141. *Reflective Teaching of Pedagogical Inquiry Strategies for Scientifically Literate Citizens*

Jeremy A. Ervin, Richard Stockton College of NJ, ervinj@stockton.edu

ABSTRACT: As a professor teaching general core science courses to non-science majors, I want to successfully implementing inquiry strategies to enable my students to be scientifically literate citizens. In this initial phase of my action research study, I seek to investigate: What impact will implementing inquiry strategies into a general education college course have on developing attitudes about scientific literacy? Through quantitative analysis, I measured student attitudes about science by means of the Test of Science-Related Attitudes (TOSRA). The 35 item pretest (beginning semester) and post-test (end) measured these 7 categories: Social Implications, Normality of Scientists, Attitude to Inquiry, Adoption of Scientific Attitudes, Enjoyment of Science Lessons, Leisure Interest in Science, and Career Interest in Science. A two-tailed t-Test determined a significant difference ($p < 0.05$) of increase to 3 of the categories (Social, Normality, & Enjoyment) and decrease to 2 of the categories (Attitude & Career). The interpretation exposed student's ability to have a greater conceptual understanding of science along with its impact on their careers and personal decisions. The findings invite readers to consider the implementing inquiry activities and assessments in their general core science courses in order to have greater impact on our culture by providing scientifically literate citizens.

A143. *Transformative Learning and Science Education: Preparing University Students for Taking Action*

Lyn Carter, Australian Catholic University, lyn.carter@acu.edu.au

Carolina Castano, Australian Catholic University

Mellita Jones, Australian Catholic University

ABSTRACT: Sociocultural approaches to science education that aim towards a kind of scientific literacy for active citizenship have been increasing in recent years and are now firmly entrenched. Authors such as Bencze (2001) argue that education often creates citizens who are large, a-critical consumers who perpetuate the current environmental crisis. Similarly, Orr (2004) believes that what we have are foremost problems of 'mind, perception and values' (p. 27). Included in much of this literature is the concept of education for transformation of attitudes and actions. While more often than not used colloquially, transformation is also a term d'art within field of transformative learning (TL). TL is not well known within science education, and we believe it may offer new insights into ways of progressing some of our sociocultural agendas. This paper presents findings from a science teaching elective unit with 25 pre-service teachers which followed transformative learning theory to transform students' attitudes and actions towards socio-ecojustice practices and actions. We discuss how transformative learning could serve us to educate teachers that will be committed to act and teach within a social justice and ecojustice framework and the implications for teacher science education.

Strand 10: Curriculum, Evaluation, and Assessment

Poster Session A

3:15pm – 4:15pm, Río Mar Ballroom 5

A145. Evaluating Engineering Standards, Perceptions, and Skills

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Tamara J. Moore, University of Minnesota

Kristina M. Tank, University of Minnesota

Aran W. Glancy, University of Minnesota

Jennifer Kersten, Richfield High School/University of Minnesota

Cathy Lachapelle, Museum of Science, Boston

Jonathan Hertel, Museum of Science, Boston

Preeya Phadnis, Museum of Science, Boston

Christine M. Cunningham, Museum of Science, Boston

Patrick McCrum, Purdue University

ABSTRACT: Recent developments in state and national standards highlight the importance of teaching engineering in K-12 classrooms and necessitate rigorous and organized research in this area. However, while the integration between science and engineering in K-12 classrooms is important, the researchers in these two fields rarely come together in an organized manner. This paper set on engineering education is part of a NARST paper set series in engineering education and aims to build a community to organize research efforts in engineering education. This collaborative paper set specifically focus on addressing the following research questions: (1) What is the quality of K-12 academic science standards relating to engineering? (2) What perceptions do students have about technology? and How can we effectively assess these perceptions? (3) What are elementary teachers' perceptions about engineering? What are innovative ways of assessing teachers' views? and (4) How do elementary students use specialized skills such as engineering trade-offs? How can we assess learning of engineering skills? The paper set aims to address gaps in assessment in engineering education and promote discussion on how to infuse and improve engineering in elementary classrooms.

A149. Investigating Variations of Inquiry in Elementary Science Classrooms: Establishing Validity/Reliability of a Modified Observation Protocol

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Cory T. Forbes, University of Iowa

Laura Zangori, University of Iowa College Of Education

ABSTRACT: Using a framework of the variations of inquiry (NRC, 2000, p. 29), this study explored the validity and reliability of a modified version of an existing instrument. This instrument measures the amount of teacher direction ranging from very teacher-directed styles ('guided inquiry') to very learner-directed styles ('open' inquiry). We investigated 40 elementary teachers' lesson plans and videorecorded enactments as the data source for the study asking

these questions: 1. Is the modified [instrument name blinded for review] a valid and reliable instrument? 2. Is there a relationship between teacher scores on the existing and modified [instrument]? Teachers need support to learn how to adapt their curriculum across this inquiry continuum. This study is a first attempt at looking at inservice elementary teachers' ideas about the continuum and if they adapt their curriculum across it. Results show that the modified instrument is valid and reliable, and that only one feature of inquiry showed a significant difference between planned and enacted lessons. The teachers taught their curriculum with relatively high degrees of fidelity. This study is grounded in prior research with preservice teachers' learning about the inquiry continuum, and also research on inservice teachers' ideas about the five essential features of inquiry.

A151. Differentiating language skills, reading ability, and scientific knowledge with the Scientific Terminology Assessment Instrument (STAI)

Hendrik Haertig, IPN - Leibniz-Institut, haertig@ipn.uni-kiel.de

ABSTRACT: Research has emphasized a so-called 'fundamental sense' and a 'derived sense'. The fundamental sense comprises scientific language skills, and thus is essential for students' conceptual understanding. Therefore assessing scientific language skills is of central importance in science assessment. Up to now there has been a lack of instruments capable of generating valid inferences about students' scientific language skills. Even if there are studies concentrating on English-language learners, little is known about the structure of scientific language skills. For this reason we developed a theoretical model which integrates (1) linguistics, (2) the fundamental, and (3) the derived sense of scientific literacy in order to delineate the construct of scientific language skills. First evidence for such an integrative perspective is collected with a new developed Scientific Terminology Assessment Instrument [STAI]. The instrument shall be able to diagnose students semantic abilities explicitly in scientific language in differentiation to everyday language and the derived sense of scientific literacy. The STAI has been evaluated within a group of 99 students from high-school. Results from the study provide evidence that students' scientific language skills assessed with the STAI can be separated from everyday language abilities as well as from the derived sense of scientific literacy.

A153. Engagement and the Middle School Science Curriculum

Jeremy F. Price, University of California - Berkeley, jeremy.price@berkeley.edu

Jacqueline Barber, University of California - Berkeley

Seth Corrigan, University of California - Berkeley

Jennifer Tilson, University of California - Berkeley

Alison Billman, University of California - Berkeley

Suzy Loper, University of California - Berkeley

ABSTRACT: The Framework for K-12 Science Education places a premium on student engagement and highlights "students' engagement in instructional activities" (NRC Framework, 2012, p. 314) as an essential area for researchers to address. This mixed-methods research examines the characteristics of activities in a Framework- and Next Generation Science Standards-based middle school Earth and space science and life sciences curriculum in terms of student engagement. We focus on the following lesson characteristics: Reading-Focused, Argumentation-Focused, Hands-On, and Cognitive Construction. We find that students are more engaged when the learning goals and activities are clearly aligned. We also find that lessons in which students are involved in hands-on and cognitive construction tasks and that lessons where students are encouraged to use science to discuss and describe interests and issues outside the classroom, such as the social implications of video games, also contribute to student engagement. Our recommendations to curriculum developers and teachers center on three points: ensuring clear linkages between learning goals and activities, tightly weaving more engaging and less engaging curriculum activities together, and linking science activities to topics and areas of students' interest and expertise outside the science classroom.

A155. Developing Computer Model-Based Formative Assessments for High School Chemistry

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Noemi Waight, University at Buffalo - SUNY

Erica L. Smith, University at Buffalo - SUNY

ABSTRACT: This interactive poster reports the process and findings of developing computer model-based formative assessments for high school chemistry. Computer models are flash and NetLogo environments to make simultaneously

available three representations in chemistry: macroscopic, submicroscopic, and symbolic. Students interact with computer models to answer assessment questions. Student responses provide an indication of their understanding of two big ideas in chemistry: matter-energy and models. Teachers incorporate computer models during the unit of instruction and give the computer model-based assessment at the end of the unit. The assessment results of students' levels of understanding on matter-energy and models are used by the teacher to plan the instruction of the next unit. Multi-dimensional Rasch modeling suggests that assessment items have good technical quality and the assessments have adequate construct validity and reliability. Students who used computer model-based formative assessments extensively did statistically significantly better on the chemistry conceptual test than students in the comparison classes, although there was no statistically significant difference on NY Regents test scores between the experimental and comparison classes. Results also suggest specific areas of improvement for computer model-based assessments, and integration of the models and assessments in high school chemistry courses.

A157. Preliminary Results from Gymnasium Student's Perceived Competence, Determined through Self-Assessment against Components of Scientific Literacy

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Miia Rannikmaa, University of Tartu

ABSTRACT: This study focuses on students' self-assessment of competencies which are related to the components determining the levels of students' scientific literacy. The instrument was developed based on a review of relevant international literature plus competencies emphasised in the Estonian curriculum. The first part includes interdisciplinary socio-scientific situations, which require utilization of curriculum-related science knowledge and skills and lead to a measure of levels of understanding of science processes, problem solving and decision making skills. The second part is designed to determine perceived competence related to previously mentioned components of scientific literacy through self-assessment, the perceived value of science lessons and future career preferences. This proposal concentrates on the second part of the test. The representative sample of students from grade 10 (2217) and 11 (2145) were tested November 2011-April 2012. Preliminary results indicate high perceived competence among both grades of students, especially in competencies assessed in science lessons (e.g. understanding science processes); lower, but still relatively high evaluation is related to problem solving skills. According to students' visions, science lessons don't develop competencies to a sufficient degree. A strange anomaly is that students seek careers related to decision making, although they don't feel themselves competent in decision making areas.

A159. Rubric for Judging Quality of Scientific Reasoning

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ABSTRACT: Science instruction should focus on developing and enhancing students' reasoning skills. Using techniques to effectively assess students' reasoning performance is important in achieving this aim. The present paper presents a rubric including specific dimensions that could be used in making judgments on learners' quality of scientific reasoning. The rubric's dimensions converge with the dominant characterization of scientific reasoning as the coordination of theory and evidence. The rubric aimed to externalize participants' lines of reasoning as they coordinated between their prior knowledge and the evidence provided in conceptual scenarios. Illustrations on the use of the rubric are provided.

A161. Optimizing Machine-Learning Models for Automated Computer Scoring of Natural Selection Concepts

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Simon Dennis, The Ohio State University

Ross H. Nehm, The Ohio State University

ABSTRACT: Recent literature in science education has emphasized the importance of assessing students' explanations and arguments using open-response assessments. However, numerous limitations of manual scoring by human graders currently limit the widespread implementation of practice-based assessments. While machine-learning tools have shown great promise in science education assessment, few studies have explored different approaches for training machine-learning programs to generate robust scoring models. Our study aims to investigate the effects of three machine-learning parameters: n-gram selection, stemming, and dataset balancing. We used a corpus of 10,270 human-scored evolutionary explanations written by 2,978 participants of varying expertise levels (e.g., non-majors, majors, experts) to evaluate different machine-learning parameters. Using a series of statistical tests, our study showed that n-

gram selection influenced model performance depending on the complexity of the concepts we sought to score. Using stemming and whole-dataset balancing was shown to be most beneficial to scoring performance. We also observed that n-gram selection and balanced datasets caused a trade-off between precision and recall (which are related to score overestimation and accuracy). Machine-learning scoring-system developers need to consider the weights that they place on precision vs. recall and consider the optimal parameters for each concept that they seek to assess.

A163. *Assessing Young Students' Abilities in Science*

Lena Löfgren, Kristianstad University, lena.lofgren@hkr.se

Britt Lindahl, Kristianstad University

ABSTRACT: The Swedish compulsory school had a new curriculum in 2011. The curriculum stresses that pupils should be given the opportunities to develop three abilities: 1) to use knowledge of science to examine information, communicate and take a view on questions concerning scientific issues, 2) to carry out systematic studies in science, and 3) to use concepts of science, its models and theories to describe and explain scientific relationships in society, nature and within the human body. From the government there is a demand for earlier assessment and grading. A project group has been given the task to produce a formative assessment material in science for school years one to six. In addition the group, slightly increased, produces national tests for school year six in biology, chemistry and physics. The project group has decided to follow what happens to science teaching during these changes. Questionnaires, observations and interviews have been used to collect data. At the conference a presentation of the first ideas from teachers, students and researchers on the effect of the changes will be given. Another question that will be discussed concerns the possibilities to produce exercises used in tests which measure the three abilities asked for in the curriculum.

A165. *Developing Interdisciplinary Science Curricula that Foster Energy Literacy for Undergraduate Student*

Shannon Sung, University of Georgia, Shasung@uga.edu

Ji Shen, University of Georgia

ABSTRACT: Interdisciplinary understanding (IU) is a critical learning objective across all levels of education. However, a typical college curriculum does not necessarily support this objective. In this study, we propose three distinctive approaches to build interdisciplinary science curricula to foster students' IU and illustrate them with the topic of energy. Energy is one of the most fundamental science concepts that apply to almost all science disciplines; however, students have difficulties grasping the complex ideas of energy and applying them to different contexts (Liu, Ebenezer, & Fraser, 2002). The explicit IU curricula may help students to depict a holistic picture of energy, and therefore, develop adequate energy literacy (DeWaters & Powers, 2011). Implications and limitations of the curricula are also discussed in this paper.

A167. *Examining the Mastery of Science Skills using the 4th Grade Science TIMSS*

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Yoon Soo Park, University of Illinois at Chicago

Youngjin Song, University of Northern Colorado

ABSTRACT: Providing fine-grained diagnostic information on examinee performance is useful for learners as well as instructors in science education (Pellegrino, 2012). Cognitive diagnostic models (CDMs) were developed to provide information to researchers and educators on skills or attributes that are required to solve an item. Consequently, diagnostic information can be applied to various instructional practices by identifying the presence or the absence (i.e., mastery and non-mastery) of specific, fine-grained skills or attributes. The purpose of the study is to conduct a CDM analysis using the 4th grade science data from the 2007 Trends in International Mathematics and Science Study (TIMSS) to examine the distribution of mastery in science attributes between the U.S. (ranked 8th), Singapore (ranked 1st), and Hong Kong (ranked 3rd). This study will provide a rich source of information for educational researchers and classroom teachers to direct their attention to specific areas where students need further instruction by identifying strengths and weaknesses in the performance of U.S. students. Results of the study will also inform researchers on the use of emerging methodology in CDMs to examine possible sources of diagnostic information in science assessments.

A169. *A Psychometric Look on Writing and Evaluating Arguments*

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Elena Papanastasiou, University of Nicosia

ABSTRACT: The purpose of this study was to design and validate an argumentation assessment tool that could easily be used by teachers to evaluate their students' written arguments in science. An additional purpose of the study was to explore the different characteristics of students written arguments, as for example different levels of complexity or sub-skills that might exist in written arguments, and the content dependency of arguments. Two written argument tools that were designed for 11-14 year old students are presented, along with the validation process, and the main outcomes from applying the tools with 246 students in as European country. The analysis of the data shows that the scores from the tests have a good degree of reliability for evaluating written argumentation when the first item is removed (Cronbach's alpha .674 Test A and .705 Test B). Additionally, we have identified characteristics of students' written argumentation, namely that (a) evaluating a written argument is a lower level sub-skill of argumentation that writing an argument, and (b) argumentation is content-specific.

Strand 11: Cultural, Social, and Gender Issues

Poster Session A

3:15pm – 4:15pm, Río Mar Ballroom 5

A171. *The Science of Broadening Participation: An Opportunity for the NARST Equity and Ethics Community*

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ABSTRACT: As the goal of increasing the number of individuals from groups underrepresented in the U.S. STEM workforce has garnered attention from the President's Council of Advisors on Science and Technology (PCAST) and organizations like BHEF and the Association for American Universities in their articulations of priorities and initiatives, discussions around a science of broadening participation are becoming more prevalent in some circles. What is meant by the science of broadening participation remains ill-defined and is an opportunity for the NARST Equity and Ethics (E&E) community, the community whose work most closely aligns with the broadening participation emphasis, to shape what it could be. How can the work of the E&E community be a contributor to not only refining what is meant by a science of broadening participation but also to the development of the science?

A173. *Building a Collaborative Community to Recruit and Retain Underrepresented Preservice Elementary Teachers of Science*

Michelle A. Fleming, Wright State University, mabfleming@gmail.com

Reynee Kachur, University of Wisconsin Oshkosh

Bhaskar Upadhyay, University of Minnesota

Oliver Schinkten, Oshkosh Area School District Oshkosh, Wisconsin

ABSTRACT: The Collaborative Community in Science, Technology, Engineering, and Mathematics Education (C2STEM) project was designed to recruit and retain underrepresented undergraduate college students (i.e. female students and/or students of color) in STEM education. The C2STEM project created a university-based collaborative community comprised of pre-education and current education undergraduate students, university multicultural education advisors, retention specialists, STEM faculty, and PK-12 educators/coordinators. Pre-education students were defined as students admitted and enrolled in the university but not admitted in the college of education. Current education students were defined as students currently admitted and enrolled in the college of education in a teacher education program (i.e. elementary and secondary science education). A mixed methods case study approach was used to investigate how a STEM education collaborative community impacted underrepresented students' interests, attitudes, and access to the profession. Additionally the participants' views of their capacity to learn and teach science were examined throughout the year-long project. Issues of recruitment and retention were woven into the study.

A175. *Middle-School Science Curriculum in Chile and Pakistan: Addressing Issues of Equity and Social Justice*

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Samina Naseem, Michigan State University

ABSTRACT: In this paper, we analyze official documents of middle-school Science Curriculum in two developing countries: Chile and Pakistan. Our analysis and reflection on these documents aim to provide insights on how equity and social justice are understood by curriculum developers and transmitted into schools through curricular guidelines. We

point out that both curricula, despite their cultural and geographical differences, mention the importance of equity in Science Education, although they are not able to concretize their stances into the problems and challenges that each country faces in terms of science teaching and learning, especially in multicultural contexts characterized by strong inequalities. We also discuss to what extent the stances about equity and social justice in Science Education curricula in developing countries emerge in a context of globalization.

A177. *The (Im?)Possible DREAM: Undocumented Latin@s' Testimonios on Crossing the Borderlands of High School Science*

Jean Rockford Aguilar-Valdez, University of North Carolina, Greensboro, msrockford@gmail.com

ABSTRACT: This study introduces nine high-achieving undocumented Latin@ students in top tier science courses in a Southern, high-poverty Title 1 high school. Critical narrative analysis of their testimonios [testimonies] are utilized. Testimonio, a form of counter-storytelling originating in Latin American literature, is a method of speaking truth to power and an act of solidarity with others who have been similarly oppressed. These students' authentic voices and stories of struggle and success illustrate their crossing of cultural and political borderlands (Anzaldua, 2007) and humanize their complex realities. While Obama's new deferred action opportunity gives these DREAM-act eligible students some relief, they're still painfully aware of the oppressive barriers to equal access to college and no path to citizenship. Students persevere in spite of, perhaps because of, the additional obstacles they face, to "prove" their worth and rise above low expectations of students of their ethnicity and undocumented status. These students' remarkable success in school science, both through formal and informal measures, lead one to question why more isn't being done to help these students achieve their dreams in the field of science, given the demand for scientific minds and talent such as theirs, in the scientific world today.

A179. *What is Good Science Teaching? Challenges in Teaching Science to Urban ELL Middle School Students*

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Beth Wassell, Rowan University

Sarah Braden, University of Utah

ABSTRACT: This study uses the Reformed Teaching Observational Protocol (RTOP) to document and describe the classroom practices and environment of six, urban middle school science teachers. Students answered a survey on their perceptions of their teachers' classroom practices, their classroom activities and their views about science. Students held more positive views about science when they had a positive "Student Teacher Relationship" with their teacher. The study also defines norms for interpreting RTOP from the research literature. Teachers' lessons were described as scoring 'low, average or high' on RTOP and the subscales. Most of the teachers' lessons and average scores had low or average scores indicating the challenges science teachers face when their class have a high percentage of ELL students who need instructional support to improve their literacy skills.

A181. *Elementary Students' with Visual Impairments Conceptual Understanding of Sound*

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Sally M. Hobson, The Ohio State University

Tiffany Wild, The Ohio State University

ABSTRACT: Little research has been conducted to determine students' conceptual understanding of sound. Studies related to the understanding of these concepts by children with visual impairments are absent from the literature. Utilizing conceptual change theory, this study examined students' with visual impairments conceptual understandings of sound before and after completion of an inquiry-based science curriculum provided during a week-long summer camp. The camp theme was integrating the literacy skills of reading and writing braille into learning about basic sound concepts. Inquiry-based lessons included experiences with producing and manipulating sound. The purpose of this study was to understand and describe the misconceptions and conceptual understanding about sound that may exist among students with visual impairments. A secondary goal was to identify instructional techniques that may help students with visual impairments to develop a scientific understanding of sound. Prior to the study, none of the students had complete scientifically accurate understandings of sound. However, after the study all of the students had some scientific understanding of sound and two of the students developed a complete scientific understanding of sound. Although this study focused on students with visual impairments, the findings may also apply to general education students.

A183. *Reported Barriers to Academic Success for Hispanic Physician Scientists: An Exploratory Qualitative Study*

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Donna B. Jeffe, Washington University in St. Louis

Dorothy A. Andriole, Washington University in St. Louis

Heather D. Wathington, University of Virginia

Robert H. Tai, University of Virginia

ABSTRACT: Despite Hispanics being the largest minority group in the United States (US), students from the Hispanic community lag behind other non-minority races and ethnicities in terms of their achievement in higher education. This paper uses the framework of cultural-ecological theory to understand disparities in minority student achievements. We examine the different barriers reported by the Hispanic students in nationally funded medical scientist training programs that are considered hindrances to their academic success. Our overarching research question is: "How do Hispanic physician-scientists in the medical scientist training program define and make meaning of the barriers they face within or outside the program that poses challenges to their success in the program?" We used an interpretivist paradigm and analytic induction to qualitatively analyze four interviews of Hispanic physician scientists in the program. Analysis indicates that the barriers are primarily due to an overlap between the individual and institutional characteristics. Implications include developing future initiatives that will help students identify programs that are a better fit based on the individual and institutional characteristics. In the future, we also propose to examine the barriers reported by the non-Hispanic students and students not in the medical scientist training program as potential comparison groups.

A185. *Under the Microscope: Exploring Equity and Diversity in a Decade of Science Education Research Literature*

Linda J. Collins, The University of Akron, ljc9@uakron.edu

Eugenia Johnson-Whitt, University of Toledo

Jaclyn P. Gordon, University of Akron

Kathleen S. Crooks, University of Akron

Xin Liang, University of Akron

Francis Broadway, The University of Akron

ABSTRACT: Many educators grapple with how to extend the "S" in STEM to all learners (Brown, Brown, Reardon, & Merrill, 2011). As the educational field directs its attention toward addressing equity and diversity in varied educational settings, science educators affirm this commitment and incorporate it as a key pillar in the formation of the Next Generation Science Standards. This study reviews a decade of science education literature in light of "science for all" (Fensham, 1986). It examines the advancement of science education literature through a comprehensive quantitative content analysis of the two major science education journals, *The Journal of Research in Science Teaching* and *The Journal of Science Teacher Education*. The researchers analyzed each article in both journals from 2001 (start of the new century and commencement of the No Child Left Behind legislation) to the present reorganization of the science standards. Analyzing 920 articles, researchers discovered that diverse populations and varied instructional settings are noted but not fully addressed in the science research literature. The study notes gaps and areas of strength in the science literature and offers specific suggestions to promote addressing diverse student populations to fulfill the goal of equitable access for all to the science curriculum.

Strand 12: Educational Technology**Poster Session A**

3:15pm – 4:15pm, Río Mar Ballroom 5

A187. *Using Technology in Teaching Modeling: Scientific Modeling with Etoys*

Morten Lundsgaard, University of Illinois at Urbana Champaign, mlundsga@illinois.edu

Avigail Snir, University of Illinois at Urbana Champaign

Lisa Blank, University of Montana, Missoula

ABSTRACT: Modeling is a fundamental tool in all disciplines of science, and when taught within the various disciplines it may help students make that connection between subjects that Next Generation Science standards are looking for. Preparing pre-service teachers for teaching scientific modeling is thus paramount to science education, and research on

how to teach scientific modeling effectively is of general interest to the field of science education. This study researches a new way of teaching scientific modeling by using an authoring multimedia program Etoys that allows its users to become modelers. We report findings from the implementation of two Etoys centered units in a methods class for K-8 pre-service science teachers. Prior to the Etoys invention, no students to the methods class would choose to teach scientific modeling during their field experience. In the paper we show a remarkable change in the behavior of pre-service teachers with up to 80% of a cohort teaching scientific modeling during their field experience.

A189. *Teacher Enactment of Web GIS Tectonics Investigations*

Alec M. Bodzin, Lehigh University, amb4@lehigh.edu

Denise M. Bressler, Lehigh University

Farah Vallera, Lehigh University

ABSTRACT: A potential method for teaching geospatial thinking and reasoning is through spatially-enabled learning technologies. We developed four Web GIS (Geographic Information Systems) tectonics investigations using an instructional model with eight key elements for teaching science with spatially-enabled learning technologies such as GIS. This study investigated the variations of implementation fidelity when four urban middle school teachers enacted the Web GIS tectonics investigations. Twenty-nine observations were conducted in the classrooms of the four teachers with an observational protocol. Pedagogical implementation was mostly consistent for each teacher for each ability track level they taught. There was little variability among the teachers with regards to adherence to the key elements of the instructional model during the curriculum enactment. The teachers did not modify the instructional materials and predominantly enacted the investigations as designed. Curriculum time constraint played a large role when the last key element of the model was not implemented. The findings provide support that geospatial thinking and reasoning related to a science content area can be taught formally to students in an urban middle school and can be supported by appropriately designed curriculum materials and Web GIS.

A191. *Use of a Technology-based Elementary Curriculum focused on Scientific Inquiry: Unexpected Barriers*

Amanda N. Clark, Florida State University, aclark@fsu.edu

Sherry A. Southerland, Florida State University

Paul Marty, Florida State University

Victor D. Sampson, Florida State University

Anne Mendenhall, Florida State University

Nicole Alemanne, Florida State University

ABSTRACT: The central goal of science education reform efforts is promote student proficiency in science (Duschl, SchweIngruber, & Shouse, 2007). It is posited that such learning would best be fostered through instruction in which students engage in the practices of science, as is the case with inquiry-(AAAS, 1993; NRC, 2000). Many suggest such inquiries can be enhanced through the use of technology (Schneider, Krajcik & Blumenfeld, 2005). When employing technology rich, inquiry-based instructional support materials, focusing on scientific inquiry and nature of science, what are the barriers teachers face when enacting these materials in elementary science classrooms? Participants included 21 fourth and fifth grade science teachers from three diverse school districts and 15 schools serving a range of students. Given the strong emphasis placed on the use of technology in learning, we were surprised by the difficulties teachers face to their use of technology to support students' scientific inquiries. While preliminary observations suggested that each of these schools had the technological capacity necessary to support the Habitat Tracker curriculum, closer analysis suggest that teachers must navigate around very real barriers in the wake of the technological demands and mandated curriculum changes placed on schools in an era of high stakes accountability.

A193. *Tracing the Development of FUTURE WORLDS: An Intelligent Cyberlearning System for Interactive Museum-based Sustainability Modeling*

James Minogue, North Carolina State University, james_minogue@ncsu.edu

Jon Rowe, North Carolina State University

Marc Russo, North Carolina State University

Arthur Kney, Lafayette University

Eleni Lobene, North Carolina State University

Brad Mott, North Carolina State University

James Lester, North Carolina State University

ABSTRACT: There continues to be a growing interest in the potential of emerging computer technologies to advance STEM teaching and learning. The project chronicled in this interactive poster session responds to some key challenges of environmental education through the design, development, and evaluation of an intelligent cyberlearning platform for museum-based sustainability modeling. FUTURE WORLDS, a critical issue-based informal science education exhibit, leverages the complementary technologies of game-based learning environments and intelligent tutoring systems to engage users in the exploration of key environmental sustainability issues including climate change, alternative energies, and energy trade-offs. This interactive poster session will detail the first year of the project during which the interdisciplinary research team laid the foundation for the intelligent cyberlearning platform for museum-based sustainability modeling. Key activities included: clarifying the science content foci, designing the system and engaging in preliminary development, conducting focus-group studies, and investigating assessment and evaluation options. A description of these activities and their outcomes will be presented.

A195. *Exploring the Reasons for Using Electronic Books and the TPACK of Elementary Science Teachers*

Syh-Jong Jang, Chung-Yuan Christian University, jang@cycu.edu.tw

ABSTRACT: There has been little research conducted that employs quantitative measures to examine teachers' reasons for using or not using E-books. The purpose of this study was to examine elementary school science teachers' reasons for using or not using E-books and the use of E-books relates to their TPACK in Taiwan. The survey was developed based on an overview of the discussions from prior research related to the benefits and drawbacks in using E-books. The results show the percentages for four reasons of using E-books were high, and low on four reasons of not using E-books. The teacher's perceptions of the E-book's usefulness, motivation and interaction increase were significantly different according to gender, and the perceptions of the E-book's interaction increase were significantly different according to teaching experience. There was no significant difference found in TPACK according to gender, except in teachers' technological knowledge. Teachers who had more years of teaching experience demonstrated significantly higher TPACK than the teachers who had fewer years of teaching experiences. The results of this study can provide researchers, policy makers, and school administrators with a better understanding of elementary school teachers' perspectives.

A197. *Computer-based Models in Chemistry Classrooms: Using Visual Literacy to Decode and Translate Model Representations*

Noemi Waight, University at Buffalo, nwright@buffalo.edu

Xiufeng Liu, State University of New York At Buffalo (SUNY)

Roberto Gregorius, Canisius College

Mihwa Park, University at Buffalo

ABSTRACT: This study, conducted in the context of computer based model implementation in a high school chemistry classroom, documented how teacher conceptions of models impacted an immersive, multi-instructional approach of different modes of representation (macroscopic, submicroscopic and symbolic) of chemistry phenomena at the high school level. More specifically, we explored how these different representations were decoded and translated during the enactment of different instructional approaches (e.g. lesson introductions, use of exploratory guides, differentiated labs). Data collection included indepth teacher and student interviews, classroom observations, and researcher notes. Teacher conceptions highlighted the role of models as tools; the benefits of **ABSTRACT** portrayal via visualizations; appropriate enactment of model implementation; and concerns with student learning. Enactment of computer-based models revealed numerous challenges reconciling macro, sub micro and symbolic phenomena. Students' reactions reflected a continuum of confusion and benefits which were directly related to their background knowledge and experiences with instructional modes. Both teachers and students revealed difficulties decoding and interpreting visual representations. The findings have implications for the role of teacher knowledge of models, the modeling process and PCK; the continuum of student knowledge as novice users; and the role of Visual Literacy in model decoding, comprehension and translation.

A199. *Simulating Science: Supporting Elementary and Secondary Teachers' use of Computer Simulations*

Amanda L. Gonczi, University of Virginia, alg3cb@virginia.edu

Randy L. Bell, Oregon State University

Jennifer Maeng, University of Virginia

Lindsay B. Wheeler, University of Virginia

ABSTRACT: The purpose of this study was to understand the instructional context in which participants used computer simulations and in what ways their use aligned with intended outcomes of a state-wide professional development (PD) program. Among other goals, the PD was designed to introduce participants to computer simulations for inquiry instruction and problem-based learning through a summer workshop and on-going support. Participants were 52 elementary and 11 secondary teachers in a statewide PD program. Data sources included open-ended surveys, weekly computer simulation login reports, classroom observations and observation forms, and interviews with a subset of participants. Data analysis indicated that participants who used simulations did so most often to teach science content or concepts and less commonly to support inquiry instruction within problem-based learning contexts. This pattern of use was inconsistent with the goals of the PD, which promoted learning of science content and using inquiry skills within the context of real-world problems. Since simulation use was greatest during the initial four months of the PD, follow-up instruction and consistent coaching may produce more appropriate and sustained use. Further, PD may need to model simulations in a problem-based, scaffolded context to promote intended and effective use.

A201. *Indicators Impacting the STEM Career Pipeline Through Serious Educational Game Design and Development*

Len Annetta, George Mason University, lannetta@gmu.edu

Richard Lamb, George Mason University

David B. Vallett, George Mason University

Rebecca Cheng, George Mason University

Karen Peterman, Karen Peterman Consulting

ABSTRACT: With an increasing need for workers to fill science, technology, engineering and mathematics (STEM) careers in the United States, it is imperative that researchers and teachers find ways to develop student interest in science at a time in their lives when research has shown they are most likely to consider careers in STEM fields. High school students creating science-based Serious Educational Games became the subjects of this study. Structural Equation Modeling was used with four outcome measures as a means to understand the interrelationships between Career Choice, Self-Efficacy, Science Interest, and 21st Century Skills. Results suggest science self-efficacy is a stronger indicator of STEM career awareness than science interest or 21st century skills.

Strand 13: History, Philosophy, and Sociology of Science**Poster Session A**

3:15pm – 4:15pm, Río Mar Ballroom 5

A203. *What do Scientists Know About The Nature of Science? A Case Study of Turkish Graduate Research Assistants*

Mehmet Aydeniz, The University of Tennessee, maydeniz@utk.edu

Kader Bilican, Ataturk University

ABSTRACT: The purpose of this study was to investigate science graduate research assistants' understanding of NOS. The participants consist of 15 graduate students in natural sciences: (9) males (1 biology, 3 chemistry, 5 physics), (6) females (2 Chemistry, 4 biology) ranging from 2nd year masters students to 4th year doctoral students. The results show the limitations of GRAs understanding of certain NOS aspects. the discussion focuses on ways to address the issue of scientists' understanding of NOS.

A205. *Comparison of NOS Teaching and Learning Approaches in the Context of a Research Apprenticeship Program for High School Students*

Stephen R. Burgin, Old Dominion University, sburgin@odu.edu

Timothy M. Barko, University of Florida

Troy Sadler, University of Missouri

ABSTRACT: In traditional school settings, an explicit/reflective approach to NOS teaching and learning appears to be more effective in positively influencing students' ideas about NOS than other approaches. That being said, uncertainties remain regarding the merits of an implicit approach to NOS teaching and learning in authentic contexts where participation in scientific practices closely mirrors the working habits of professional scientists. In this study, three different approaches to NOS teaching and learning (implicit, reflective and explicit/reflective) were investigated in the context of a research apprenticeship program designed for high school students. Participants were given an open-ended NOS questionnaire at the beginning and again at the end of the apprenticeship. Categorical data analysis was used to investigate the changes in participant understandings of different NOS aspects. Results indicated that the only whole group significant growth in NOS understandings was evidenced by the participants experiencing the explicit/reflective approach and only in their understandings of the differences between theories and laws in science and the myth of the scientific method. However, individual students experiencing either the reflective or the implicit approach demonstrated growth in a number of NOS aspects. Implications for NOS teaching and learning are discussed.

A207. *Teacher's Religious Beliefs and the Teaching of Biological Evolution: A Case Study*

Jose Soto-Sonera, University of Puerto Rico-Rio Piedras Campus, jose.soto@upr.edu

ABSTRACT: This presentation has two main objectives: first, analyze to what extent teachers' religious beliefs are a relevant element in the teaching of the theory of biological evolution in the classroom; second, formulate some implications on science and teacher education. This case study was carried out in Puerto Rico by completing in-depth interviews with four in-service teachers (seventh-ninth and tenth-eleventh grades) and two pre-service teachers (fourth-sixth and seventh-ninth grades). The analysis of the data allowed for the development of the model Biological Evolution-Religious Beliefs (BERB), a theoretical explanation that emphasizes the relevance of religious beliefs by describing how participants construct and sustain, in syncretic form, their version of biological evolution.

A209. *The Influence of a Philosophy of Science Course on Teachers' Views of SI and NOSK*

Kostas Kampourakis, Illinois Institute of Technology, kkamp@ath.forthnet.gr

Norman G. Lederman, Illinois Institute of Technology

Judith S. Lederman, Illinois Institute of Technology

ABSTRACT: Philosophy of science can enrich teachers' understanding of core scientific inquiry (SI) and nature of scientific knowledge (NOSK) ideas, such as what constitutes scientific evidence, what the form of scientific explanations is etc. An online course was designed for in-service teachers, with the aim to provide a comprehensible presentation of key topics in philosophy of science with explicit examples of how these can inform and enrich secondary science instruction. The course was not about philosophy of science per se but was directly connected to teachers' interests and instructional requirements, as each class was explicitly linked to particular SI or NOSK ideas. It was investigated if such an explicit course about SI/NOSK had an impact on teacher's conceptions as well as on their competence to design relevant instructional material. Results indicate that such a course explicitly linked to science instruction can have a positive impact on teacher's conceptions about SI/NOSK.

Strand 14: Environmental Education

Poster Session A

3:15pm – 4:15pm, Río Mar Ballroom 5

A211. *School Gardens: Promoting Environmental Awareness and Community Building*

Isha Decoito, York University, IDeCoito@edu.yorku.ca

ABSTRACT: School gardens are considered informal learning settings and a key source of experiential learning. They have been used to teach core academic subjects such as science, history, art, language, and mathematics in an inquiry based, hands-on, experiential learning environment. School gardens promote life skills education which focuses on the development of skills that allow children to become capable, competent, and confident, including critical thinking, cooperation, community service, self-discipline, and wise use of resources. This paper reports on one of the school gardens in a larger project. Through questionnaires, interviews, observations, and document analysis, this mixed-methods research study explores a school garden and addresses the following research questions: a) what effect, if any,

does the school garden have on the development of communities of learners? b) what can the school garden teach students about environmental awareness and environmental stewardship? Results indicate that the school garden offers students many occasions for achieving insight into the long-term human impact on the natural environment. As reported by participants, in addition to the school garden supporting academic study, it also has the potential to foster environmental stewardship and community building.

A213. *Space, Place and Identity: Using Critical Geography as a Theoretical Lens in Environmental Education Research*

Vanessa A. Klein, Kent State University, vklein1@kent.edu

Evan M Mooney, Kent State University

ABSTRACT: A love of nature can strongly influence our attitude and behavior toward the environment. This connection with the environment has been with us since we were one cell in the sea and we have evolved in close association with our environment. Only recently, have we falsely extricated ourselves from nature's womb and regarded ourselves as separate from nature. This metaphorical separation denotes the environment as a "place;" a place that has specific meaning and context. It is this idea of place and identity and the recursive and iterative relationship between them that necessitates a more overt discussion about these terms and ideas within environmental education (EE). Utilizing critical geography as a form of inquiry, and as a theoretical framework, allows researchers to attend explicitly to space, place, and identity concepts embedded naturally in EE.

A215. *The Impact of an Experiential Biodiversity Curriculum on High School Students in Dangriga, Belize*

Marissa E. Bellino, City University of New York, marissabellino@gmail.com

Stephen E. Harris, City University of New York

ABSTRACT: Environmental education is a field that is still underrepresented in traditional curriculum throughout Latin America. This includes Belize, where students have limited access to hands on learning experiences. As a result, there is a disconnect between the science students learn in school and how it relates to their local environment. We present BioBelize, an informal science research program where local high school students from Dangriga, Belize participate in a week long biodiversity curriculum. Throughout the week students successfully built a physical invertebrate collection, calculated biodiversity of local habitats, and set up the foundations for using DNA barcoding to identify local species. Through participation in the BioBelize program, students have gained new knowledge related to Belize's ecology and biodiversity. Additionally, by having students conduct authentic research, they gained a deeper understanding of how biological concepts are applied to scientific investigations and an appreciation for their immediate surroundings. This study is part of a longer term initiative to bring STEM education to Belize in the hopes of training future scientists to study and protect Belize's unique biodiversity.

A217. *Exploring Causal Structures of Variables Regarding Ecological Attitude on Insects*

Jun-Ki Lee, Chonbuk National University, junki@jbnu.ac.kr

Minsu Ha, The Ohio State University

Sungwon Ko, Chonbuk National University

ABSTRACT: This study aims to examine two hypothetical models for the variables of students' environmental attitudes. The first hypothetical model is the mediating role of recognition and familiarity between aesthetic and negativistic attitudes. The second hypothetical model is the separate paths from humanistic to dominionistic attitudes. One hundred and four 10th grade high school students participated in this study. We used statistical analyses such as Pearson correlation, partial correlation, and path analysis to examine the fitness of our two hypothetical models. The findings showed that the mediating role of recognition and familiarity between aesthetic and negativistic attitudes was statistically accepted. To prevent students' bias against fancy or gross animals, the learning (e.g. recognition and familiarity) may play a role in reducing the bias. Second, there were two differential paths from humanistic to dominionistic attitudes; one was an ecologicistic-naturalistic path and the other was a scientific-utilitarian path. While the ecologicistic-naturalistic path does not reach dominionistic attitudes, the scientific-utilitarian path does reach dominionistic attitudes. To prevent the development of students' dominionistic attitude toward nature, it is important that they form ecologicistic-naturalistic minds for nature.

A219. *An Examination of Agricultural Literacy Content in Upper Elementary Science Curricula*

Farah L. Vallera, Lehigh University, fav203@lehigh.edu

Alec M. Bodzin, Lehigh University

ABSTRACT: Agricultural literacy of U.S. citizens is quite poor, even though it is significant in both science and environmental literacy, can create wiser consumers, globally competent citizens, and environmentally conscious individuals. Teachers' lack of knowledge of agricultural concepts contributes to this problem, but this may be due to their adopted curriculum. This exploratory study investigated how agricultural literacy is embedded in upper elementary science education curricula. A content analysis of the most widely adopted fifth grade basal science textbooks and modular curriculum programs was conducted for the presence or absence of agricultural content using ten overarching categories aligned to the Food and Fiber Systems Literacy (FFSL) Framework (1998) and A Framework for K-12 Science Education (2011). While some agricultural topics appeared in all textbooks and curricula analyzed, the development of most ideas was disconnected from the agricultural literacy standards defined in FFSL and the Framework. The analysis revealed a lack of curriculum coherency within and across each overarching agricultural topic explored. Implications for curriculum redesign with the integration of agriculture into science curriculum in a coherent fashion are discussed.

A221. *How Literate in Green Building the Undergraduates are in Taiwan*

Quo-Cheng Sung, Chien Hsin University of Science and Technology, tyhsaliang@gmail.com

Ming-Liang Lin, Kaohsiung Normal University, Taiwan

Ko-Yu Shiao, Chien-Hsin University of Science and Technology, Taiwan

Chia-Chen Wei, Chien-Hsin University of Science and Technology, Taiwan

Yi-Lin Jan, Chien-Hsin University of Science and Technology, Taiwan

Li-Ting Huang, Chien-Hsin University of Science and Technology, Taiwan

ABSTRACT: The construction industry accounts for a significant amount of the total carbon dioxide emissions. Promoting green building policy is one of the most effective ways to meet the national carbon reduction commitment. Taiwan government launched green building policy in 1990. Almost twenty years later, there is still lack of an assessment of green building literacy among the general public in Taiwan. This study constructed a framework for green building literacy. With the help of the Delphi panel, we developed a questionnaire as a tool for measuring the undergraduates' green building literacy. We surveyed 1,268 countrywide undergraduates. The results indicate low levels of green building-related knowledge and 25~30% of the respondents have misconceptions in green building. Nevertheless, most students possess proactive attitude, and take responsibility for green residential living. The correlation analysis results imply that attitude and responsibility are the most important factors beyond knowledge learning. Based on the findings, We recommend that the green building literacy curriculum design should not only convey factual knowledge of green buildings, but also emphasize on personal conduct knowledge and skills rather than just understanding the facts of green building, and most importantly foster students' sense of responsibility and proactive attitude

A223. *Lights, Camera, Action: Promoting Environmental Stewardship through Documentary Film Creation*

Stephanie Hathcock, Old Dominion University, shath005@odu.edu

Daniel L. Dickerson, Old Dominion University

ABSTRACT: This study explored how documentary filmmaking was implemented in an environmental education summer camp and what impacts it had relative to other program activities. The film used video clips from the 9th grade, urban participants to form a story about pollution in the Chesapeake Bay and how citizens could address it through positive stewardship behaviors. Other major components of the camp included: Student-directed conversations with scientists, Activities with a local NGO, Coast Guard ship tour, Research vessel cruise with scientists, Hands-on STEM activities, STEM career activities, and a Canoe exploration of the Elizabeth River. Data were collected on all major components relative to: student knowledge of environmental science, student knowledge of college and careers, students' engagement in environmental advocacy, and intergenerational learning. Using a mixed-methods, case study approach, findings indicated that all participants developed video clips containing accurate environmental science content, however, the amount of content and the quality of the video varied dramatically. The film making was perceived to have less importance relative to other program components regarding college and career opportunities,

but was considered very important with helping them become a better environmental steward. The movie screening also proved to be an effective tool for intergenerational learning.

Strand 15: Policy

Poster Session A

3:15pm – 4:15pm, Río Mar Ballroom 5

A225. *Practical Work in Science: Failure of Large Scale Reform in Pakistan*

Nelofer Halai, Aga Khan University, nelofer.halai@aku.edu

ABSTRACT: This paper provides a picture of science education reform in Pakistan with a focus on practical work and examines how despite high investments of money and human resources the effort has not borne fruit. The main reason for this state of affairs is that the practical activities instead of exposing students to science as a “way of knowing” and developing inquiry skills have been used as a means to obtain maximum scores and supplant the scores obtained in the paper pencil summative examinations. This has been achieved by converting the practical activity into a “rote memorization” activity. Furthermore the practical activities are not aligned with instruction in the classroom so that they are seen as something separate from the theories and concepts of science instead of supporting and supplanting them. For practical work to have any serious effect on developing students’ understanding of science, science teachers need to help students interact with the ideas and concepts of science as they handle apparatus, equipment and other artifacts of science.

A227. *Time Spent Teaching Science and the Relationship to Accountability Policies*

Eugene Judson, Arizona State University, Eugene.Judson@asu.edu

ABSTRACT: Achievement results from mathematics and reading are always included in high stakes accountability calculations. Therefore, it has been generally argued that other subjects, particularly science, have been minimized or even altogether pushed aside. This has been an argument made with evidence from elementary classrooms. However, there has not been any research that distinguishes different accountability policies among the states and how that possibly affects the amount of time spent on science in elementary classrooms. In this study, the accountability practices of states were differentiated into three groups based on the degree to which science achievement has contributed to accountability formulas. Data from NAEP Teacher Questionnaires were evaluated to assess the amount of time fourth-grade teachers devoted to mathematics, reading, and science. Teachers from the three groups of states reported spending equivalent amounts of time on mathematics and reading. However, the frequency of teachers reporting spending at least four hours of weekly instructional time on science was significantly higher in states that integrate fourth-grade science achievement into accountability formulas.

Poster Session B**4:15pm – 5:15pm, Río Mar Ballroom 6****Strand 1: Science Learning, Understanding and Conceptual Change****Poster Session B**

4:15pm – 5:15pm, Río Mar Ballroom 6

B2. Global Climate Exchange – Students' Science Learning in a Global Classroom

Majken Korsager, University of Oslo, majken.korsager@uv.uio.no

Doris Jorde, Norwegian Centre for Science Education

James D. Slotta, Ontario Institute for Studies in Education

ABSTRACT: This paper reports on a project to establish an international collaborative curriculum, the Global Climate Exchange, with an emphasis on peer discussions of climate change issues and inquiry activities where students make personal connections to climate change science. We engaged four cohorts of students from Canada, China, Norway and Sweden in a wiki-based activity where they collaborated with peers locally and internationally to create "climate change issue" pages, then discussed the international implications of those issues. In a prior paper we analyzed conceptual understanding of the Norwegian secondary students, and found a positive impact of this curriculum on their ecological and global understandings of climate change. In this paper we will look further into the details of the students' behavior trying to understand what characterizes students' engagements in the different online GCE-activities and how to support students in inquiry-based science teaching involving peer collaboration to best develop their conceptual understanding climate change

B4. Middle and High School Students' Responses to Climate Change: The Conflation of Mitigation and Adaptation

Matthew Kloser, University of Notre Dame, mkloser@nd.edu

Laura Bofferding, Purdue University

ABSTRACT: Scientists, environmentalists, and policymakers emphasize the important role that education can play in minimizing the effects of climate change on biological and physical systems. Research on climate change education has largely focused on mitigation while overlooking what the Intergovernmental Panel on Climate Change has deemed to be equally important – adaptive responses. This study used a pre-test – instruction – post-test format to identify 387 middle and high school students' climate system knowledge and action knowledge of both mitigation of and adaptation to climate change. Results indicate that adolescents currently conflate climate change mitigation strategies with unrelated environmental problems, like the depletion of the ozone layer, far less than in previous studies. However, the results also showed that many students have difficulty distinguishing between adaptation and mitigation responses. After engaging in an instructional unit on climate change, students expressed fewer misconceptions, but significant misconceptions remained that conflated mitigation of and adaptation to climate change. Future research should explore the obstacles to students' understanding of different types of responses to climate change.

B8. Developing a Hypothetical Learning Progression for Plate Tectonics

Scott McDonald, Pennsylvania State University, smcdonald@psu.edu

Meredith Hill Bembenic, Pennsylvania State University

Peter R. Licon, Pennsylvania State University

Megan Pickard, Pennsylvania State University

Stephanie Danette Preston, Pennsylvania State University

Tanya Furman, Pennsylvania State University

ABSTRACT: This research poster describes preliminary work on a hypothetical learning progression in around the big idea of Plate Tectonics. While Plate Tectonics is a central principle in geosciences, little research has been done about students developing ideas around this concept or the underlying phenomena of earthquakes, volcanoes and mountain building. Based on open-ended, conceptual interviews (N=41) across urban, suburban and rural students in Pennsylvania, dimensions for a hypothetical learning progression are proposed. Findings suggest the possibility that

emphasizing events (earthquakes and eruptions) and then moving to patterns of events (faults and volcanoes) might help students build toward a more productive understanding of earth as a dynamic system. Findings also indicated that students misattribute phenomenon that are driven by earth energy systems to processes that are driven by solar energy. These two findings taken together shape a hypothetical learning progression that focuses on short temporal events and moves toward longer term patterns of phenomena and focuses on the energy that drives those phenomena as a way to build productive early understandings as a foundation for Plate Tectonics.

B10. *The Impact of Integrated Science and Math Instruction on Preservice Elementary Teachers' Nature of Science Views*

Huseyin Colak, Northeastern Illinois University, h-colak@neiu.edu

Alex Carstensen, University of Illinois at Chicago

ABSTRACT: Normal.dotm 0 0 1 220 1258 Northeastern Illinois University 10 2 1544 12.0 0 false 18 pt 18 pt 0 0 false false false /* 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-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:"Times New Roman"; mso-ascii-font-family:Cambria; mso-ascii-theme-font:minor-latin; mso-fareast-font-family:"Times New Roman"; mso-fareast-theme-font:minor-fareast; mso-hansi-font-family:Cambria; mso-hansi-theme-font:minor-latin; mso-bidi-font-family:"Times New Roman"; mso-bidi-theme-font:minor-bidi;} This study explored preservice elementary teachers' nature of science views and determined the impact of implementing integrated science and math activities on participants' development of informed understandings of NOS conceptions. The Views of Nature of Science Questionnaire (VNOS-C) and semi-structured interviews were used to assess the pre-service teachers' conceptions of NOS focusing on all seven NOS concepts: (1) science is tentative; (2) science is empirical; (3) science is subjective; (4) science is socially and culturally embedded; (5) science is a creative and imaginative endeavor; (6) the difference between observation and inference; and (7) the relationships and functions of scientific theories and laws. As the participants involved in understanding of science and math concepts, they tended to improve their nature of science view towards more informed understanding. In the study, we found that there is, in general, a significant change in all participants' NOS views towards informed views of NOS.; and therefore, implementing integrated science and math intervention activities can help preservice elementary teachers improve their understanding of both science and math concepts and nature of science views. The results of this study should benefit educators and teachers with respect to an integrated science and math instructional approach.

B12. *Using Science Notebooks and Inscriptions to Promote Preservice Teachers' Understanding of the Nature of Science*

Rita Hagevik, The University of North Carolina at Pembroke, rita.hagevik@uncp.edu

Patty Stinger-Barnes, The University of Tennessee

ABSTRACT: The purpose of this study was to determine if the use of inscriptions in science notebooks could change elementary pre-service teachers' views of science. Seventy-nine preservice elementary science teachers in a semester long science methods course were compared to a control group of seventy preservice elementary science students enrolled in the same methods course. Results showed that the construction of and collective interpretation of the inscriptions stimulated development of nature of science (NOS) beliefs through explicit reflection on the science inquiry-based learning activities used in the pre-service elementary teachers science methods course. The science notebooks and the writing of science as well as a focus on inscriptions facilitated the development of these beliefs. This study illustrated that one way pre-service elementary teachers can develop sophisticated NOS beliefs is to engage in the use of inscriptions while writing about and reflecting on how science is done.

B14. *Middle School Students' Understanding of Genetic Inheritance*

Tamara J. Heck, Michigan State University, heckt@msu.edu

Joi Merritt, Michigan State University

Jacob Porter, Michigan State University

Kyle Erlenbeck, Michigan State University

ABSTRACT: Though genetics inheritance is taught at the middle school level, little information is known about the understandings middle school students' hold with regard to the relationships between chromosomes, genes, alleles, and

the passage of genetic information from parent to offspring. This paper examines middle school students' conceptions of genetics inheritance prior to and after a five-week curriculum intervention in the technology-enhanced WISE From Genotype to Phenotype module. One science teacher and 166 students from a Midwestern middle school participated in the study. Students' were presented with 19 identical pre and posttest items, of which the responses from 7 inheritance items comprise the data presented here. Students experienced significant learning gains during the course of the curriculum as evidenced by the pre/posttest data. In addition to deepening their understanding of the structures and processes involved with genetic inheritance, students tended to move toward normative ideas about equal contribution of genetic information from both parents, thus leading to a better understanding of genotypic and phenotypic relationships. By taking an in depth look into the concepts held by middle school students about genetics inheritance, this study provides information which curricula developers can use to provide students and teachers with improved materials.

B16. *Conceptual Change in Elementary Kinematics and Ecology through the Development of Agent-based Computational Representations*

Amanda C. Dickes, Vanderbilt University, amanda.c.dickes@vanderbilt.edu

Pratim Sengupta, Vanderbilt University

Gokul Krishnan, Vanderbilt University

Amy V. Farris, Vanderbilt University

Kara Krinks, Vanderbilt University

ABSTRACT: Developing authentic representational practices and generating inscriptions is central to the development of scientific expertise (Latour, 1999; Lehrer & Schauble, 2000, 2006). Research has shown that science learning is dependent upon the development of representational systems that symbolize important aspects both within and across scientific phenomena and domains (Latour, 1999; Lehrer, Schauble, Carpenter & Penner, 2000). The focus of this paper is to investigate how the practice of agent-based modeling can integrate separate curricular domains, specifically, physics and ecology, in elementary grades. We report on two studies conducted in the design-based research paradigm (Cobb, Confrey, diSessa, Lehrer & Schauble, 2007). Study 1 is an exploratory study in which we investigated how third grade students can develop their understandings of structure, behavior and function within an ecosystem by generating mathematical representations of embodied, agent-based modeling activities. Study 2 builds on our findings from study 1, and investigates how the same genre of mathematical representations that students generated in Study 1 can be leveraged through the use of multi-modal, agent-based modeling platforms in order to support conceptual growth and development of representational expertise in both kinematics and ecology.

B18. *Elementary Students Designing Investigations in Astronomy*

Julia Plummer, Pennsylvania State University, jdp17@psu.edu

Arzu Tanis Ozcelik, Pennsylvania State University

ABSTRACT: We explored how children consider the nature of evidence and the design of investigations about the daily apparent motion of the sun, moon, and stars and the lunar phases. Analysis of interviews with K-4 students (N=26) demonstrates that most children were able to provide methods that would yield observational evidence to evaluate their claims. The children employed a range of creative design strategies, though not all were fully developed or accurate enough to be sufficient for evaluating their claim. Children also used both personal theories about content accuracy as well as the practices of science to evaluate other people's astronomy investigations. These findings suggest that children are likely to need further support in learning methods to successfully track the location of celestial objects across time. Children also need explicit instruction that coordinates the nature of science and the work of scientist with their own personal engagement in designing astronomical investigations.

Strand 2: Science Learning: Contexts, Characteristics and Interactions**Poster Session B**

4:15pm – 5:15pm, Río Mar Ballroom 6

B20. *Synthesizing Modeling-based Instruction in Science Education from 1980 to 2010*

Ji Shen, University of Georgia, jishen@uga.edu

Jine Lei, Syracuse University

Bahadir Namdar, University of Georgia

Ye Chen, Syracuse University

ABSTRACT: This synthesis study provides a comprehensive review of the research and practices for modeling-based instruction (MBI) in K-12 science education over the last three decades. We collected and examined the literature to conceptualize the landscape of the theoretical frameworks of MBI approaches, identify the effective design features of modeling-based learning environments with an emphasis on those that are technology-enhanced ones, review the assessment strategies used, and illustrate the most effective MBI practices that are associated with successful student learning through a meta-analysis. The proposed project will create a framework for the science education community to better understand and to effectively implement modeling-based science teaching and learning.

B22. *Productive Failures: Deal with Troubles in Doing Science*

Pei-Ling Hsu, University of Texas at El Paso, phsu3@utep.edu

ABSTRACT: Given that students cannot know beforehand what they are about to learn, encountering trouble is inevitable and necessary event in the process of learning. Therefore helping students to deal with troubles has become an important issue in education. The study aims to understand how participants repair troubles into learning opportunities during a high school students' science internship. Data sources include observations, field notes, and video recording throughout the science internship. Drawing on conversation analysis, I identified different forms of pedagogically relevant conversational repairs that transformed troubles into learning opportunities to support students' further participation. These pedagogical repairs can serve as useful resources for teachers to help students deal with and learn from troubles.

B24. *Teaching Multiple Modes of Representation: Impact on Middle School Science Learning*

Ryan Nixon, Brigham Young University, rynixon@gmail.com

Leigh K. Smith, Brigham Young University

ABSTRACT: This study examined the effect of explicitly teaching multiple modes of representation (MMR) on middle school students' understanding of science content and their unprompted use of MMR on a science unit test. Participants in this quasi-experimental study were seventh- and eighth-grade students enrolled in science courses taught by three different middle school science teachers. Half of the students received explicit instruction in MMR in addition to their regular science instruction; the other half received only regular science instruction. Ordinary least squares multiple regression analysis was used to determine the relationship between gain scores on unit assessments/end-of-level and whether students received explicit MMR instruction, and demographic variables. Additionally, regression analysis was used to examine how receiving explicit instruction in MMR and demographic variables predicted student use of MMR on the final unit test. These analyses indicated that receiving explicit instruction in MMR did not influence students' gain scores or use of MMR on a final test. However, Latinos and females used MMR more often than Whites and males, respectively, on the final test, even though these two groups of students did not use MMR more often on the pretest. Implications for classroom teachers and educational researchers are discussed.

B26. *The Pedagogy of Ingenuity: Scientific Creative Thinking in the Secondary Science Classroom*

Allison Antink Meyer, Illinois State University, aameyer@ilstu.edu

Norman G. Lederman, Illinois Institute of Technology

ABSTRACT: The purpose of this study was to inform an understanding of the potential relationships between teacher practice, student learning and student scientific creative thinking. Two hundred eighty four student participants' were administered a pre and post measure of scientific creativity (Hu & Adey, 2002) that was then compared against case studies developed of each participating classroom in order to determine trends. This methodology facilitated insights

into aspects of teaching and learning that are related to student development of creative thinking abilities in science. The analysis suggested three distinct relationships between classroom variables and students' scientific creative thinking. These trends: originality in the use of scientific tools, originality and variety in the development of scientific questions, and the role of context in the development of original, engineering-type design tasks are discussed in the context of research on creative thinking in science and in the science practices included in the Next Generation Science Standards (NRC, 2012).

B28. *Enhancing Thinking Dispositions and Views on the Nature of Science using Writing-to-Learn-Science*

Tili Wagner, Beit Berl College, tiliw@beitberl.ac.il

Tamar Levin, Tel Aviv University

Dalia Imanuel, Beit Berl College

ABSTRACT: The paper examines the simultaneous development of students' views on the nature of science (NOS) and their general thinking dispositions (TD) in the context of writing-to-learn science. The study provides hard evidence that the combined use of diversified types of informal writing-to-learn tasks in science and reflection on the writing can enhance both eighth graders' general TD and their views on NOS. We used an action research design for one and a half school years, applying both quantitative and qualitative methodologies. The study suggests that writing experiences that offer a meaningful context for developing students' epistemological beliefs and thinking dispositions should be provocative, open-ended, stimulating, and creative, express complex questions concerning real world dilemmas, and should be articulated in different genres. The study further shows that epistemic views on science are most meaningful in predicting more general thinking dispositions. The study renders an optimistic view of pedagogical opportunities for developing scientific literacy, suggesting an integration of explicit and implicit learning experiences that have the potential to support STEM learning.

B30. *The Antecedents of Adolescents' Continuing Motivation for Science Learning*

David L. Fortus, Weizmann Institute of Science, david.fortus@weizmann.ac.il

Dana Vedder-Weiss, Weizmann Institute of Science

ABSTRACT: An important goal of science education should be to develop the foundation for lifelong learning, including the motivation to learn science in school, out of school, and after school. The goal of this study was a comprehensive examination of the relations between environmental factors and students' continuing motivation for science learning (CM), expressed as engagement in extra-curricular science related activities. The environmental factors that were assessed included: schools' culture, teachers' goals emphases, parents' goals emphases and peers' goals in science learning. Data was collected from 1600 5th to 8th grade students from 30 schools, their science teachers, parents and school managements. Data was analyzed using SEM, HLM, and standard regression. Results show that students' perceptions of their parents and teachers' goals emphases predicted students' CM, and to a lesser extent also did their perceptions of peers' and school's goals. Most relations were mediated by students' mastery goals orientation. Students' CM was predicted not only by their perceptions of their teacher's, parents' and school's goals emphases but also by the teacher's, parents' and school managements' self-reports. Through the perspective of Achievement Goals Theory, the results of this study offer insights into the disturbing issue of adolescents distancing from science learning

B32. *Learning in a Virtual World: Teaching Concepts of Heat, Pressure and Random Motion*

M. Gail Jones, North Carolina State University, gail_jones@ncsu.edu

Gina Childers, North Carolina State University

Brandon Emig, North Carolina State University

Joel Chevrier, Université Joseph Fourier Grenoble

Vanessa Stevens, North Carolina State University

Hong Tan, Purdue University

ABSTRACT: This study investigated the efficacy of using visuohaptics (visualization and force feedback) in virtual worlds to teach students particulate motion and concepts of heat, pressure and random motion. The simulation allowed students to experience forces (the collisions of particles under different conditions) through their own somatosensory system in real time. Participants included 64 middle school students who completed a pre-, post-, and delayed post-assessment of knowledge and an investigation of particle motion using either the visuohaptic or a visual learning

environment. The results showed that there were significant differences in the knowledge of both groups of students from pre to post-assessment but there were no significant differences in post scores for visuohaptic and visual conditions.

B34. *Environmental Argumentation as Sociocultural Activity*

Alandeom W. Oliveira, University at Albany, SUNY, aoliveira@albany.edu

Valarie L. Akerson, Indiana University

Martha Oldfield, University at Albany, SUNY

ABSTRACT: While environmental argumentation has recently received much attention from science educators, little consideration has been given to how personal identities and social relationships can either support or constrain student argumentation. We attend to this issue by examining environmental argumentation as a sociocultural activity (how students implicitly create identities and relationships through environmental warrants and claims). By integrating rhetorical and sociocultural discourse analysis, we examine argumentation about environmental dilemmas (problematic scenarios involving animals and the environment). Although students set forth a variety of warrants (social, economic, contextual, biocentric, and expertise-based), the dilemmas led to distinct forms of argumentation. One dilemma involving the disposal of an unwanted pet iguana fostered non-adversarial argumentation wherein students identified themselves as animal lovers and cooperative discussants. By contrast, the other two dilemmas (the hypothetical encounter with a fawn in the woods and the observation of classroom lights being unnecessarily left on) led to the unexpected emergence of sexual identities, combative disagreement, and conflict resolution on social rather than rational grounds. This study highlights the need to pay closer attention to the text design of dilemmas to foster a productive sociocultural classroom context for rational and reasoned environmental argumentation without the constraints of unexpected social complications.

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

Poster Session B

4:15pm – 5:15pm, Río Mar Ballroom 6

B38. *Children's Literature as an Invitation to Science Inquiry in the Early Years*

Mellita M. Jones, Australian Catholic University, mellita.jones@acu.edu.au

Karen J. McLean, Australian Catholic University

Clare Schaper, Australian Catholic University

ABSTRACT: This paper reports on a pilot study exploring teachers' confidence to plan and implement science inquiry experiences in an early childhood setting. The aim of the study was to explore whether the use of children's literature could support early years' teachers to recognise and plan for science inquiry learning. Research reports that there is an issue around early years' teachers' confidence in their background knowledge and ability to teach science (Harlan & Rivkin, 2012) and consequently, there tends to be missed opportunities to develop engagement in science learning. A single case study methodology was employed in a four year old kindergarten setting in Australia. Researchers worked with the teacher to develop 'I wonder' science inquiry learning experiences stemming from themes taken from children's literature. Findings showed that children's literature provided the teacher with a guide to introduce and scaffold science inquiry. Findings also demonstrated a shift in the teacher's practice of looking for literal links to science in the selected book, to using the book to develop thematic approaches to plan for science inquiry. However, further research is needed to investigate whether more time and experience would enable the teacher to become consciously aware of this shift.

B40. *Young Children's Knowledge and Skills in Life Science—Implications for STEM Education*

Robert Williams, University of Texas, rivers40@yahoo.com

Mary E. Hobbs, Center for STEM Education

ABSTRACT: Researchers discuss outcomes and implications from four years of NSF funded research looking at what four year olds know and can do in science. Currently in its final year, Building Base Line Objectives for Children's Knowledge & Skills for Science (BLOCKS) involved 24 pre-kindergarten teachers as teacher-researchers. Working in

variety of settings, with an emphasis on including classrooms where students are culturally and economically diverse, these teachers worked collaboratively with our team of university mentors in the collection, analysis and reporting of student data. The teachers played a critical role in the research as we investigated: What should children know and be able to do in science when they enter kindergarten? What core STEM ideas should be stressed in prekindergarten/kindergarten science learning activities? The intent was that BLOCKS would incorporate the most current ideas on how students learn into a classroom model where curriculum and formal and informal assessments are based on concepts of science rather than on science theme topics. We investigated three “big ideas” in each of the physical, life and earth sciences. This presentation focuses on preliminary findings in the life sciences.

B42. *What Teachers' Want: Supporting Primary School Teachers in Teaching Science*

Angela Fitzgerald, Monash University, Melbourne, Australia, angela.fitzgerald@monash.edu

Katrin Schneider, Monash University, Melbourne, Australia

ABSTRACT: It is widely acknowledged that issues such as limited science content knowledge and low levels of confidence in teaching content matter as being key deterrents in primary school teachers teaching science. Though while much research has been conducted into why primary school teachers do not feel confident in the teaching of science, there is very little research identifying what could actually change this situation. Broadly, science education has a responsibility for developing the scientific literacy of all students. To assist in building the capacity of individuals as scientifically literate citizens, confident teachers of science are required. This project acknowledges the impact of various issues on science teaching in primary schools, but aimed to examine practical solutions for overcoming any hurdles and identifies the support required by primary school teachers. Nine teachers from three government-funded primary schools completed an online questionnaire with three participants opting to undertake an interview. Their perspectives uncovered four themes underpinning the support required in teaching science: resources, time, space and teacher knowledge. While these findings may be of no surprise to those working in science education, this work does problematise primary school science teaching and enables opportunities to open up in terms of re-imagining science education.

B44. *Exploring What Sustains Teachers' Attention and Responsiveness to Students' Scientific Thinking in the Classroom*

Jennifer Richards, University of Maryland, College Park, jrich@umd.edu

ABSTRACT: This study aims to better understand what sustains teachers' attention and responsiveness to the substance of students' scientific thinking in the classroom. Such attention and responsiveness is important for students' content learning (e.g., Carpenter, Fennema, Peterson, Chiang, & Loef, 1989; Pierson, 2008) and engagement in scientific practices (e.g., Driver, Newton, & Osborne, 2000; Duschl & Gitomer, 1997), but it is unfortunately rare in American classrooms (NRC, 2007). Yet there are teachers who foreground student thinking in their classrooms, and I identified and analyzed episodes from three such teachers' classrooms in which they sustained their attention and responsiveness to student thinking for extended periods of time. Specifically, I focused on 1) what seemed salient to the teachers in the episodes, and 2) how these salient features might have interrelated with the teachers' attention and responsiveness, triangulating claims with evidence from teachers' reflections on the episodes. Here, I present themes from these analyses within and across teachers to provide a sense of the variability of what might stabilize teachers in focusing on student thinking in the classroom, as well as to highlight commonalities that may provide particularly useful emphases in professional development aimed at helping teachers focus on students' ideas.

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

Poster Session B

4:15pm – 5:15pm, Río Mar Ballroom 6

B46. *Teachers' Reflections on their Subject Matter Knowledge Structures and their Influence on Classroom Practice*

Stephen Bartos, Illinois Institute of Technology, sbartos@iit.edu

Norman G. Lederman, Illinois Institute of Technology

Judith S. Lederman, Illinois Institute of Technology

ABSTRACT: Research has indicated that experts' subject matter knowledge structures (SMKSs) differ from those of novices in that they contain more cross-linking, interconnections, and overarching thematic elements, characteristics that are in accordance with those espoused in current reform documents. Unfortunately, teachers' SMKs are not necessarily translated into classroom practice, for either novice or more experienced classroom teachers. A means to facilitate the translation of teachers' SMKs into practice would ensure that those desired characteristics of experts' subject matter knowledge manifest themselves in teachers' classroom practice. Four experienced physics teachers diagrammed their SMKs, which were then compared to those inferred from their classroom practice. Prior to instruction, two teachers, as part of the explicit-reflective treatment, were asked to reflect at multiple time points on congruence between their SMKs and classroom practice focusing on the presence of essential concepts, interconnections, and overarching thematic elements. No discernible difference was apparent between control and treatment groups, as teachers from both groups showed a high-degree of congruence between inferred and diagrammed SMKs. Results further substantiate the challenges in identifying a means for both developing and facilitating the enactment of coherent, connected, and dynamic SMKs or, in effect, accelerating teachers' pedagogical content knowledge.

B48. *Teacher Beliefs and the Implementation of Curriculum Focusing on the Practices of Science*

Sherry A. Southerland, Florida State University, ssoutherland@fsu.edu

Patrick J. Enderle, Florida State University

Victor D. Sampson, Florida State University

Jonathon Grooms, The Florida State University

ABSTRACT: The new science frameworks for science envision learning as the development of multiple science proficiencies, to be achieved through student engagement with the practices of science. To enact this vision, teachers will need well-designed curricula that emphasize such practices. However, it is clear the enactment of such curricula is an act of interpretation. The goal of this study was to describe how science teachers' beliefs about teaching influences their enactment of a curriculum that features students' active engagement in the practices of science. The curriculum examined, designed around the Argument-Driven Inquiry instructional model, is designed to foster the development multiple aspects of scientific proficiency. Data from interviews, surveys, and four weeks of observations of classroom practices were collected from six science teachers engaged in the design and field-testing of a new curriculum. Teachers' adherence to the instructional model and their enactment of various stages were varied. Case studies of two teachers reveal that teacher beliefs about reform were less influential in curricular enactment than the individuals' teaching experience. Unexpected interactions were found between teachers' beliefs about teaching and learning, their affect regarding their teaching practice, and their enactment of the curriculum.

B52. *Factors Influencing Middle School Teachers' Planning and Facilitation of Visualization-based Instruction*

Jacqueline Samuel, University of Southern Mississippi, jacqueline.samuel@eagles.usm.edu

Kristy Halverson, University of Southern Mississippi

ABSTRACT: Visualizations is a categorical term which is often used to provide visual imagery to the communication of processes, concepts, exemplar phenomena, and general information. Objects such as graphs, tables, diagrams, animations, and pictures fall under this category. Typically associated with science education, visualizations are used in many professional fields and are being integrated in both graduate and undergraduate programs. This study explored factors influencing middle school teachers planning and facilitation of visualization-based instruction. Qualitative data was collected through semi-structured interviews, card-sorting tasks, and artifact analysis. Results indicate that while teachers viewed visualizations in a beneficial manner, the use of visualizations in the classroom did not necessarily coincide with these views. The classroom environment and teachers' previous experiences with visualizations heavily influenced integration into the classroom. Findings indicate there is a need for professional development opportunities in this area to better allow teachers to utilize visualizations as a teaching and learning tool in the middle school classroom.

B54. *Using Learning Progressions to Map High School Student Understandings of Molecular Genetics*

Amber Todd, Wright State University, rosenberg.5@wright.edu

Lisa Kenyon, Wright State University

ABSTRACT: Because the general public is beginning to encounter molecular genetics during the course of their everyday lives with genetic screening, genetically modified food, and stem cell research; scientific literacy in molecular genetics is increasingly important in society today. Two learning progressions have recently been published by Roseman, Caldwell, Gogos, & Kurth (2006) and Duncan, Rogat, & Yarden (2009). Our study aims to test the upper bounds of the Duncan et al. (2009) progression in three different classroom contexts using 10th graders and supplying teachers with molecular genetics intervention units. These units differ from normal classroom instruction by introducing proteins before DNA and targeting instruction to components of the Duncan et al. (2009) progression. We found that student performance before instruction fell on the low end of the progression, but student achievement increased in all three contexts after instruction. Several students were able to give level 3 (highest progression level) responses in multiple components of the progression after instruction. Several intermediate student ideas were also found and could be added to revise and refine the progression. Additionally, students were able to reason in all three models of genetics simultaneously both before and after instruction.

B56. *Dimensions of Physics Teachers' Professional Knowledge*

Sophie Kirschner, University Duisburg-Essen, sophie.kirschner@uni-due.de

Andreas Borowski, RWTH Aachen University

Hans Ernst Fischer, University Duisburg-Essen

ABSTRACT: Teachers' professional knowledge is assumed to be an essential variable for effective teaching. Nevertheless, the connection between the three supposed dimensions, including content knowledge (CK), pedagogical content knowledge (PCK) and pedagogical knowledge (PK), has not been empirically examined. The question as to how the dimensions should be taught –integratively or separately – should be explored after an empirical examination of professional knowledge in an effort to enhance teacher education. For this study, model-based physics oriented CK and PCK tests and a general PK test were developed and used with N=279 physics teachers. The tests are valid and show good reliability. The results of a multidimensional Rasch-Analysis indicate a clear distinction in the three dimensions, CK, PCK and PK. CK and PCK correlate with $r=.66$, $p<.001$; PCK and PK correlate with $.39$, $p<.001$; CK and PK don't correlate significantly, as expected. It appears that we can teach the dimensions separately, but should keep in mind the substantial correlations between the dimensions. The connections between knowledge dimensions should not be left to every single teacher to make, but they should be additionally supported in teacher education.

B58. *Influence of Teachers' CK and PCK on the Development of Students' System Thinking in Biology*

Ute Harms, IPN - University of Kiel, Germany, harms@ipn.uni-kiel.de

Kerstin Münchhoff, IPN - University of Kiel, Germany

Miriam Waldmann, IPN - University of Kiel, Germany

Kristina Brandstädter, IPN - University of Kiel, Germany

ABSTRACT: The abilities needed to organize knowledge in a system context, to understand the functionality of systems, and to develop systemic problem solutions are fundamental for biology understanding as biology is the science of living systems. Little is known about the structure and the development of system thinking so far. Studies that examined students' system thinking revealed that students of the same age taught by different biology teachers vary in their system thinking abilities. This evidence was the starting point for our study. We wanted to elucidate which personal factors of the teacher have impact on students' system thinking development. Several studies point out that teachers' professional knowledge content knowledge (CK) and pedagogical content knowledge (PCK) influences the development of students' learning in general. In our study, we investigated the impact of teachers' CK and PCK on system thinking in biology. Data collection is realized via multiple-choice items and open questions. The results of the pilot study show that the developed instruments are reliable and valid. In the main study, 8th-graders and their biology teachers are tested in a pre-post test design in a quantitative field study. The findings of the main study data collection will be presented at the conference.

B60. *Using Beliefs and Science Education Experiences to Understand the Instructional Actions of Science Teachers*

Dionne B. Jackson, Hendrix College, jackson@hendrix.edu

ABSTRACT: Science teachers' epistemological beliefs and science education experiences influence their teaching. These beliefs and experiences cause teachers to teach science anywhere from traditionally to more reform-based. The purpose of this study was to discover more about the reasons why science teachers teach the way they do and gain a better understanding of the types of beliefs and experiences that might foster more reform-based teaching. Therefore, using the multiple-case study design, this investigator developed instructional profiles of science teachers based on their epistemological beliefs and science education experiences. Participants included a total of three science teachers. Data collection for this ten month study included semi-structured interviews, direct observations of instructional techniques, and the collection of artifacts. Preliminary framework analysis revealed that two of the cases had beliefs, experiences, and instructional methods that were teacher-centered and the other was transitioning from teacher-centered to student-centered. Implications and suggestions for future research are discussed.

B62. *The Periphery of Teaching: Influence of External Factors on Science Teacher Practice*

Lauren E. Jetty, Syracuse University, lejetty@syr.edu

John W. Tillotson, Syracuse University

Monica Young, Syracuse University

ABSTRACT: Understanding how the school context can shape early career teachers over time is crucial to learning how to better prepare and support new science teachers. This qualitative research study uses a combination of interviews and classroom observations collected over a three year period to examine the changes in beliefs and practices of fifteen graduates from three different teacher preparation programs teaching across four states as they progress from their student teaching experience through the first years of teaching. Qualitative data analysis reveals several contextual factors common across participants that impact their practice: the administration, colleagues, students, curriculum, resources, state examinations, community support, and perceived level of autonomy. Factors associated with participants that implemented reform-based teaching practices in their classrooms were having a supportive school culture as well as a high degree of perceived autonomy. Contextual factors such as overbearing administration, rigid curriculum, and pressures from state examinations were identified as constraints on practice. The constraints of the school context expressed by some participants appear to have impacted teaching practices more so than the teachers' personal beliefs about teaching.

Strand 5: College Science Teaching and Learning (Grades 13-20)**Poster Session B**

4:15pm – 5:15pm, Río Mar Ballroom 6

B64. *Preparing undergraduates for research experiences through laboratory courses*

Meredith T. Knight, Boston University, meredith.knight1@gmail.com

Patricia Fortin, Boston University

Kenneth W. Adams, Boston University

Paul A. Lipton, Boston University

ABSTRACT: Research experiences provide a number of opportunities for undergraduate science majors to learn about scientific careers, strengthen content knowledge, and build laboratory and analytical skills. Undergraduates often pursue research experiences in their junior or senior year; however, early research experiences have been identified as a promising strategy for retaining students in science majors. Traditionally, the undergraduate laboratory experience has been the method of preparing students for research experiences. This study reveals that laboratory courses do contribute to undergraduates' preparedness for research, and that research experiences also contribute to students' preparedness for further laboratory and academic courses.

B66. *Preparing Students for the Global Workforce: The Benefit of Undergraduate Research Experiences in Soft Skill Development*

Penny S. Jeffrey, North Carolina State University, FREEDM Systems Center, pmshumak@ncsu.edu

Kristen Molyneaux, Firelight Foundation

ABSTRACT: Bachelor degrees in Science and Engineering fields account for approximately one-third of all degrees awarded in the past decade (NSF, 2010). Most undergraduate science and engineering curricula are not able to address soft skill development necessary for students entering either graduate schools or industry. Many students participate in undergraduate research opportunities at some point within their academic career and note that the experience aided them in their academic, government, or industry careers (NSF, 2010b). Students participating in a ten-week undergraduate research experience at an NSF-funded Engineering Research Center were assessed soft skill development using the Engineering Global Preparedness Index (EGPI) (Ragusa, 2010). The instrument measured students' preparedness to work in global workforces through their understanding of place in engineering ethics, global engineering efficacy, engineering global-centrism, and engineering community connectedness. Using pre-post surveys, the post-scores measured growth in all areas except engineering ethics. A significant increase ($t(19)=2.59$, $p<0.05$) was noted for overall EGPI pre-to-post. It is important to prepare undergraduate students with soft skills for future leadership within their fields. This study shows that encouraging students to participate in undergraduate research can provide an avenue for soft skill development.

B68. Using Manipulative Models to Develop Tree-Thinking

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Carrie J. Boyce, The University of Southern Mississippi

ABSTRACT: It is well known that students often struggle with tree-thinking even though it is a core aspect of evolutionary education. Phylogenetic trees are considered multidimensional hypotheses of evolutionary relationships by scientists. However, student often only view textbook diagrams as static, two-dimensional images. Physical manipulatives have been used to facilitate learning science content in areas such as genetics, but these instructional tools have not yet been tested in tree thinking. In order to circumvent students' tree-thinking struggles, we investigated the use of manipulative, three-dimensional tree models in an introductory biology course designed for non-science majors. We compared three treatment groups across three semesters: 1) control; 2) multichromatic model; and 3) monochromatic model. We used a mixed methods approach gathering data from pre/post assessments and course observations to measure student tree-thinking learning gains and interactions when exposed to each instructional treatment. We found that students had the highest tree-thinking learning gains when given explicit instruction tied with a multichromatic model. The use of multiple colors aided students understanding of the major components of trees and were able to easily distinguish among the multiple taxa represented. This investigation provides empirical evidence to support the use of manipulatives in tree-thinking instruction.

B70. Positive Impacts of Authentic Scientific Research Practice on First and Second Year Life Science Majors

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Johnavae Campbell, University of North Carolina at Chapel Hill

Mary Beth Hawkins, North Carolina State University

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ABSTRACT: Undergraduate life science majors, especially underclassmen, have limited opportunities to participate in or prepare for authentic research practice; and researchers are hesitant to accept them into their independently funded research laboratories. This study examines the effects of an intensive two-semester research preparedness research track (RT), on students' attitudes and preparation for scientific research. We hypothesize that RT increases students' (1) interest in science and research, (2) preparedness to participate in scientific research, and (3) self-reliance in scientific practice. Using a comparative experimental design, student gains were measured using pre- and post-Classroom Undergraduate Research Experience (CURE) surveys, student interviews, and focus groups. Survey findings show that RT participants make significant gains in course elements ($p=0.005$) including ability to read and understand primary literature, analyze data, and use scientific discourse effectively. Coded focus group responses indicate gains in procedural and content knowledge, and survey findings show significant gains in student benefits ($p=0.001$) including increased collaborative skills, ability to apply knowledge to other courses, and interest in research. Learning how to function in authentic scientific research contexts positively impacts early-stage undergraduate life science majors, developing attitudes and competencies that serve as a foundation for scientific research careers.

B72. Promoting Epistemic Change in Students through a Physics Gateway Course: An Intervention Study

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Xiang Huang, Concordia University

Ahmed Ibrahim, McGill University

Calvin Kalman, Concordia University

Mark Aulls, McGill University

ABSTRACT: Epistemic beliefs are found to have important effects on individuals' cognition, motivation and achievement, and expert-like epistemic beliefs are considered as a desired educational outcome. Three instructional activities—Reflective Writing, Conceptual-Conflict Collaborative Group and Critique Writing—were used in a one-semester intervention study to promote epistemic change in the novice learners in a physics gateway course. Participants in the experimental group exposed to all the instructional interventions, while the control group instead of performing any of these activities wrote a summary for each chapter. The Discipline-focused Epistemological Beliefs Questionnaire was administered at the beginning and end of the semester. Results showed that for the experimental group, students' beliefs in simplicity and certainty of knowledge, and in attainability of truth developed towards more expert-like, although the change is not statistically significant. This means students become to see knowledge as interconnected rather than as pieces of facts, and that truth is attainable. However, their beliefs in source of knowledge and justification of knowledge went less advanced. Theories supports that beliefs about knowledge (simplicity, certainty of knowledge) develops before beliefs about knowing (justification, source of knowledge). Better results can be expected when a larger and more balanced sample is used with longer intervention.

B74. Eye Tracking Assessment of the Cognitive Processes of Experts and Novice in Graph Reading

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Adam V. Maltese, Indiana University

ABSTRACT: In the sciences, adequate proficiencies in graphing are widely held as a central element for scientific literacy given the importance of graphs to succinctly present complex information. However, while prior research espouses methods to improve graphing proficiencies, there is little understanding to how students develop these skills. This study uses eye tracking to lend insight on expert and novices' cognitive processes when tasked with answering questions when viewing graphs. Preliminary findings demonstrate variation in the general patterns (focal attention and visual search) of participant eye movement when reading and interpreting graph-based information as a function of expertise. It is believed this study will be useful in refining our understanding to how students develop literacy skills, and development of instructional strategies.

B76. Is Brief Electricity and Magnetism Assessment a Biased Test?

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ABSTRACT: The Brief Electricity and Magnetism Assessment (BEMA) is a 30-item multiple-choice test designed to measure student basic understanding of electricity and magnetism (E&M) concepts in introductory physics. Since its creation, BEMA has been broadly used to gauge student learning across different curricula, one of which is a content-reformed physics course entitled Matter and Interactions (M&I). Previous studies have shown that students in M&I consistently outperformed their counterparts in traditional courses—a finding that is replicable with different student populations and in multiple institutions; inferences therefore have been drawn that M&I is more effective in promoting student conceptual understanding of E&M topics than traditional curricula. In reaching this conclusion, an important and yet implicit assumption has been made; that is, BEMA is not biased in favor of M&I. However, no empirical evidence exists to support this assumption. In this study, we use the Rasch-based differential item functioning (DIF) framework to examine potential bias in BEMA items using data collected from both M&I and traditional E&M courses. Results show equivalent functioning for most BEMA items within the 95% confidence intervals, but 7 items demonstrate DIF either in favor of the M&I students or those in the traditional course.

B78. Utilizing Case-Based Learning in a Summer Pre-Freshman Bridge Program to Impact STEM Retention Rates

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Patricia A. Marsteller, Emory College

ABSTRACT: Numerous reports call for universities and colleges to engage with local, regional and national school systems to improve the success rate of students transitioning to college especially in STEM disciplines. Programs vary widely depending upon the nature of the institution and the kinds of funding available. A recent NSF STEP grant has allowed us to develop a unique summer bridge program incorporating both residential and online instructional models using case-based learning; student tailored science writing and course advising workshops and guided self-assessment activities. While preliminary, our data indicates students (n=33) built core analytical and communication skills required to be successful in STEM while enjoying the diverse topics covered. We intend to build on this success to refine our bridge program and develop review materials which will be available to all incoming pre-freshman.

Strand 6: Science Learning in Informal Contexts

Poster Session B

4:15pm – 5:15pm, Río Mar Ballroom 6

B80. Long Term Effects of a Science Focused Summer Camp on SAT Scores

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Robert M. Capraro, Texas A&M University

James Morgan, Texas A&M University

Alpaslan Sahin, Texas A&M University

Niyazi Erdogan, Texas A&M University

ABSTRACT: Research has shown that learning experiences in informal science educational settings such as camps provide significant benefits for secondary students. In order to expand the amount of students entering into Science, Technology, Engineering and Mathematics (STEM) university majors and ultimately careers in STEM fields, our STEM Center conducted a two-week summer camp for secondary students (n=35) over 2 years. This study demonstrated the learning successes based on informal PSAT scores and SAT scores that can be achieved through inquiry-based experiences of a STEM summer camp at a major Texas university with inner city high-school students. Results on the PSAT and SAT pre/post tests by mathematics, writing, and reading using the 95% confidence intervals indicated that there were statistically significant gains across subjects and females outperformed males on SAT Math while males outperformed females on SAT Writing.

B82. Viewing STEM Learning Through A Community-Wide Lens: The Synergies Project

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Lynn D. Dierking, Oregon State University

Nancy Staus, Oregon State University

Julie Haun-Frank, Oregon State University

William R. Penuel, University of Colorado

Jennifer Wyld, Oregon State University

Deborah Bailey, Oregon State University

ABSTRACT: Despite the importance of science, technology, engineering, and mathematics (STEM) in the increasingly scientific and technological world of the 21st century, research indicates that many citizens do not engage with STEM or understand the underlying concepts. In particular, children's interest in STEM topics appears to decrease significantly between middle childhood and adolescence which may lead to less engagement with STEM over time. Our 4-year, longitudinal study of 5th – 8th graders seeks to improve understanding of how STEM interest develops and how STEM education providers within a community can support that development. This mixed-methods study will document these changes and the factors within students' families and communities that affect STEM learning and engagement. Our study will lead to the development of intervention strategies to enhance middle school children's strong interests in STEM topics that may lead to life-long engagement in these fields.

B84. STEM After School: Using Careers to Build Middle School Students' Science Knowledge and Skills

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Barbara Tharp, Baylor College of Medicine

Gregory Vogt, Baylor College of Medicine
Alana Newell, Baylor College of Medicine

ABSTRACT: Early experiences develop students' science interest and knowledge, and contribute to later success in science careers. Yet many students already are behind their peers in science and other subject areas by middle school. We investigated whether an after school program could help students develop the knowledge and skills they would need to be successful in their formal science courses. We designed and piloted a six-week module that allowed students to sample the types of questions and activities that are typical of STEM careers, while also learning content and skills needed to be successful in middle school science. The project was evaluated in 10 schools with 238 students. We found that an approach that emphasizes how real people use STEM skills is effective in stimulating students' engagement with and learning of science topics related to rockets, force and motion, and the engineering design process. Reports from teachers indicated that students developed skills that are valuable for success in school (and science class), such as being able to work as a member of a team, use scientific vocabulary words appropriately, and follow directions to achieve a goal.

Strand 7: Pre-service Science Teacher Education

Poster Session B

4:15pm – 5:15pm, Río Mar Ballroom 6

B86. *Tracing a Beginning Elementary Teacher's Identity Development for Science Teaching*

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ABSTRACT: The purpose of the case study reported in this paper was to examine the identity development of an elementary teacher from her first year in University, her field experience and through her first-year of teaching. The question that has driven the design of this study is: what kinds of actions and interactions does Maria engage into over a period of time to convey the images she has about herself as a learner of science and as a teacher of science? Several kinds of data were collected over a period of five years: six interviews, seventeen reflective entries, various assignments, lesson plans and four classroom observations. These data were analyzed by means of open coding techniques and led to the following assertions: a) The preparation program and specifically the science methods course had a critical impact on the development of Maria's reform-based identity as a teacher of science; b) Maria faced various difficulties during her field experience mostly associated with constraints such as the curriculum and a non-productive relationship with her mentor; c) The supportive nature of the school culture and her colleagues enabled Maria to apply in practice her reform-based philosophy of science teaching. The findings of this study illustrate: a) the formation of a teacher's identity is a complex and multidimensional process influenced by a wide range of experiences; and, b) examining the types of experiences that seem to be critical on teachers' development of science teaching identity is a valuable and essential form of research.

B88. *Pre-service Teacher Students' Concerns about the Implementation of Inquiry-Based Science Education*

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ABSTRACT: Inquiry-Based Science Education (IBSE) can be seen as the basis of contemporary science education. When IBSE is implemented, teachers assume a central role. Therefore, they are confronted with particularly high expectations. Following the theory of planned behavior, IBSE is more likely to be performed if teachers are more open-minded towards this approach. With this in mind, we examine how attitudes and concerns of pre-service science teacher students can be influenced in the context of IBSE-oriented university courses. For our study, we apply an adapted Stages of Concern questionnaire to 138 pre-service teacher students. With these data we test the scientific quality of the SoC questionnaire. The results of these analyses show that the adapted SoC questionnaire provides the opportunity to analyse changes in attitudes and concerns of pre-service teacher students regarding the implementation of IBSE into practice. Furthermore, the results of our pre-post analyses show that by means of our Continuous Professional Development program for pre-service science teachers it becomes possible to affect the participants' attitudes and concerns about the implementation of IBSE in a positive manner.

B90. *Developing Emergent PCK of Irish and Australian Pre-service Science Teachers during Teaching Placements*

Adam Bertram, Monash University, adam.bertram@monash.edu

Louise Lehane, University of Limerick

ABSTRACT: This paper reports on an exploratory study which sought to offer pre-service high school science teachers (n=40) a scaffolding approach for developing their emerging pedagogical content knowledge (PCK). A particular feature of this approach was to explore how pre-service teachers from Ireland (n=35) and Australia (n=5) engaged with or began developing their own PCK during a five (Australia) or six (Ireland)-week teaching practicum. Both groups followed identical methodological approaches where participants were introduced to PCK and to a Content Representation (CoRe) framework that would assist them to identify, relate to and develop their PCK. After completing a CoRe before (Ireland) and during (Australia) their practicum, participants were asked to evaluate its use in scaffolding their PCK and whether it was useful in developing their knowledge of teaching and learning through their eyes as beginning teachers. Findings revealed, independent of country, both groups believed that providing a scaffolded means for developing PCK, and being able to recognise it in their own teaching through the experience of actual teaching experience on their practicum, was powerfully meaningful for them in not only developing their emerging PCK but also their understanding of teaching and learning more broadly in the sciences.

B92. *Examining a Teacher Preparation Program Participants' Perceptions and Confidence Levels in Standards-based Knowledge Types*

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Hersh Waxman, Texas A&M University

Danielle B. Brown, Texas A&M University

Kayla Rollins, Texas A&M University

Beverly Alford, Texas A&M University

ABSTRACT: Teacher quality is under scrutiny; student achievement on national and international exams is considered a direct product of teacher quality. As a result of student achievement and assumptions about teacher quality, policy makers have developed and reformed many educational policies. In accordance with national trends, Texas state education policy has reformed its education standards. Reformed standards include K-12 student standards called the Texas Essential Knowledge and Skills (TEKS) and the College and Career Readiness Standards (CCRS), and teacher certification standards called Texas Educator Standards. The changes of these standards have caused teacher education programs to align their curricula to new standards, essentially educating and training new teachers according to the new standards. Currently, there isn't an acceptable method for evaluating the quality of Texas teacher education programs that have aligned their curricula with these reform-based standards. The present study assesses a reform standards-based teacher education program by administering a survey with Likert-scaled statements and open-ended questions to key teacher education program participants. The concurrent triangulation mixed methods study employs analysis of participants' responses to Likert-scaled survey statements and open-ended questions. Descriptive statistics and content analysis of participant data form the results and findings of this study.

B94. *Science Days a University-School Collaboration*

Katherine A. Welsh, University of Wyoming, kmuir@uwyo.edu

Kate Kniss, Albany County School District #1

ABSTRACT: Science Days are science inquiry experiences that provided elementary age students opportunities to interact with science concepts and generate investigable science questions that lead to the use of science practices. Teams of four to six university student teachers work with in-service teachers to design, plan, teach, and evaluate a Science Day. This study looks at the impacts on teachers of participating in Science Days. Data collected included teacher reflections and focus group interviews. Science Days are an opportunity to build collaborative relationships between teachers without adding to the already extensive list of demands on teachers because Science Day professional development experiences are built into the regular school day allowing participants to witness firsthand the benefits inquiry based science instruction that is developed and implemented collaboratively.

B96. *Using Concept Maps and Vygotsky's Theory of Concept Development to Assess Elementary Preservice Teacher Knowledge*

Pamela Harrell, University of North Texas, pam.harrell@unt.edu

Karthigeyan Subramaniam, University of North Texas

David Wojnowski, University of North Texas

ABSTRACT: This research study reports on the use of concept maps as an assessment tool to assess elementary pre-service teacher knowledge about dissolving. Propositions from pre/post concept maps were scored using the total proposition accuracy scoring technique and concepts were classified as scientific or spontaneous using Vygotsky's theory of concept development. After instruction, statistically significant improvement was shown on a paired sample t-test ($t = -4.154$, $p < .001$) and many spontaneous concepts appearing on the pre-concept maps, were either reduced or eliminated. Some spontaneous concepts increased or exhibited only a small reduction after instruction. The frequency of post concept map propositions showing dissolving is a chemical change increased from 10% to 16% after instruction, while propositions that indicate dissolving involves the breakdown of substances, or formation of a mixture were decreased to 10% and 15% respectively. The most common scientific concepts observed included that solute and solvents form solutions (16%); and heat, physical agitation, and concentration affect dissolving rate (28%). These findings suggest weak science content knowledge about dissolving and many pre-service teachers continued to hold the same misconceptions as reported for K-12 students in previous studies (Kikas, 2001; Kind, 2004; Calik & Ayas, 2005; & Dawkins, 2008).

B98. *Teaching Science for Social Justice: Curriculum Development and Preservice Teacher Resistance*

James C. Eslinger, OISE/UT, james.eslinger@utoronto.ca

ABSTRACT: Scholarship and assessment results continue to demonstrate a substantial science achievement gap between some racialized minority groups and their White peers despite of the fact that the science for all agenda has been prevalent for the past thirty years in both Canada and the United States. While numerous critical scholars have argued that an emphasis on equity and social justice must be made explicit in teacher education programs and courses, there is a substantial gap in the literature concerning the integration of social justice in elementary science preservice teacher education courses. To address this gap, this qualitative study will explore my creation of an elementary science methods course that places equity and social justice front and center. I delineate what I call the critical – cultural framework as the theoretical underpinnings of the course and elaborate on three dimensions I argue are imperative to teaching science for social justice. Furthermore, I offer an analysis of preservice teachers' perceptions and present six themes of preservice teacher resistance to teaching science for social justice.

B100. *Elementary Preservice Teachers' Developing Identities as Science Teachers During STEM-focused Teacher Preparation*

Sarah J. Carrier, North Carolina State University, sarah_carrier@ncsu.edu

Daniell Difrancesca, North Carolina State University

Ellen McIntyre, North Carolina State University

ABSTRACT: The present study examined preservice teachers' (PSTs) personal memories of science and science teaching to uncover their developing identities as elementary teachers of science. We present qualitative data documenting preservice teachers' growth and persistent images of science teaching and discuss the continuum of teaching (Femian-Nemser, 2012) that describes teachers' developing identities and growing recognition of effective teaching. Findings from this study highlight the potential for informing elementary preservice teachers' developing identities as teachers of science. Few PSTs, who were elementary students during the NCLB implementation and marginalization of science, had memories of elementary science instruction. Many expressed a fear of science and naïve views of science and teaching. Yet a concentrated STEM focused teacher preparation program, along with multiple field opportunities working with children having a range of backgrounds and needs seemed to contribute to PSTs' initial development as teacher/learners of science and their recognition that their teacher preparation is only the beginning of learning to teach science.

B102. Preservice Teacher Noticing and Feedback: A Proxy for Emergent Science Teaching Knowledge and Practice

Amanda Benedict-Chambers, University of Michigan, mbenedi@umich.edu

ABSTRACT: Although research on professional preparation in the fields of medicine, law, and teaching underscore the role of feedback in developing knowledge and practice, feedback has not been leveraged in teacher education to foster preservice teachers' science teaching. Furthermore, the feedback that preservice teachers offer one another has not been conceptualized as a source of rich information of their learning about science teaching. This work focuses on preservice teachers' noticing and feedback in feedback discussions, and in particular, the feedback that novices offer after opportunities to practice teaching science lessons in an elementary science teaching methods course. Novices used an "EEE Framework for Science Teaching Rubric" to offer peers targeted feedback. The EEE Framework rubric parsed reform-oriented science teaching into three dimensions of science lessons: Engage, Experience and Explain phases. This study uses van Es & Sherin's (2002) conceptualization of teacher noticing to argue that novices' noticing and feedback serve as a proxy for their emergent knowledge of science teaching practice. Qualitative data analyses of novices' noticing and feedback indicate that novices attended to and reasoned about peers' instructional decisions and students' scientific thinking with the support of the EEE Framework Rubric.

B104. Utilizing Photovoice to Empower Learners to Connect with and Care about Socio-scientific Issues

Kristin L. Cook, Bellarmine University, kcook@bellarmine.edu

ABSTRACT: Many science educators support the idea that all students should have fair and equal opportunities to become scientifically literate through authentic, community-based science education (Calabrese Barton, 2000; Bouillion & Gomez, 2001; Hodson, 2003; Roth & Lee, 2004). However, this challenge requires teachers to find ways to help all students feel comfortable with and connected to science. Here, we investigated the potential of SSI to empower pre-service teachers to connect with the scientific community through the use of a promising participatory action research tool termed photovoice (Wang & Burris, 1994), which has received attention in public health education and community development- and more recently in science education (Author, in press) for engaging participants in democratizing the research and learning process. It was evident in this study that photovoice was essential for both the connection to and empowerment of the students to engage with the science in their community. This study provided insights into ways in which a curriculum could be structured to meet these goals.

Strand 8: In-service Science Teacher Education**Poster Session B**

4:15pm – 5:15pm, Río Mar Ballroom 6

B106. The Variability of Self-Efficacy Patterns in Professional Development

Jan Alexis Nielsen, University of Copenhagen, janielsen@ind.ku.dk

Robert H Evans, University of Copenhagen

ABSTRACT: The explorative study reported here sought to gain an initial sense of self-efficacy score patterns (by which we mean the various ways in which self-efficacy scores can change over time) for future use in teacher development. Thus the aim was to prepare for intentionally enhancing self-efficacy during in-service teacher professional development (TPD) programs to improve the viability of back-in-the-classroom outcomes. There are indications that there is not a straightforward singular pattern in teachers' efficacy as it develops over time around a TPD program. This poster reports on a pilot study that revealed different self-efficacy patterns found in relation to five different TPD programs in different countries, contexts and educational levels. The aim of the interactive poster presentation is to use the pilot findings presented here to engage NARST members in a discussion about how different self-efficacy patterns can inform TPD leaders about their efforts to intentionally influence capacity beliefs.

B108. Reflecting on Teaching Practices: The Alignment between Teaching a Lesson and Talking about It

Andri Christodoulou, University of Southampton, a.christodoulou@soton.ac.uk

Maria Evagorou, University of Nicosia

Christina Howell-Richardson, Coventry University

ABSTRACT: The purpose of this case study is to explore possible differences between how teachers perceive their

science teaching, and the extent to which these perceptions are consistent with their views of science, and with current perspectives on dialogic and argument-based learning. The study was conducted in a European country, and the participant is a secondary school teacher from a suburban area with 4 years of teaching experience. The teacher was observed teaching a lesson, and was also interviewed before and after the lesson. The findings suggest that: (a) there is an alignment between the teacher's beliefs of science and his understanding of teaching and learning in science; (b) the teacher's understanding of teaching and learning in science and his actual teaching practice are not coherent; (c) although the teacher does not have a pedagogical understanding of argumentation, his understanding of argumentation as a scientific practice was aligned with current perspectives and, (d) the teacher's view of collaborative group-work in science is different from that observed in his actual teaching practice. Implications in light of recent recommendations (NRC, 2012) for engaging students in scientific practices such as argumentation and explanation are discussed.

B110. Professional Development for the integration of Engineering in High School STEM Classrooms

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Julie Ross, University of Maryland

Taryn Bayles, University of Maryland

Yvette Lee, University of Maryland

ABSTRACT: The need to recruit more students into engineering and technology fields in the U.S. is urgent. Although increased employment opportunities for engineering careers are forecast for the future, national enrollment in engineering disciplines has been declining (Hecker, 2001; NSF, 2008). To meet the immediate and pressing national challenge, new innovative high school curricula are needed. The purpose of this study was to investigate the impact of a prototypical professional development program on high school STEM teachers' ability to enact pedagogical strategies, learning technologies and materials (e.g., Integrating engineering and science practices, technology rich, meaningful content) that align with the recent STEM reforms. Data were generated through evaluation of teacher practice using the Reformed Teaching Observation Protocol (RTOP) (Sawada et al., 2002). Data were collected before, as well as twice during the Post-Institute classroom enactments (Lessons 11 and 14). Results demonstrate that the instructional practices of the teacher-participants were significantly impacted as a result of the professional development program. Changes in RTOP scores illustrated a significant increase in the use of reform-based practices between the "before" and "after" time periods.

B112. Professional Development and Improving Science Content and Inquiry Practice

Ted Fowler, University of Cincinnati, kathie_sund@hotmail.com

Kathie Maynard, University of Cincinnati

Shelly Micham, University of Cincinnati

ABSTRACT: It is well documented that the best school predictor of student outcomes is high-quality, effective teaching. Darling-Hammond believes that high-quality teacher can have considerable impact on student learning and outcomes. Earlier evidence on the effectiveness of professional development often was traditional in approach, a one-shot session, and not connected to practice. As a result, much of the professional development offered to teachers simply does not meet the challenges of the "reform" movement. The research questions in this study were: 1) How effective is professional development in improving teacher content knowledge and inquiry instructional practice?, 2) How effective is professional development in increasing student science achievement, and 3) How effective is the professional development in impacting the systemic change? A mixed methods approach was used to establish the effectiveness of the processes, facilitation, and implementation of the PD and its effects on teachers' content knowledge and PCK, as well as student achievement in science. This setting was a high-needs suburban school in the Midwest. The results of the study revealed increased teacher content knowledge and improved RTOP scores for inquiry teaching as well as increased student achievement on the state high-stakes test. Systemic change indicators were also observed for the district.

B114. The Impact of an Immersive Course on K-8 Teachers' Content Knowledge

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Peter S. Garik, Boston University

Margaret D. Nolan, Boston University

Thomas Hunt, Boston University

Thomas Hunt, Boston University
Enrique M Jariwala, Boston University
Glenn Stevens, Boston University
Bennett Goldberg, Boston University

ABSTRACT: The School of Education and the Departments of Mathematics and Physics at a major urban research university together offer K-8 teachers' immersive professional development courses in science. In prior work, we reported on the impact of the immersion courses on teachers' content knowledge in science, process skills for experimentation, self-efficacy for teaching science, and understanding of reform teaching practices (Authors, 2010; Authors, 2012). Here we revisit the content knowledge gains of the participants. Despite statistically significant content gains based on standard science surveys from our past studies, the raw scores remained disappointingly low. This was in contrast to the claims by teachers in interviews that they had learned a lot. The remaining open question then is: If the participants' absolute scores on concept surveys results are disappointing, what is it that the participants learned? The objective of this study was to approach the participants with open-ended questions to discover what they had learned from the course as opposed to using standard surveys that focused on what we thought we had taught.

B116. *Physics and Physical Science Teachers' Knowledge Development through a Continuous Professional Development Context*

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Dennis W. Sunal, The University of Alabama
Cynthia Szymanski Sunal, The University of Alabama

ABSTRACT: A phenomenological study was conducted to investigate the development of pedagogical content knowledge (PCK) of physics and physical science teachers who participated in a "science and technology" continuous professional development program. There were five teachers who participated in this study. The researcher found a high-need for the availability of quality professional development. Additionally, the researcher found that teachers misunderstood authentic applications of research-based science teaching practices. The results of the study suggested reformed professional development institutes still might be the most efficient way to instill twenty-first century practices in science teachers' PCK. Based on the phenomenon of science teacher knowledge development through a continuous professional development program, the researcher theorized a non-linear model of their PCK development.

B118. *Professional Empowerment of Pre-K Teachers Over Three Years of Sustained Science Teacher Professional Development*

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Mary E. Hobbs, Center for STEM Education

ABSTRACT: While the primary research objective of this overall research study was the collection of data on what four year olds know and can do in science, this paper addresses the secondary objective of identifying professional development practices that best supported and empowered the teaching of complex STEM concepts to young learners. We used the construct of professional empowerment as the theoretical frame to explore 24 pre-kindergarten teachers' professional growth over time to investigate the following question: How did the teacher-researchers change in terms of professional empowerment over the course of the three-year project? To explore the research question, 24 teachers completed a 31-question, mixed-modal Teacher Empowerment Survey. To serve as a pre-post qualitative 'snapshot' of these teachers' professional growth, each teacher completed the survey at Year One and at Year Three. For the scope of this paper, we focus our analysis on eight items that specifically correlate to each of the six dimensions of empowerment, including two open-ended questions. The empowerment qualities that these teacher-researchers considered most critical to their own professional narrative involved two specific dimensions: professional growth and impact. The preliminary results indicate that certain aspects of teacher empowerment, through long-term professional development, are integral to its success.

B120. *A Clearer Vision: Findings from the First Year of a Project Designed to Develop Teacher Leaders*

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Greg Rushton, Kennesaw State University

ABSTRACT: Through the support of a multi-year grant, we are implementing a project designed to recruit new teachers

into chemistry and physics, as well as to develop experienced teachers in those disciplines into teacher leaders. This session will focus on the outcomes from our first year of work with the experienced teachers, who we will identify as Potential Teacher Leaders (PTLs). The project team went into the first year with a model for teacher leadership produced by a synthesis of Goodwin's (1994) notion of professional vision and Dempsey's (1992) four metaphors for describing the nature of a teacher leader. In this session we will present data from videotaping of professional development sessions, interviews with PTLs, surveys taken by PTLs, observations of lessons, and records of leadership activities which indicate the limitations of the initial model and suggest modifications to it. Further, we will explore an evolving definition of [science] teacher leader, which we argue must be flexible enough to acknowledge that leadership qualities will manifest themselves in quite different forms for different individuals.

B122. *Teacher Leadership Pathways as Seen Through Blogs*

Somnath Sinha, University of Missouri, ssqh9@mail.missouri.edu

Candace R. Kubby, University of Missouri

Deborah L. Hanuscin, University of Missouri-Columbia

ABSTRACT: Although teacher leadership has been long recognized due to its contribution in the educational arena, it has not received much attention till now (Kezar, 2002). Furthermore, there are scarcity of studies shedding light on the pathways through which teachers develop leadership skills and abilities (York-Barr & Duke, 2004). Within this backdrop, this study intended to understand leadership pathways of teachers as projected by their blog narratives. These teachers participated in a National Science Foundation funded (NSF) Math and Science Partnership (MSP) professional development program designed to support 9th grade teacher-leaders for implementation of 'Physics First' curriculum. Since blog narratives were used as the primary data, the analytic method of narrative analysis was followed in this investigation. Finally we came up with two interesting findings. Firstly, we found that the leadership pathways of the teachers were varied and unique depending on their context and career stage. Secondly, teachers' leadership pathways were largely self-directed, and not constrained by opportunities to hold a formal position.

B128. *Self-Efficacy as a Predictor of Science Content Knowledge*

Robert E. Bleicher, California State University, Channel Islands, bob.bleicher@csuci.edu

Julie L. Lambert, Florida Atlantic University

ABSTRACT: This study examines relationships between science teaching self-efficacy and science content knowledge in high school science teachers. Data sources included the STEBI-A and the Climate Science Knowledge Inventory. Fifteen teachers participated while attending a 7-day NASA-funded climate change summer institute and camp. T-tests and ANOVA showed that teachers with higher self-efficacy demonstrated higher climate change science knowledge. It is recommended that data on self-efficacy be collected to construct a more robust evaluation for inservice professional development projects.

Strand 9: Reflective Practice

Poster Session B

4:15pm – 5:15pm, Río Mar Ballroom 6

B130. *Understanding Preservice Elementary Teachers' Beliefs about Science Teaching and Reflective Practice*

Cynthia Deaton, Clemson University, cdeaton@clemson.edu

Rory Tannebaum, Clemson University

ABSTRACT: This single case study examined preservice elementary teachers' science teaching philosophies and reflective writings to understand what they focused on as they discussed their beliefs and examined their science teaching practice. Open coding was used to analyze the data. Findings indicate that participants had four foci for their science teaching philosophies: (a) discuss their previous learning experiences, (b) discuss their professional development goals, (c) discuss their vision of an ideal science teacher and (d) showcase their knowledge of concepts taught in the science methods course. There were four foci for their written reflections: (a) comfort level with science content, (b) planning of lesson and lesson implementation, (c) connections to other lessons or science content, and (d) encouraging student participation.

B132. Photovoice as a Pedagogical Tool in Introductory Chemistry

Mary W. Stroud, Xavier University, stroud@xavier.edu

ABSTRACT: This project explores the use of Photovoice as a pedagogical tool in two introductory chemistry courses for non-science majors. Photovoice as an investigative approach has been historically linked to participatory action research. It is a qualitative mode of inquiry in which the perspectives provided are generally personal, subjective and unique (Cohen, Manion, & Morrison, 2007). Therefore the use of Photovoice as a pedagogical approach in an introductory chemistry course represents a departure from the positivism and teacher-centered style of lecture often associated with the study of chemistry. In this instance, the resulting distinctions in student engagement and perspective are considered. The apparent effectiveness of Photovoice as a student-centered teaching tool in two issues-related introductory chemistry courses is summarized.

B136. Increasing Students' Motivation to Learn Science: An Action Research Project

Nancy Caukin, Eagleville High School / Middle, Tennessee State University, caukinn@rcschools.net

ABSTRACT: The purpose of this National Science Foundation funded (Robert Noyce Grant #0934731) mixed-methods action research project was to determine if employing the writing-to-learn strategy known as "Science Writing Heuristic" would positively affect secondary Honors Chemistry students' motivation to learn science. Science Writing Heuristic (SWH), designed by Brian Hand and Vaughan Prain (1996), is a tool for designing science experiences that move students away from "cookbook" experiences and allows them to design labs based on their own ideas and questions. This non-traditional instructional strategy focuses on claims that students make based on their evidence. Their claims are compared with their peers and then compared with those within the established science community. Students engage in reflection, meaning making based on their experiences, and demonstrate those understandings in multiple ways.

B138. Teaching the Greenhouse Effect with Inquiry-Based Computer Simulations: Improving Content and NOS Understanding

Edward Cohen, Piscataway Township Board of Education, EDtheScienceGuy@gmail.com

Timothy Zimmerman, Rutgers University

ABSTRACT: The research described herein follows a practitioner inquiry paradigm. This study focuses on how students use a greenhouse effect simulation. The simulation is embedded within an inquiry-based technology-mediated science curriculum known as the Web-Based Inquiry Science Environment (WISE). For this research, students from a suburban, diverse, middle school setting were asked to use the simulation as part of a week-long class lesson on global warming and climate change. Using a combination of student interviews, focus groups, and students' conversations while they used the simulation, the authors present evidence of shifts in student motivation, understanding of science content, and ideas about the nature of science, all connected to the use of the simulation. There was a control group of students using the current WISE curriculum and a modified variable group which had seven embedded videos of scientists explicitly discussing NOS concepts. Students conduct "extreme testing" where they make the simulation as cold as possible and as hot as possible. The curricular modifications with "extreme testing" show over a 20% increase in learning gains between pre/post testing. The cohort of interviewed students had a 10% increase in learning gains compared to the control interview cohort.

B140. A Narrative Inquiry into Teaching Physics as Inquiry: One Teacher's Journey

Paige K. Evans, University of Houston, pevans@uh.edu

ABSTRACT: Studies suggest that teachers who have experienced inquiry are more likely to practice the inquiry method in their own classrooms. In this narrative inquiry, I illuminate one secondary science teacher's inquiry journey while co-constructing curriculum with her students. Changes in the teacher's personal practical knowledge after participating in a graduate level physics inquiry course and subsequent professional development sessions emerge throughout her story. In addition, several roadblocks encountered when altering curriculum mandates in ways that would enable her to work with the inquiry method are revealed. The images of teacher as a curriculum maker and teacher as a curriculum implementer demonstrate what needs to be taken into account when a teacher lives physics curriculum alongside her students in a physics classroom setting. The exemplar featured in this presentation paper elucidates one teacher's developing knowledge as she expands her understandings of inquiry in a physics inquiry course and her subsequent

enactment of science curriculum in her own classroom with her students as they, too, inquire into physics. The implications of this research for informing my personal practice of preparing both preservice and in-service science teachers are discussed.

Strand 10: Curriculum, Evaluation, and Assessment

Poster Session B

4:15pm – 5:15pm, Río Mar Ballroom 6

B144. *The Inclusion of the Essential Features of Inquiry in Science Intermediate Grade Textbook Activities*

Saeed Alshamrani, College of Education & Obiekan Chair for Science and Mathematics Education, King Saud University, sshamrani@ksu.edu.sa

Nasser Mansour, Exeter University

Abdulwali Aldahmash, The Excellence Research Center & Obiekan Chair for Science and Mathematics Education, King Saud University

ABSTRACT: The purpose of the study is to portray the inclusion of the essential features of inquiry in Saudi intermediate science textbooks (7-9 grades). The researchers used the content analysis to collect the data through the data collection protocol which was developed based on the essential features of inquiry presented by the National Research Council (NCR, 2000). The validity of the protocol was assured through the face and content validity; however, the reliability was assured through Inter-rater reliability. The sample of this study encompassed all activities in the analyzed textbooks in all three grades; the total number of activities were 144. The results indicated that 433 essential features of inquiry were included in these activities. Almost all of these activities engage students in scientifically oriented questions, give students priority to evidence in responding to questions, and give them the opportunities to formulate explanations from evidence. However, a few of these activities give students opportunities to both connect explanation to scientific knowledge and communicate and justify their explanation. Moreover, the results indicated that these activities include these features with less amount of students-self direction.

B146. *Effect of the Science Writing Heuristic Learning Approach on Future Achievement*

Luke Fostvedt, Iowa State University, fostvedt@iastate.edu

Mack Shelley, Iowa State University

Joan Baenziger, Iowa State University

Dai-Trang Le, Iowa State University

Dai-Trang Le, Iowa State University

Brian M. Hand, University of Iowa

William Therrien, University of Iowa

ABSTRACT: A longitudinal analysis of the annual Iowa Assessment standardized exams is used to evaluate the effect of the Science Writing Heuristic (SWH) learning approach on student performance. A multivariate linear mixed effects model is used to analyze the Science, Mathematics and Reading subtests simultaneously. The multivariate linear mixed effects model is used in order to borrow information from the three different longitudinal processes which are expected to be highly correlated. This provides a method to determine whether the effect of the SWH curriculum is cumulative, whether it is sustained over time, and will begin to address the question of whether the SWH learning approach provides an increased transfer of knowledge across subjects.

B150. *Educational Testing Techniques, Students' Conceptual Understanding and Applicability of Physics Knowledge: National and International Context*

Tunde Owolabi, Lagos State University, Nigeria, owot2002@yahoo.co.uk

Peter A. Okebukola, Lagos State University

Hakeem Akintoye, Lagos State University

Solomon Aregbede, Lagos State University

Solomon Aregbede, Lagos State University

ABSTRACT: This study was designed to determine the spreads and demands of examination questions in physics and its

extrapolation to skills that are germane to transferability of scientific knowledge to daily life experiences of learners. It was guided by Stake's (1967) countenance model and Bloom's (1956) taxonomy of educational objectives in the cognitive domain. A combination of quantitative and qualitative research was employed to determine the tasks involved in physics examination of two examining bodies (West African Senior School Certificate, ordinary level and University of Cambridge International Examination, general certificate of education ordinary level). It also established the extent to which the questions directly or indirectly relate science concepts to daily life experiences of learners. Data were gathered through documentary analysis of past examination questions in physics, readability indices of the questions were determined using Perceptual Rating Scale (PRS) and an open-ended interview carried out among two students who sat for the two examinations in the same year and performed exceptionally. This was done to validate earlier findings of this study. They were respective graduates of medicine and engineering of a Nigerian University. Finding of this study revealed the preponderance of question items at lower levels (knowledge and comprehension) of Bloom's (1956) taxonomy of educational objectives in the cognitive domain. Findings further revealed inadequacy (Cambridge) or complete absence (WAEC) of questions along the higher level. Normal 0 false false false EN-GB JA X-NONE

B152. *Assessment Conversations in a Middle School Science Classroom: An Exploratory Study with English Language Learners and non English Language Learners*

Preetha K. Menon, UC Santa Cruz, pmenon@ucsc.edu

ABSTRACT: This paper will provide insights on how assessment conversations, a form of formative assessments can support science learning for English Language Learners. Assessment conversation is a specially formatted instructional dialog that embeds assessment into the activity structure of the classroom and helps teachers to continually acquire information about their students' understanding on the topic at hand (Duschl and Gitomer, 1997; Ruiz-Primo and Furtak, 2006). This study describes the discussions between the teacher and the whole class, by identifying the assessment conversations (AC) and analyzing them using systemic functional linguistic approach (SFL). The AC were identified through the ESRU cycle – Teacher Elicits, Student responds, Teacher Recognizes, Teacher Uses (Ruiz-Primo and Furtak, 1997). The complete cycles were elicited with open-ended questions, which tapped into strategic and schematic knowledge (knowing why, when, and how). The SFL analysis showed the teacher used parallel grammatical construction of grammatical metaphors to help the students understand the learning goals (Schleppegrell, 2009). The teacher maintained rigor and positioned the students such that they used certain forms of academic language in order to express their ideas in science. This study shows how to raise the awareness of linguistic choices that enables students and teachers better participate in the contexts of learning.

B154. *The Core Principles of Big Ideas of Physiology: Results of Student Responses to a Survey*

Ann W. Wright, Canisius College, wrighta@canisius.edu

ABSTRACT: This proposal focuses on students' conceptual understanding of homeostasis. Homeostasis is one of the core principals of physiology. Physiology faculty members from a variety of two- and four-colleges and medical schools determined 15 core principles in physiology (Michael, J. and McFarland, J., 2011). The results from a second survey determined five essential core principles "cell membrane," "homeostasis," "cell-to-cell communications," "interdependence," and "flow down gradients." To help us understand students' conceptual understanding of "homeostasis," we asked students what they knew about homeostasis. Forty-seven sophomores completed a homeostasis survey. The results also revealed students' misconceptions (alternative conceptions) of homeostasis which is consistent with previous research. The results will be used in the development of a concept inventory in physiology funded by NSF TUES Grant 103443.

B156. *Unpacking the Elements of Scientific Reasoning*

Keisha Varma, University of Minnesota, keisha@umn.edu

Patricia Ross, University of Minnesota

Douglas W. Huffman, University of Kansas

Gillian Roehrig, University of Minnesota

Ying-Chih Chen, University of Minnesota

Leah McGuire, Measured Progress

Frances Lawrenz, University of Minnesota

ABSTRACT: Research about the development of scientific reasoning and its role in science concept learning has a long history in cognitive development, educational psychology and science education. Generally speaking, scientific reasoning involves the skills required for successful learning from inquiry instruction that focuses on rich, authentic, experimentation activities. As reform efforts aim to promote the higher order thinking skills involved in scientific reasoning, there is a need to better understand what these skills are and exactly how they relate to the overall construct of scientific reasoning. The work presented in this proposal reviews research from the above mentioned perspectives in order to better define the construct of scientific reasoning. This task is part of an NSF-funded project that is designing a new measure of scientific reasoning.

B158. *Beyond the Black Box: Investigating how Teachers use Student Performance Data to Make Pedagogical Decisions*

Rachel Ruggirello, Washington University in St. Louis, ruggirello@wustl.edu

Phyllis Balcerzak, Washington University in St. Louis

Vicki L. May, Washington University in St. Louis

ABSTRACT: This study addresses how middle school science teachers use student performance data, the ways in which organizational and individual factors affect data use and the effect of data use on student outcomes. We employ a micro-process perspective centered on the interactions among individuals and the ways in which these interactions are mediated by structures, norms, resources, policies and institutions. This study is grounded in sociocultural theory and uses qualitative research methods to uncover how teachers use data. Using student performance data, field notes from professional learning conversations, and classroom observations, this study deepens our understanding of how and under what conditions teachers use data for instructional improvement. Our findings forefront the ways in which teachers are able to use data for instructional decision-making, mediated by individual and structural factors. We highlight a shift over time in how teachers interpret and apply data to pedagogical decisions. We demonstrate improved student outcomes on a local level, but no significant difference in achievement based on state test data.

B160. *Photo-documentation: An Alternative Approach to Investigating Middle School Students' Knowledge and Perceptions of Climate Change*

Consuelo J. Morales, University of Michigan, Ann Arbor, cjmorale@umich.edu

ABSTRACT: Student performance in science is currently dependent on standardized exams. Although this is one way to determine what students are learning, they may not always accurately measure students' understanding of science. As education researchers, it is essential for us to find different ways to assess student learning apart from standardized testing. One interesting assessment design to encompass the more complex aspects of student knowledge is through photo-documentation, student generated photos and essays. Photo-documentation is an engaging way to encourage students to establish more explicit links between their real-world experiences and classroom science. The study presented here contributes to the goal of assessing student knowledge through the use of photo-documentation as an alternative form of assessment compared to paper-based assessments often used to measure student learning. Twenty six 7th grade students participated in this exploratory study. Results show that students who use photo-documentation are able to and do provide responses that yield more detailed information about their knowledge and perceptions about climate change and greenhouse gases that were otherwise not articulated through a traditional science content and Likert-scale perceptions assessment. This study contributes to the ongoing discussion of how education researchers can develop and successfully use alternative forms of science assessment.

B162. *Coherences between Communication Competence, Decision Making and Content Knowledge in Chemistry*

Iwen Kobow, University of Duisburg-Essen, Iwen.Kobow@uni-due.de

Maik Walpuski, University of Duisburg-Essen

ABSTRACT: In science education students should acquire Scientific Literacy which includes different skills and abilities. One ability is to deal with information and to draw evidence based conclusions using these information. For this purpose, students need to select and evaluate information and to argue in complex situations. These actions – at least to some extent depend on students' content knowledge. The project presented in this paper investigates the connection between content knowledge, communication skills and decision making skills in chemistry empirically. For this reason, different test items are developed, validated and administered to 540 students.

B164. *Seeking "Trickle Down": Examining Student Work for Evidence of Teacher Uptake of Educative Curriculum Materials*

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Anna Maria Arias, University of Michigan

Elizabeth A. Davis, University of Michigan

Annemarie S Palincsar, University of Michigan

ABSTRACT: The purpose of this study was to identify evidence in student work of teacher uptake of educative features in educative curriculum materials (ECM). This study was prompted by previous work in ECM and the need to determine how teachers' use of ECM can influence student learning. Student work was analyzed for evidence of teacher uptake of educative features, as well as characteristics of quality for scientific practices and instances of content ideas. We compared content ideas in the student work to student achievement on pre- and post- assessments to characterize areas of strength and struggle. Findings from the student work revealed that the teachers used many of the supports in the ECM, especially those that could be used directly with students. Some educative features for quality of the scientific practices were also present in the student work. The content analyses revealed that the students used language from the content supports, but not always in accurate ways. This study supports and extends other work related to how teachers' use of ECM can influence student learning and has implications for supporting teachers' productive implementation of the dimensions in the new Framework for K-12 Science Education.

B166. *Assessing Systemic Thinking and Quantitative Reasoning: Understanding Factors Explaining the Decline of Timber Rattle Snakes*

Michele Crowl, Pennsylvania State University, michelecrowl@gmail.com

Peter R. Licon, Penn State University

Richard A. Duschl, Penn State University

ABSTRACT: Effective learning environments employing learning progressions incorporate diagnostic assessments that make thinking visible. We report on a research study that examined students' systems thinking and quantitative reasoning in the context of an endangered species with a goal of better understanding the design of assessments. Three cohorts students in 4th/5th, 7th/8th, and undergraduate grades were interviewed about the reasons for the population decline of snakes and the challenges with counting snakes. IUCN criteria for red-listing species and Earth Systems Science biotic/abiotic factors were used to develop a coding scheme. Inter-rater reliability of coders exceeded 80% for all cohorts. Frequency counts were compiled and used to ascertain 1) patterns of reasoning and 2) patterns of factors for snake decline. Results show the same general pattern of causes and reasons among all three cohorts. A Trifold fact sheet used in the interview stimulated consideration of abiotic factors for the snake decline. Beginning with elementary school to middle school and on to college there are cohort members who have rich knowledge that reflects systems thinking and quantitative reasoning. Implications for designing assessments to inform learning progressions are discussed.

Strand 11: Cultural, Social, and Gender Issues**Poster Session B**

4:15pm – 5:15pm, Río Mar Ballroom 6

B168. *Cross-cultural and Place-based Education of the Cofan*

William R. Veal, College of Charleston, vealw@cofc.edu

ABSTRACT: The purpose of this three year study was to investigate the role of culture in science learning and how important place-based education is when indigenous students cross cultural borders to learn Western modern science. This study was embedded in a theoretical framework of place-based education and culture. Specifically, the study focuses on two indigenous students who left their Amazon village to receive a Western education at an American international school. These students had to negotiate between their knowledge and definition of science in the jungle with that of standard, Western science in the classroom. Data were collected from three years of classroom observations, observations in the Amazon jungle, science class artifacts, interviews, and field notes. The VNOS-C was used with three bicultural young men who had been able to negotiate between the two cultures. The results indicate that place-based education is important in certain settings for specific purposes. These children struggled with adapting

to Western modern science due to the epistemological differences in the worldviews. This suggests that cross-cultural instruction should be used in classrooms in which students come from diverse cultural backgrounds. Many multicultural methods do not work due to the large cultural gap between cultures.

B172. *Through Their Lens: The Potential of Photovoice for Documentation of Environmental Perspectives among African Teachers*

Cassie Quigley, Clemson University, cassieq@clemson.edu

James Dogbey, Clemson University

Megan Che, Clemson University

Jeff Hallo, Clemson University

Jeff Hallo, Clemson University

Patrick Womac, Clemson University

ABSTRACT: This study explores the potential of a digital photo-elicitation method, photovoice (Wang & Burris, 1994), for understanding environmental sustainability perspectives of teachers in the XX District in Africa. The objective of this paper is to share this photo-methodology with science educators so they may use it as an innovative methodological tool to understand the construction of environmental perspectives. This study used a qualitative study of participants' environmental perspectives. Thirty-eight teachers participated in this study. Four themes emerged: Sharing cultural knowledge, On-going knowledge production, Conversation to action, Documentation of reality. Photovoice allows the participants' voices to emerge through multiple modalities, thus providing the researchers with rich data sources from the participants' perspectives.

B174. *Creating School Scientific Communities Among Urban Refugee ELL Populations*

Joseph J Johnson, Edinboro College, JJOHNSON@edinboro.edu

Randy K. Yerrick, State University of New York at Buffalo

ABSTRACT: Studies have been conducted from a range of theoretical and disciplinary perspectives, the findings of which have indicated growth in science achievement among ELLs when exposed to science inquiry. Yet studies are still needed to address the needs of specific groups within this large, and growing population. Children who are underserved in schools offering limited ELL support continue to be marginalized, and the gap for their future professional and higher education opportunities continues to grow when compared to their majority peers. Teachers often lack the experience, knowledge, and the institutional support needed to address the complex educational needs of ELLs. The goal of this study was to examine aspects of multimodal science inquiry teaching strategies using technology with a specific group of students learning English as their second language. This intervention study took place in a science classroom located in a large urban school district in the northeastern United States in a classroom identified as one of the lowest performing schools in the district. Participants include several seventh and eighth grade students who have been in the United States for less than a year, coming from Burma by way of refugee camps in Thailand.

B176. *Latinas: Pathways to Success in Science*

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Lorena Claeys, University of Texas at San Antonio

Belinda Flores, University of Texas at San Antonio

Alejandro J. Gallard, Georgia Southern University

Wesley Pitts, Lehman College, CUNY

Diane Torres-Velasquez, University of New Mexico

ABSTRACT: The rationale for our paper is to identify, understand and document the complexity of circumstances that afford Latinas' success in science while in high school, upon and after graduation from high school in high-poverty communities. We posit the idea of contact zones as a type of social field, where participants help to create and value interactions (i.e., dynamically changing resources that afford the development of positionality) that help them enact culture to meet their personal and academic goals. These case studies revealed successful contextual factors that are pertinent to high school and college level Latinas, but are overlooked by generalized pedagogical models. We further argue that both general and science educators need to be aware of these contextual factors in order to respond to Latinas in their daily teaching and interactions.

B178. *Student's Socioeconomic Background and School's Socio-economic Composition Relation to the Student's Science Performance*

Imbi Henno, PhD student, imbi.henno@tlu.ee

Priit Reiska, Professor

ABSTRACT: The purpose of this study was to answer to a question: how does the socio-economic background of different language instruction school students impact the performance and how does a school's socio-economic composition relate to the science performance of students from different socio-economic backgrounds. Estonian schools were grouped according to their socio-economic intake relative to the national average. Three categories of schools were identified: socio-economically disadvantaged schools; socio-economically advantaged schools; and socio-economically mixed schools. Students' actual performance in advantaged, disadvantaged and mixed schools was compared with their predicted performance based on their individual socio-economic background. The next stage the schools were sorted by the difference in observed and expected performance of students. Three categories of schools were identified: schools, where students' average actual performance was statistically significantly higher than expected; schools, where students' average performance was higher but the difference was not statistically significantly; schools, where students performed at lower level than expected. The differences of socio-economic status of Estonian and Russian language instruction schools and also the relationship between the school' status and students' science performance was examined. Differences between different schools' groups and students' science performance became evident.

B180. *We Stumble, Fall, Get Up, and Continue Walking; Latino/a Students' Science Attitudes*

Kathryn Scantlebury, University of Delaware, kscantle@udel.edu

Beth Wassell, Rowan University

Sarah Braden, University of Utah

ABSTRACT: Survey results from 147 ethnically Latino/a students showed that significant differences on students' mean scores on "What I do in class", "What my teacher does", "What my friends do", " and "Views of science" depending upon whether students spoke English or Spanish as their first language in the home. Students who spoke Spanish at the home had a higher mean scores on the "What my teacher does", subscale but lower mean scores compared to students who spoke English in the home on the other subscales. There were no differences on the "What adults do" subscale. Analysis with gender showed significant differences on the same subscales for female and male students. With increasing diversity in the K-12 population and emphasis on language skills such as argumentation, science educators need to explore the different learning needs for Latino/a students depending upon their language acquisition and proficiency levels.

B182. *How Gender, Ethnicity and Experience Influence Scientist Identity and Career Attitudes among Research Program Students*

Brandon J. Nzekwe, The National High Magnetic Field Laboratory, nzekwe@magnet.fsu.edu

Susan Carol Losh, Florida State University

ABSTRACT: This study compares science researcher role-identity salience among science majors in honors programs and/or research internships, and how salience relates to science career attitudes. From a situated learning perspective, undergraduate experiences such as honors programs or Research Experiences for Undergraduate internships foster role-identity salience, which can relate to effort, persistence, role-aspirations, and anticipatory role-behaviors. The salience of a particular role-identity can signify its importance; thus, in an era in which more women, African Americans and Hispanics are encouraged to enter science it is important to study undergraduate science role-identity salience. Using a confirmatory factor analysis to model role-identity salience and career attitudes, we found both research internships and honors programs promoted a science researcher role-identity. Participants of both programs identified with it the most. Women were more often in honors programs (compared with REUs) and in life sciences (compared with physical sciences or engineering), and had slightly fewer relationships based on their research activities. African American students had more negative science career attitudes and Hispanics most often perceived that others expected them to pursue science careers. Our results help explain how undergraduate research experiences affect diverse students' identification with prospective science careers and suggest avenues to improve outreach research programs.

Strand 12: Educational Technology**Poster Session B**

4:15pm – 5:15pm, Río Mar Ballroom 6

B184. Augmented Reality Supports Instruction during Ecosystem Science Field Trips

Amy M. Kamarainen, New York Hall of Science, akamarainen@nysci.org

Shari Jackson Metcalf, Harvard University

Tina Grotzer, Harvard University

Chris Dede, Harvard University

ABSTRACT: The ability to understand ecosystems is richly enhanced by experiences in real environments. Yet, the real world can be a challenging learning environment, and can provide challenges for instruction. We studied whether using mobile devices with an augmented reality (AR) application could support instruction during field trip experiences. AR is an “immersive” interface utilizing mobile, context-aware technologies (e.g., smartphones), and software that enables participants to interact with digital information embedded within the physical environment. AR interfaces can provide contextualized, just-in-time instruction; self-directed navigation to information-rich hotspots; and feedback on student actions and responses. In the fall of 2011, we worked with three teachers, five classes and approximately 70 students to conduct a middle school science field trip curriculum, called EcoMOBILE, which integrated mobile broadband devices with AR capabilities. Teachers completed written surveys and a round-table discussion following the field trip curriculum. Teachers suggested the AR supported student independence and collaboration; it also supported class management during the field trip allowing the teacher to act as a facilitator assisting students who needed help. We present findings from these surveys and interviews indicating that AR can provide a powerful pedagogical tool that supports student-centered learning in outdoor environments.

B186. ConSOL: A Computer-Based Diagnostic Instrument Based on the “Two-Tier Multiple-Choice Test Items” Method

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Isabelle Harpin, Universite de Montreal

Caroline Cormier, Universite De Montreal

Alexandre Tremblay, Universite de Montreal

Andoni Garritz, Facultad De Quimica, UNAM

David F. Treagust, Curtin University

ABSTRACT: Alternative conceptions are of interest not only to Science Education researchers, but to all those concerned with effective science teaching. Several techniques have been used to identify and diagnose alternative conceptions; in particular, the “two-tier multiple-choice test items” method developed by Treagust (1988) is widely preferred due to its many advantages. However, this method had not yet been adapted to exploit the possibilities of an ICT application for its administration and analysis. Within the scope of a multinational project that looks into exploring and comparing conceptions among college students in Quebec, Mexico and Australia, we have developed an instrument that allows for a more refined administration and analysis than with the traditional paper-based version. After a brief explanation of the two-tier method, this presentation will discuss the bases for the development of the ICT-based instrument with some examples.

B188. Comparing Student Discourse and Actions while Experimenting with Physical and Virtual Manipulatives in Physics

Georgios A. Olympiou, University of Cyprus, olympiog@ucy.ac.cy

Zacharias C. Zacharia, University of Cyprus

ABSTRACT: The purpose of this study was examine how the experimental procedures/actions that students follow, as well as the discourse that takes place during experimentation, differ when the students experiment with PM or VM or a blended combination of PM and VM (PM&VM). In doing so, three instructional conditions were designed, each using one of the aforementioned means of experimentation, and implemented while experimenting in the domain of Light & Color. The participants of the study were 70 undergraduate students, out of which we randomly selected 22 of them and analyzed their video data for two of the experiments of the curriculum implemented. A total of 744 minutes of student conversations were analyzed. The data analysis involved the use of a coding scheme that resulted through open-coding from prior research (Author, 2012). The findings revealed that the different means of experimentation (PM, VM and

PM&VM), influenced in a different manner the experimental procedures/actions and the discourse that took place while students were experimenting. This implies that the selection of the means of experimentation is crucial for optimizing the procedures/actions that need to take place during experimentation and for establishing productive conversations among students that lead to understanding the scientific concepts under study.

B190. Individual Differences, Flow Experience, and Science Learning in Serious Educational Games

Rebecca Cheng, George Mason University, wcheng3@gmu.edu

Leonard A. Annetta, George Mason University

Richard Lamb, George Mason University

David B. Vallett, George Mason University

ABSTRACT: The continuous development and deployment of Serious Educational Games (SEGs; Annetta, 2008) for science learning becomes one of the approaches to strengthen the United States' STEM education and prepare workers for the 21st century skills (FAS, 2006). With over thirty years of digital game research, the topic of motivation and enjoyment continue to be the focus in the science education community. Playing digital games is a very personal experience and affects learning (Prensky, 2005). Flow model of optimal experience helps explained the intrinsic motivation of one's engagement in an activity. Understanding of individual differences in learners can ensure a close match between the science learning activities and the required outcomes. Understanding the role of flow in the process of learning offers promising directions for science education as well as educational game research. This study provides evidence that individuals' science interest and perceived video game experience correlate with flow while learning science through the two SEGs, Operation: Resilient Planet and Neuromatrix. Results also showed that there is statistically significant positive relationship between flow experience and science learning. Thus, the positive flow experience in SEGs can be used to trigger the attention and further inspired students' interest to learn science.

B192. Effects of SEG Design on Visuospatial Ability, 21st Century Skills, and STEM Career Selection

David B. Vallett, George Mason University, dvallet2@gmu.edu

Len Annetta, George Mason University

Richard Lamb, George Mason University

Rebecca Cheng, George Mason University

ABSTRACT: This study examines the interplay between visuospatial ability, 21st Century Skills, and interest in STEM careers in secondary students (n=558) sampled from five schools across two Mid-Atlantic states. An intervention with participants creating serious educational games and comparison of pre/post measures of all variables followed. Results indicate that there is a significant relationship between gender, ethnicity, and visuospatial ability, and a strong link between visuospatial ability and 21st Century Skills. A significant but weaker relationship is noted between visuospatial ability, 21st Century Skills, and interest in STEM careers; all variables are incorporated into a theoretical model. Examination of the results of the intervention indicate that visuospatial ability in lower performing groups can be improved through the design of virtual environments. Findings imply that improving learners' visuospatial ability could in turn improve 21st Century Skills and foster interest in STEM careers.

B194. Teacher-Centered Design: Improving a K-12 Science Curriculum and its Dashboard

Virginia W. Snodgrass Rangel, Rice University, Center for Digital Learning and Scholarship, vsr@rice.edu

Carlos Monroy, Rice University Center for Technology in Teaching and Learning

J. Reid Whitaker, Executive Director, Rice University Digital Learning and Scholarship CEO, STEMscopes

ABSTRACT: Though technology is changing the landscape of education and how students learn, there are still barriers that limit technology's potential impact on K-12 classrooms, including the gap between the purpose for which a technology or tool was designed and the way it is used in classrooms. This study has two goals: to document and discuss the roles science teachers play in revising and improving one particular K-12 science curriculum program and data dashboard, and second, to uncover how teachers use, perceive their use, and feel about the curriculum and dashboard, and to compare patterns of use across different kinds of teachers and schools. This study uses a mixed methods design to investigate X-STEM, an online K-12 science curriculum. The qualitative component comprises interviews with teachers about their use of the curriculum and dashboard, and the quantitative component consists of a survey and an analysis of teachers' actual use of the website. Interview data will be coded using a priori and emergent themes, and quantitative

data will be analyzed through the development and comparison of user profiles. The findings will have implications for the development of science curriculum and for future analysis of online curriculum programs.

B196. *Exploring Virtual Worlds: Causal Understanding and Data-Collection Behaviors in an Ecosystems-Based Multi-User Virtual Environment*

Tina Grotzer, Harvard University
Michael S. Tutwiler, Harvard University
Shari J. Metcalf, Harvard University
Amy M. Kamarainen, University of Wisconsin
Chris Dede, Harvard University

ABSTRACT: Student behavioral data from a spring 2011 quasi-experimental study will be analyzed with longitudinal (multi-level model for change) methods. We hypothesize that student prior understanding of complex causal systems will affect their data collection behaviors in the EcoMUVE, an ecosystems-based multi user virtual environment (MUVE). Findings will illuminate the role that prior causal understanding plays on student behavior within the virtual world. Full results and discussion will be presented in the final paper.

B198. *Effects of Controlled Experimentation and a Problematized Narrative on Learning Outcomes in a Chemistry Simulation*

Susan M. Letourneau, New York University & CUNY, susan.letourneau@nyu.edu
Anna G. Brady, New York University
Catherine E. Milne, New York University
Jan L. Plass, New York University
Bruce D. Homer, CUNY Graduate Center
Trace Jordan, New York University
Ruth Schwartz, New York University

ABSTRACT: Our laboratory has examined the effectiveness of narrative introductions in guiding students' explorations of computer-based chemistry simulations. In the current study, we tested the hypothesis that engendering a need-to-know (known as "problematizing") leads to improved learning outcomes by encouraging students to interact with open-ended simulations. Ninety-six students from two urban high schools were randomly assigned to use a chemistry simulation that contained either a narrative or problematized introduction. Students explored the simulation in their chemistry classrooms while process data (a computerized log of each student's interactions with the simulation) was recorded. Visual examination of students' process data revealed several patterns of behavioral activity. By coding and quantifying these behavioral events, we found that students who observed the problematized introduction engaged in more productive experimentation with the simulation overall and that students who conducted multiple controlled experiments in a row showed improved learning outcomes across groups. This indicates that systematic experimentation that impacts science learning can be revealed using process data. Furthermore, exposure to the problematized narrative limited the amount of unproductive exploration. These results suggest that students' behavioral activity patterns in open-ended, computer-based learning environments can be influenced through the presentation of carefully constructed narratives.

B200. *Multiple Representations, Collaboration and Student Reasoning: Designing Online Environments for Learning About Global Heat Transfer*

Florence R. Sullivan, University of Massachusetts, Amherst, fsullivan@educ.umass.edu
Christopher N Hill, Massachusetts Institute of Technology
Richard Adrion, University of Massachusetts, Amherst
Nat Turner, University of Massachusetts, Amherst
David Hart, University of Massachusetts, Amherst

ABSTRACT: The purpose of this pilot study was to investigate student learning of physics principles related to the phenomena of global heat transfer through the use of an electronic integrated book (EIB) that featured video, animations and a virtual experiment. The theoretical basis for our design and development of the Global Heat Transfer EIB unit is cognitive flexibility theory (Spiro, Coulson, Feltovich & Anderson, 1994). We sought, through the design and

development of a primarily visual and visually interactive online environment, to examine how students make sense of multiple visual and interactive representations of the physics principles underlying global heat transfer. An important pedagogical aspect of the implementation of our curriculum unit was collaboration; students worked together in collaborative dyads to view, interact with and make sense of the various representations. A total of 49, primarily Latino/a, eighth grade students took part in the study. Pre-post tests of content knowledge revealed a statistically significant gain in student content knowledge related to convection and rotation $t(42) = -7.101$, $p = .000$. Preliminary analysis of videotaped, collaborative student interactions indicates that students use the various representations to reason about the phenomenon. Our presentation focuses on how students interacted with the various representations to construct knowledge.

Strand 13: History, Philosophy, and Sociology of Science

Poster Session B

4:15pm – 5:15pm, Río Mar Ballroom 6

B202. *Modeling Relationships among Aspects of the Nature of Science: Representing Co-Occurrences with Epistemic Network Analysis*

Erin E. Peters-Burton, George Mason University, epeters1@gmu.edu

ABSTRACT: The development of a scientifically literate citizenry requires teaching both concepts in science and how those concepts are discovered and validated. It has been suggested that investigations uncovering the way connections between aspects of the nature of science (NOS) are understood may lead to more effective ways of learning. This study attempted to reveal how teachers at different times in their careers connect aspects of NOS to make sense of the scientific discipline (co-occurrences). An epistemic network analysis (ENA) of pre-service and in-service teachers was used to interpret the ways NOS was framed. Data sources included VNOS-B instruments and follow-up interviews. Twenty four pre-service teachers demonstrated few connections ($n=66$) among aspects of NOS except for a strong connection between the empirical nature of science and habits of mind of scientists. Twenty-four in-service teachers discussed more co-occurrences ($n=100$) than pre-service teachers with highest frequencies of co-occurrences found with empirical/social, empirical/laws and theories, and empirical/habits of mind. In-service teachers also had tighter connections among the aspects of NOS than the pre-service teachers, indicating that with additional experience teachers could begin to connect more aspects of the nature of science to have a broader view of NOS.

B204. *The Depiction of the Phenomenon of Industrial Melanism in American Biology Textbooks*

Janice M Fulford, Western Michigan University, janice.m.fulford@wmich.edu

David W. Rudge, Western Michigan University

ABSTRACT: This poster shares an analysis of how the phenomenon of industrial melanism is portrayed in American college biology textbooks. Textbooks often state the phenomenon of industrial melanism as an excellent example of natural selection. Textbook accounts are often based on H.B.D. Kettlewell's research on the phenomenon in the peppered moth, *Biston betularia*. The phenomenon was introduced into textbooks in the early 1960's and was ubiquitous throughout the 1970s, 1980s and 1990s. Science educators support the use of the peppered moth story as an example of natural selection because its components are very relatable, but they make the case that textbook accounts fall short of the actual story. This research considers the inclusion of industrial melanism in textbooks from the 1960's to the 2000's. The analysis attempts to determine the limitations of the textbook accounts by considering how the science content and the scientific process concerning the phenomenon are portrayed. The research reveals trends in the amount of text devoted to industrial melanism, the level of detail used, and the use of index keywords referencing the phenomenon. The research also demonstrates how the representation of industrial melanism in textbooks has changed in the last fifty years.

B206. Stakeholders' Views on Scientific Literacy in Germany – Results from an International Delphi Study on Science Education

Theresa Schulte, Freie Universität Berlin, t.schulte@fu-berlin.de

Claus Bolte

ABSTRACT: Embedded in the European PROFILES project (Professional Reflection-Oriented Focus on Inquiry-based Learning and Education through Science), the German project partner at the Free University of Berlin (FUB) as well as 17 other partner institutions from different countries carries out a curricular Delphi study on science education, collecting and analyzing systematically in three consecutive rounds the views on desirable aspects of modern science education from different stakeholders involved with science or science education. Our poster informs about the German (FUB) results from the first and the second round. In the first round of the FUB Curricular Delphi Study on Science Education, the opinions of 193 stakeholders concerning motives, situations and contexts as well as topics, fields and qualifications were collected and analyzed. In the course of the qualitative analysis, a classification system with 88 categories of desirable science education was developed. The results of the quantitative analyses show general tendencies but also specific focuses of the different sub-sample groups. The results from the second round make clear which aspects are considered as especially important and how science educational practice is currently perceived. Especially the group of students features considerable findings.

B208. Science Research to Science Teaching: Developing Preservice Teachers' Knowledge and Pedagogy for NOS and Inquiry

Renee S. Schwartz, Western Michigan University, r.schwartz@wmich.edu

Cathy K. Northcutt, Western Michigan University

Gunkut Mesci, Western Michigan University

Susan Stapleton, Western Michigan University

ABSTRACT: How do preservice science teachers develop views and pedagogical abilities for nature of science [NOS] and scientific inquiry [NOSI] during a 13-month undergraduate professional development program? The program entails: (1) A 10-week science research internship; (2) Explicit/reflective NOS instruction, inquiry pedagogy, and support through group sessions and semester course; (3) a teaching practicum involving a 2-week science camp for middle school students. We tracked changes in participants over the 13 months as they went from science research to science teaching. Surveys and interviews targeting views of NOS, NOSI, and science teaching beliefs were collected in a pre/mid/post program format. Lesson plans, field notes, and video of classroom teaching were collected. Results indicate participants made progressive improvements in understandings of all targeted NOS/NOSI aspects. Results suggest that the background and career goal of the participant (science major/ college teaching versus education major/ secondary or elementary level) may relate to the extent of growth seen over the program. Teaching views shifted from teacher-centered/fact-based to valuing a student-centered/ inquiry-based style. Challenges persisted in putting views into practice, with high demands for modeling and feedback to address issues of management, language, and resources. NOS/NOSI were not given high priority during these first teaching attempts.

Strand 14: Environmental Education**Poster Session B**

4:15pm – 5:15pm, Río Mar Ballroom 6

B210. Epistemic Contributions to Students' Autonomous Socioscientific Actions

John Lawrence Bencze, University of Toronto, larry.bencze@utoronto.ca

Mirjan Krstovic, Peel District School Board

ABSTRACT: Many jurisdictions have urged educators to engage students in decision making regarding socioscientific issues — such as debates about climate change. Scholars argue, however, that students also need to take socio-political actions — such as lobbying of power-brokers — to address issues. Experience indicates, however, that such a tack in formal schooling often meets structural barriers. There is, however, evidence to suggest student motivation to act can be enhanced when they self-direct research they use to inform their actions. In the study reported here, we concluded — based on constant comparative analyses of qualitative data — that, in addition to be engaged in apprenticeship

activities, involving students in (implicit and explicit) cycles of reflections on the nature of research ('science') and actions ('technology') and possible application of such reflections in action project work, can increase students' expertise and motivation for self-directing research-informed actions on socioscientific issues. In essence, increases in student autonomy in research-informed actions can arise from increases in their levels of shared epistemic agency. Implications for promotion of socio-political actions through school science are discussed.

B212. Secondary Science Teachers' and Students' Climate Change Conceptions and Teachers' Climate Change Teaching Practices

Benjamin C. Herman, University of South Florida, bcherman@usf.edu

Allan Feldman, University of South Florida

Vanessa Vernaza-Hernandez, University of South Florida

ABSTRACT: The Coastal Areas Climate Change Education (CACCE) Partnership focuses on helping educators, students, and the public understand the interrelation among the natural environment, built environment, and social aspects in the context of climate change in coastal regions. Among CACCE's objectives include assessing the current state of climate change literacy in Florida and the Caribbean, and working with science educators to more effectively facilitate coastal climate change education, mitigation, and adaptation. These objectives are met in part by CACCE survey efforts that reveal Florida (N=145) and Puerto Rico (N=476) secondary science teachers hold many naïve views about climate change and climate change science and provide inadequate instruction about climate change. Similarly, CACCE survey efforts show that Florida secondary marine science students (N = 477) hold many naïve views about scientists' claims about climate change and the nature of climate change science. In response to these survey findings, the CACCE partnership has worked to help secondary science teachers and students become more informed about climate change and climate change science. In this session, we will present CACCE's survey results and climate change education efforts.

B214. Fostering Transfer of Ecosystem Concepts

Yawen Yu, Rutgers, The State University of New Jersey, yawen.yu.tranquil@gmail.com

Cindy E. Hmelo-Silver, Rutgers University

Suparna Sinha, Rutgers University

Catherine Eberbach, Rutgers University

Rebecca Jordan, Rutgers University

ABSTRACT: An important goal in learning about systems is for students to take ideas they learn in one system and apply it to related systems. This study examines to what extent students transferred their knowledge from one ecosystem—aquatic system to another unfamiliar system—rainforest system after participating in a technology-rich inquiry curriculum. We coded students' drawings for components of important ecosystems concepts. We examined the extent to which each of the drawings showed evidence of understanding of photosynthesis, respiration and decomposition. The results demonstrate that students gained more on aquatic systems (the learning measure) than the rainforest (the transfer measure), but they also made significant gains on the rainforest from pre to post test, suggesting that students transferred some knowledge from one system to another. Further research needs to understand how design principles and the use of conceptual representations affect learning and transfer.

B216. Understanding Attitudes Towards Nature and Sustainability Among Students at an Urban Community College

Christina P. Colon, Kingsborough Community College, christina.colon@kbcc.cuny.edu

ABSTRACT: The degree to which urban community college students feel connected to nature and environmental issues before and after taking nature oriented class was assessed in this study. It was hypothesized that students who enrolled in either People and the Environment or Ecology courses would not only be more environmentally oriented than students taking other biology courses, but would show an increase in environmental attitudes and reported activism after taking one of these courses. Both hypotheses were supported by the data. Control students who enrolled in General Biology (n=46) were significantly less environmentally oriented on six out of 46 questions, and an additional five questions approached significance, all trending towards being less "green". Analysis of Pre and Post semester questionnaires for students in the experimental groups (n=56) revealed that students showed a significant increase in environmental concern on five questions. Students reported an increase in the extent to which they notice nature, were concerned about deforestation, the amount of time they talk to family or friends about the environment, and frequency

with which they call politicians, and voice their concern in letters to the editor of publications. An additional seven questions approached significance all indicating increased concern for the environment.

B218. *Getting Outside: Three Teachers' Stories of Using the Schoolyard for Elementary Teaching*

Kelly Feille, Texas Christian University, k.k.nelson@tcu.edu

ABSTRACT: This naturalistic study addresses the experiences of three teachers who use a schoolyard garden to teach their students. Using a narrative approach, the teachers' stories are shared and layered together revealing thematic similarities and differences. Together, they reveal some insights into using the schoolyard as a component of teaching. Their stories describe a community of mentors and leaders who provide the opportunity for teachers to see successes (and failures) and gain the skills and confidence needed to take their students out, letting nature be their inspiration and their guide.

B222. *Students' Emotions in a Climate Change Course*

Elizabeth Hufnagel, Penn State University, exh5064@psu.edu

ABSTRACT: The purpose of this study is to examine ways that elementary teacher education students responded to emotion-eliciting prompts regarding the science and consequences of climate change. Because emotions arise from a given context and therefore represent social practices, emotions are one way to understand how science classroom norms shape students' connections to and ownership of this socioscientific problem. What emerged from the students' writing was a general lack of emotive writing. When students did write about their emotions, they did so by distancing themselves from not only emotions but also climate change. These findings are in contrast to how students wrote about teaching, whereby students were overwhelmingly forthcoming about their emotions. Consideration of emotion in student learning contexts provides insight into why students may (or may not) take action on the issue.

B224. *Spatial Understanding as a Means to More Sustainable Decision Making*

Heather J. Skaza, University of Nevada-Las Vegas, heaska77@gmail.com

Kent J. Crippen, University of Florida

Cindy L. Kern, University of Nevada, Las Vegas

ABSTRACT: Humans do not behave well toward the environment. Most are limited in their ability to connect their actions to the associated environmental impact. One hypothesis for this disconnect is a limited ability to use perceivable spatial characteristics and prior knowledge to understand impact beyond immediate surroundings. Computer simulation may provide the tools to increase spatial skills. This work reports on a literature synthesis that was conducted to answer two questions. First, looking across the content and timeline of learning in the sciences, what implied meaning exists for the concept of spatial thinking? Also, what role might spatial understanding play in our comprehension of environmental issues? The literature contains three broad categories of spatial thinking: spatial thinking at microscopic and mesoscopic scales, spatial thinking at macroscopic scales and understanding of scale itself. The research presented here describes how each of these ways of thinking might affect factors already demonstrated to have an impact on sustainable behavior. A proposed simulation-based curriculum to increase spatial thinking ability is also described.

Strand 15: Policy

Poster Session B

4:15pm – 5:15pm, Río Mar Ballroom 6

B226. *Failure: The Next Generation - Why Rigorous Standards are Not Sufficient to Improve Science Learning*

Mary A. Bair, Grand Valley State University, bairma@gvsu.edu

David E. Bair, Grand Valley State University

ABSTRACT: Although improving science education is a national priority in the United States, there are mixed findings regarding the effectiveness of policies that mandate college preparatory curriculum for all students. In this ethnographic case study we examine the experiences of one high school in Michigan when they implemented a policy mandating college preparatory science curriculum for all high school students. We found that requiring science for all students did not lead to improved student outcomes at this school, especially for students historically underrepresented in STEM

fields. On the contrary, in 2012, only 5% of African American students at this school were found to be proficient in the state science assessments. Our findings support what others have found; that raising standards and requiring students to take challenging courses is not sufficient to improve learning in science. We found that, although guided by good intentions, school staff did not take into account how the interaction between organizational structure, curriculum design, and instructional strategies affected students' opportunities to learn. Consequently, many of the changes they adopted were ad-hoc changes aimed at getting quick results, not long-term adjustments. Our findings suggest the need for additional resources for the people engaged in implementing policy.

B228. *Aligning Science Learning Progressions and the Common Core State Standards for Mathematics*

Tara T. Craig, The University of Texas at Austin, tara.craig@utexas.edu

Cesar Delgado, University of Texas at Austin

ABSTRACT: Learning progressions (LPs) describe the way students construct expert understanding of a core idea in science over a period of several years. LPs for a variety of big ideas have been developed for grades k-14, and are influencing the next generation science standards currently under development. Mathematics is a fundamental tool for science, and the new Common Core State Standards for math have been adopted by 45 states. This paper examines the alignment between eight published LPs for science and these math standards, in terms of math. Lack of alignment will result in teachers having to teach science topics to students that require math that has not yet been taught. A content analysis was conducted on the eight LPs, and the math identified was mapped onto the math standards. Instances of misalignment were found in some of the LPs, while others were aligned and yet others required no math. Possible solutions are explored and discussed, including delaying science instruction, modifying science instruction, adding key mathematical areas like statistics and measurement to the science curriculum, and revising the math standards for these key areas. This paper aims to contribute to the development of a more coordinated STEM curriculum.

Monday, April 8, 2013**Concurrent Session #7****8:30am – 10:00am****Administrative Sponsored Session*****Symposium - Developing a More Socially Responsible STEM Education through Community Engagement: Impact of NARST's First LSEP***

8:30am-10:00am, Pelican Room

Presider: Mei-Hung Chiu, National Taiwan Normal University**Presenters:**

Astrid T. Sinnes, Norwegian University of Life Sciences, Ås, Norway

William C. Kyle, Jr., University of Missouri - St. Louis

Mercy Kazima, Chancellor College, University of Malawi

Franci Schabort, Norwegian University of Life Sciences, Ås, Norway

Alice Saite, Mzuzu University, Malawi

ABSTRACT: In 2008, NARST's first LSEP supported the development of research capacity in Malawi as part of a larger project (Project SUSTAIN). Project SUSTAIN's goals were oriented toward community development and social transformation. Since that time, 8 PhD and 10 Master's students from Malawi, South Africa, and Zambia completed degrees within the scope of the project. This symposium highlights three examples of action research initiatives that have engaged with pupils, teachers, school leaders and local communities to transform STEM education from rote learning to a more engaging and socially responsible experience in terms of empowering pupils to transform their environment and improve their lives. By building capacity among science educators / researchers, Project SUSTAIN aimed to generate knowledge, research practice and methodologies that explored and promoted the development of and access to a more socially responsible STEM education. The symposium will summarize highlights of the 5-year project from conceptualization to the final workshop, held in Malawi in January 2012, in which stakeholders from the education and policy sector of Malawi were invited to participate actively in the workshop and offer feedback on the research endeavors of the students. Recommendations for future capacity building initiatives in sub-Saharan Africa will be offered.

Strand 1: Science Learning, Understanding and Conceptual Change***Tracing Conceptual and Computational Thinking in Technology-rich Instructional Interventions***

8:30am-10:00am, Río Mar Salon 1

Presider: Pratim Sengupta***Development of High School Students' Understanding of How Objects Interact Using Computer-Based Materials***

Jane J. Lee, Michigan State University, leejaney@msu.edu

Steven McGee, North Western University

Jennifer Duck, The Learning Partnership

Joseph S. Krajcik, Michigan State University

ABSTRACT: The purpose of this study is to investigate how high school students develop their understanding of how objects interact using computer-based material. The study took place in two high schools—one urban and one suburban over a two-week period. Four chemistry classes, five physical science classes, and two physics classes participated in the study (n=223 students). To explore how students' explanations of electrostatic phenomena and understanding of electrostatic principle change, we collected all open-ended response from each student and coded them based on the conceptual category we developed. The result shows that students' understanding about electrostatic interactions statistically improved when they finished all of the investigations in the material. Students tend to understand and apply

the principle better when they have opportunity to learn other related principles in series. Therefore, gradual integration and clear connections between a set of related ideas within the material may have helped students to make meaningful progress. This study can provide information about the challenges of connecting the simulation and hands-on experience as well as the effectiveness of it.

Tracing Learning Trajectories for Understanding Ecosystems

Catherine Eberbach, Rutgers University, catherine.eberbach@gse.rutgers.edu

Cindy E. Hmelo-Silver, Rutgers University

Suparna Sinha, Rutgers University

Rebecca Jordan, Rutgers University

ABSTRACT: This is a study about how middle school students develop an increasingly coherent understanding of aquatic ecosystems. As part of a broader design research program, we coded and analyzed 32 middle school student drawings of aquatic environments collected before, during, and after a technology-rich instructional intervention (n=125 drawings). Coding considered multiple dimensions: relations (macro/micro, biotic/abiotic, structure-behavior-function) as well as coherence, and extraneous structures. Findings suggest that the ability to observe phenomena at multiple macro/micro and biotic/abiotic levels may be an underlying constraint to also observing integrated structure-behavior-function relations and the development of a more coherent understanding of ecosystems. Students may follow multiple non-linear trajectories towards an increasingly coherent understanding of ecosystems.

An Integrated Approach for Learning Kinematics and Developing Computational Thinking in Elementary Grades

Amy V. Farris, Vanderbilt University, amy.voss@Vanderbilt.Edu

Pratim Sengupta, Vanderbilt University

Gokul Krishnan, Vanderbilt University

Amanda C. Dickes, Vanderbilt University

Kara Krinks, Vanderbilt University

ABSTRACT: Integrating computational modeling and programming with learning and teaching physics is a non-trivial challenge for educational researchers. In this paper, we describe a worked-out example of the productive integration of an agent-based programming and modeling environment called ViMAP (Sengupta & Wright, 2010) with kinematics content knowledge (e.g.: acceleration as a process of continuous change in speed). We report a study conducted with 3rd and 4th grade students which demonstrates that they were able to develop a) deep conceptual understandings of kinematics and b) relevant programming and computational modeling practices, as evidenced in an in-depth case study (Yin, 1994) and the comparison of pre- and post-test responses. We view this integrated approach to the teaching of modeling, computer programming, and physics as appropriately reflective of the intertwined nature of scientific knowledge with the tools and representational practices of science (Lehrer & Schauble, 2000; Nercessian, 1992).

Conceptual Change in Physics through Use of Digital Games

Kara Krinks, Vanderbilt University, kara.krinks@vanderbilt.edu

Pratim Sengupta, Vanderbilt University

Amanda C. Dickes, Vanderbilt University

Amy V. Farris, Vanderbilt University

Gokul Krishnan, Vanderbilt University

ABSTRACT: Research has demonstrated that well-designed games can effectively scaffold student learning. However, games for learning, especially in the domain of physics, have barely explored how the process of conceptual change occurs during game play; rather the emphasis has been on showing the effectiveness of games by showing pre-post gains. This study investigates the process of knowledge construction in students as they play a digital game based on Newtonian mechanics by using the microgenetic method. Grounded in the knowledge in pieces perspective, we identify conceptual resources that are activated during each level of game play and analyze how these resources get reorganized toward more expert-like thinking about the relevant physics concepts as students progress in their game play. We show that the situated nature of digital physics games can enable students to refine their intuitive physics ideas and construct more accurate understandings of physics concepts.

Strand 2: Science Learning: Contexts, Characteristics and Interactions***Gender-Related Issues and Science Learning***

8:30am-10:00am, Río Mar Salon 10

Presider: Miia Rannikmaa*Gender and Grade Differences in Elementary School Science Students' Engineering Identity Development*

Ji Hyun Yu, Purdue University, yu45@purdue.edu

Brenda Capobianco, Purdue University

Brian French, Washington State University

ABSTRACT: The integration of engineering concepts and practices into elementary science education has become an emerging concern for science educators and practitioners, alike (NRC, 2012). Moreover, how children, specifically pre-adolescents (grades 1-5), engage in engineering design-based learning activities may help science educators and researchers learn more about children's earliest identification with engineering. Research points to self-concept differences among students of different ages and genders pursuing career paths involving the sciences, technology, and engineering (Monhardt, 2000). The purpose of this study was to examine the extent to which engineering identity differed among pre-adolescents across gender and grade. Five hundred and fifty pre-adolescent participants completed the Engineering Identity Development Scale (EIDS), a recently developed and validated measure that characterizes children's conceptions of engineering and potential career aspirations. Confirmatory factor analyses showed adequate fit with the previous two-factor structure as suggested by Author et al. (2012) in which the EIDS reflected two factors, such as Academic and Engineering Career subscales. Results indicate that elementary school students' scores in engineering identity change were lower for older pre-adolescents; specifically first graders showed higher gains in EIDS scores, while fifth graders showed significantly lower gains and even declines.

'Whatever You Do, You will Never get them to Work'; Male Students in Physics

Alice Cottaar, Eindhoven University of Technology, a.cottaar@tue.nl

ABSTRACT: The notion of 'effortless achievement' in male students is quite persistent and in this paper it is shown that (Dutch) physics education reinforces rather than challenges this notion. Laddishness still seems to pay off as male students achieve more in physics than comparable female students, while they put much less effort in the subject. Two large scale nationwide surveys are conducted measuring achievement, engagement and work attitude in high school physics and achievement in the freshman year at university in science related fields of study. The data show practically no evidence of correlations between the measured work attitude and achievement and sometimes the benefits only show later on at the university. The relationship between work attitude and perceived understanding during the lessons is often negative, in the sense that students only start to work when they really do not understand. In order to counteract the reinforcement of the idea of 'effortless achievement', students with low potential (high interest; low understanding) benefit from a lot of teacher support so their efforts will be more often rewarded; while students with high potential (high understanding but lower interest) would benefit from challenging lessons they do not always understand.

The Influence of Context on Success Summer Research Experiences in the SETGO Program

Tracy L. Huziak-Clark, Bowling Green State University, thuziak@bgsu.edu

Moiria Van Staaden, Bowling Green State University

ABSTRACT: After four years of evaluation of the SETGO summer research program (SSR) it has become apparent that the context of the laboratory setting in both size and gender of the faculty member has an impact, especially on female students. Three case studies of multiple laboratory contexts are presented with specific findings about self-confidence, level of enthusiasm, and retention addressed. Mentoring is essential regardless of context and gender. Mentoring for the SSR was critical for student success. All of the SSR students reported success in working with their mentors. Many cited, weekly meetings, one-on-one training, and even critical thinking questioning as the keys their relationships with their mentors

Inquiry Based Science and Technology Enrichment Program: Green Earth Enhanced with Inquiry and Technology

Hanna Kim, Northeastern IL University, hkimdepaul@gmail.com

ABSTRACT: This study investigated the effectiveness of a guided inquiry integrated with technology, in terms of female middle-school students' attitudes toward science/scientists and content knowledge regarding selective science concepts (e.g., Greenhouse Effect, Air/Water Quality, Alternative Energy, and Human Health). Thirty-five female students who were entering eighth grade attended an intensive, one-week Inquiry-Based Science and Technology Enrichment Program (InSTEP) which used a main theme, "Green Earth Enhanced with Inquiry and Technology." We used pre- and post-attitude surveys, pre- and post- science content knowledge tests, and selective interviews to collect data and measure changes in students' attitudes and content knowledge. The study results indicated that at the post-intervention measures, participants significantly improved their attitudes toward science and science-related careers and increased their content knowledge of selected science concepts ($p < .05$).

Strand 2: Science Learning: Contexts, Characteristics and Interactions***Related Paper Set - Exploring Students' Reasoning Around Models in Earth Science***

8:30am-10:00am, Caribbean Salon 2

Discussant: Christina V. Schwarz, Michigan State University

ABSTRACT: Developing robust understandings of Earth System phenomena and processes is important yet challenging for both scientists and students. Building from a three-tiered construct describing students' analogical reasoning between models and the Earth System, we describe our two-year investigations of the ways that 8th and 9th grade students apply insights gained from working with dynamic physical models to understand and reason about processes of the full-scale Earth System. The four related papers describe multiple dimensions of the project: the design and analysis of written assessments associated with the construct across topics; insights gleaned from student interviews about reasoning across different representations; identification of emergent science practices in classrooms facilitated by model use; and a proposed framework for instructional design building from this work. Together, we present compelling evidence for deliberate consideration of the role of physical models and associated pedagogical strategies in instruction to support effective science learning.

Measurement of Analogical Reasoning Around Earth Science Models

Ann E. Rivet, Teachers College Columbia University, rivet@tc.columbia.edu

Kim Kastens, EDC

Mariana Schmalstig, Teachers College Columbia University

Investigating Variations in Students' Analogical Reasoning between Visual Representations and Earth Data

Cheryl A. Lyons, Teachers College Columbia University, cal2154@columbia.edu

Ann E. Rivet, Teachers College Columbia University

Emergent Science Practices Around Physical Models in Earth Science

Alison R. Miller, Teachers College Columbia University, mar2218@columbia.edu

Ann E. Rivet, Teachers College Columbia University

Students' Use of Physical Models to Experience Key Aspects of Scientists' Knowledge-Creation Process

Kim Kastens, EDC, kastens@ldeo.columbia.edu

Ann E. Rivet, Teachers College Columbia University

Discussion: Exploring Students' Reasoning Around Models In Earth Science

Christina V. Schwarz, Michigan State University, cschwarz@msu.edu

Strand 5: College Science Teaching and Learning (Grades 13-20)***Impact of STEM on Student Success***

8:30am-10:00am, Parrot Room

President: Mercy Oqunsola-Bandele***Increasing Student Performance in Large Lecture STEM Courses: A Team Approach to Successful Learning***

Kate Popejoy, University of North Carolina at Charlotte, kate.popejoy@uncc.edu

Kathryn Asala, University of North Carolina at Charlotte

ABSTRACT: High failure rates in introductory college chemistry courses have been of concern for many years. At our large, urban, southeastern US university, we have implemented a Peer-Led Team Learning (PLTL) approach in our Principles of Chemistry I course (185 students per section). This large-lecture model has proved to be ineffective at reaching a significant percentage of students, as indicated by the approximately 50% D, F, or W rate each semester (a rate similar to other universities). The large DFW rate increases faculty cost as additional sections must be offered to accommodate repeating students, diminishes retention of undergraduate majors in STEM disciplines and likely impacts students' self-esteem and motivation. As professors of science education (college of education) and chemistry (college of liberal arts & sciences), we wanted to find alternative approaches for actively engaging students in the course material and increasing students' mastery of concepts and problem-solving skills, and designed a PLTL approach. Thus far, our Team Approach to Successful Learning (TASL) has demonstrated statistically significant success as shown through an increase in the percentage of students passing the course in our initial implementation.

STEM Migration, Retention and Graduation Patterns within a Public University System

Erin D. Knepler, University System of Maryland, eknepler@usmd.edu

Nancy S. Shapiro, University System of Maryland

David May, University System of Maryland

ABSTRACT: According to estimates, less than half of students intending to major in STEM fields graduate with a STEM degree; more than a third leaves between the freshman and sophomore year. These figures can grow considerably higher for specific demographic groups and in certain STEM disciplines. As a result, the nation is not producing the diverse STEM education pipeline and workforce it needs to compete. The Bureau of Labor Statistics projects that the STEM workforce will be among the fastest growing in coming years and will require higher levels of education and training than other sectors. While this accelerated growth provides an opportunity to tap new sources of talent, the most rapidly growing segments are the least engaged in STEM. The University System of Maryland (USM) conducted a self-analysis of majors and migration patterns in STEM fields at four institutions to provide data on the flow of undergraduates, including such factors as race/ethnicity, gender, and field; and a framework for identifying the student groups and STEM disciplines most in need of intervention through the pilot work.

Utilizing Case-Based Learning in a Summer Pre-Freshman Bridge Program to Impact STEM Retention Rates

Drew Kohlhorst, Emory College, drew.kohlhorst@emory.edu

Patricia A. Marsteller, Center for Science Education Emory

ABSTRACT: Numerous reports call for universities and colleges to engage with local, regional and national school systems to improve the success rate of students transitioning to college especially in STEM disciplines. Programs vary widely depending upon the nature of the institution and the kinds of funding available. A recent NSF STEP grant has allowed us to develop a unique summer bridge program incorporating both residential and online instructional models using case-based learning; student tailored science writing and course advising workshops and guided self-assessment activities. While preliminary, our data indicates students (n=33) built core analytical and communication skills required to be successful in STEM while enjoying the diverse topics covered. We intend to build on this success to refine our bridge program and develop review materials which will be available to all incoming pre-freshman.

STEM Doctoral Student Professional Development in Teaching: Outcomes of a High-Engagement Program

Mark Urban-Lurain, Michigan State University, urban@msu.edu

Luanna B. Prevost, Michigan State University

Henry Campa, III, Michigan State University

ABSTRACT: Improving science instruction has been recognized as a national goal to enhance undergraduate STEM education. This need can be addressed by providing graduate students who are pursuing careers as faculty with professional development opportunities in teaching as well as research. For several years we have provided a year-long, high engagement program aimed at preparing STEM doctoral students for teaching and the expectations of an academic career. We assessed the outcomes of the program by conducting a survey of three cohorts of participants. Students report improved teaching and communication skills, along with increased confidence in their ability to secure future faculty roles. The program helped students confirm their interest in a teaching career and opened up new career options for some participants. Our findings suggest that this model can be successful for preparing new STEM faculty with the skills to be effective teachers.

Strand 6: Science Learning in Informal Contexts

Novel Methods for Studying Informal Learning

8:30am-10:00am, Sea Gull Room

Presider: Erika D. Tate

Investigating Students' Interest in Chemistry by Using their Self-Generated Questions

Betul Demirdogen, Middle East Technical University, dbetul@metu.edu.tr

Gultekin Cakmakci, Hacettepe University

ABSTRACT: This study investigated Turkish students' (over 14 year old) interest in chemistry by analyzing their 1027 self-generated chemistry-related questions, which were submitted to a popular science magazine. These questions were classified as the field of interest, cognitive level of the question, and motivation for asking the question. The results demonstrated that boys asked overwhelmingly more questions than girls in an informal learning environment. However, overall there was no significant difference between females and males in field of interest, type and order of the information requested, and motivation for asking the question categories. Students seemed to mostly ask questions about states of matter and solutions and nuclear chemistry and chemistry of the elements. Most of the students interested in one variable and asked for the properties of that variable. Moreover, while males were more interested than females in comparison, causal relationship, methodological information, prediction, open-ended, and general request for information, females were more interested than males in properties, factual, and explanatory types of information. There was no gender difference in the motivation for asking questions; however, students overwhelmingly asked spontaneous questions than school-related questions. Implications of students' self-generated chemistry questions for science curriculum reform and teaching are discussed in this paper

The Half-Life of a 'Teachable Moment': The Case of Nobel Laureates

Ayelet Baram-Tsabari, Technion - Israel Institute of Technology, ayelet@technion.ac.il

Elad Segev, Tel Aviv University

ABSTRACT: Some science-related events stimulate public interest, and create a teachable moment in which the underlying science temporarily becomes more interesting. Here, media attention, expressed by Google News reference volume, and changes in information seeking behavior, expressed by Google Insights for Search, were used to estimate the length of a teachable moment for 2004-2011 Nobel Prize announcements. On average, Nobel Prize announcements attracted the attention of online users for no longer than a week. News coverage declined slower and occasionally displayed seasonal trends. A closer look at the 2011 Nobel Prize announcements revealed over 50% drop in searches between the day of the announcement and the following day, as well as an analogous pattern for the news coverage of all laureates with different amplitude for different disciplines. Results point to the affordances of using publicly available online data to identify the most effective teachable moments relating to science and their length.

From Mouths to Minds: Student Problem-Solving Conversations at an Aquarium

Joy Kubarek-Sandor, John G. Shedd Aquarium, jkuba@sheddaquarium.org

Gorjana Popovic, Illinois Institute of Technology

ABSTRACT: Science learning in informal contexts, including sites such as zoos, aquaria, and museums, provide a unique venue for students to engage in real-world problem-solving outside the context of their classroom. For these sites to contribute toward developing scientifically literate individuals, we must bridge research and practice and better

understand the complexities of learning occurring at such sites. Therefore, it is essential to investigate what types of conversations students, and for that matter any group of visitors, have around science and math. The objectives of this study were multiple: 1) to identify occurrences of students engaged in problem-solving in an informal learning environment, 2) to characterize the nature of these conversations around problem-solving, and 3) to test the feasibility of a new data collection tool as well as approach to analysis. To meet these objectives, student conversations were captured using the LiveScribe® Pen and further analyzed for instances of problem-solving. The findings of the study provide insight to the nature of student conversations when problem-solving and validate the potential applicability of the LiveScribe® Pen. Additional emergent findings raised further questions about factors influencing student learning in informal settings.

Motivating Factors that Lead to Participation in an Urban County-Level Science Fair

Penny L. Hammrich, Drexel University, plh33@drexel.edu

Kathleen A. Fadigan, Pennsylvania State University

David M. Majerich, Georgia Institute of Technology

ABSTRACT: The National Science Education Standards' vision "requires that students combine processes and scientific knowledge as they use scientific reasoning and critical thinking to develop their understanding of science" (NRC, 1996, p. 105). Science fairs have tremendous potential to contribute to this vision by directly addressing the standard calling for the abilities necessary to do scientific inquiry. The science education research community knows little about science fairs. This study provides a detailed description of factors that motivate urban students to participate in a county science fair. A total of 246 students in grades 7-12 completed a 22-question survey during the city's annual science fair. Results indicate that learning new things, having fun, and preparing for the future are the top reasons that motivate students to participate in the science fair. Teachers, parents, and the students themselves are most frequently the individuals who provide the motivation or encouragement to participate. If the science fair experience indeed allows students to have fun while learning new things, then might it be inferred that their interest in STEM is maintained or even increased? In the long term, science fairs may have the potential to increase the next generation of youth who pursue STEM careers.

Strand 7: Pre-service Science Teacher Education

Understanding the Discursive Practices in Science Classrooms

8:30am-10:00am, Canary Room

Presenter: Asli Sezen

Pre-Service Teacher Science Discourses: Science as Practices Versus Science as Knowledge

Mohammad A. Basir, Oakland University, mohammad.basir@gmail.com

ABSTRACT: NRC (2012) has emphasized that science practices should not be reduced to experimental investigation with the expense of marginalizing other essential science practices. This study investigates how pre-service teacher Discourses including Science Discourses, SDs, Science Learning Discourses, SLDs, and Science Teaching Discourses, STDs, were utilized by pre-service teachers, and how the two perspectives of science as knowledge, versus practices mediated the mentioned discourses. The results of the study suggest that despite the emphasis of the methods course on science as practices, the pre-service teacher discourses is deeply mediated by the perspective of science as practices and has much more emphasis on experimental than communicational aspects of science practices such as argumentation. Furthermore, the results suggest that in the context of the science methods course aiming to change classroom discourse from science as knowledge to science as practices, the deeply rooted perspective of science as knowledge may lead the pre-service teachers to frame what they are doing in the class as effective teaching strategy rather than core practices of science. Accordingly they can be actively engaged with core science practices but still see science as knowledge.

Supporting Science Discourse Practices in Pre-Service Teachers

Imelda L. Nava, UCLA, inava@ucla.edu

ABSTRACT: This multi-year study examines discourse in pre-service science teacher classrooms by exploring the following, 1) how pre-service teachers enact and interpret discourse in the classroom, 2) how a teacher education

program can support pre-service teachers ability to enact discourse practices in urban secondary science classrooms. I use a classroom observation data, generated by a science classroom observation rubric focused on discourse and a discourse assignment that allows pre-service teachers to engage in specific classroom practices that focus on facilitating discourse and student learning. Preliminary results from classroom observation data suggest that the prevalence of discourse in the classroom is associated with science instructional task and the positive development of academic language. In the discourse paper reflections, students were challenged by various components of discourse interactions and the conditions that support discourse in the classroom, specifically, lack of academic language development and the lack of a social environment where academic risks are possible. In summary, I examine discourse in pre-service science teacher classrooms and how pre-service teachers interpret and facilitate classroom discourse over a number of cohort years and how teacher education programs can facilitate and support the development of discourse practices.

"Discovering Plate Boundaries in Data-Rich Environments": Supporting Pre-Service Teachers Involvement in Unique Practices Of Geosciences

Asli Sezen-Barrie, Towson University, asezen@towson.edu

Joel Moore

ABSTRACT: Plate tectonics is one of the core scientific concepts in both the NRC K-12 standards documents (#ESS2.B) and College Board Standards for Science (#ES.1.3). This study aims to help preservice teachers become involved in the practices of geosciences by using real data from four different fields (geography, geochronology, volcanology and seismology). We conducted an ethnographic case study of the process of learning by preservice teachers in a middle school science major at a mid-Atlantic University. The data for the study includes video and audio records of preservice teachers' learning processes as well as teachers' reflections about their learning Plate Tectonics by using real data. The video and audio data were compiled and synthesized into event maps and transcripts, which were necessary for sociolinguistic analysis. After compilation, event maps and transcripts were analyzed by using Discourse analysis. The findings of the project identified how preservice teachers' involvement in exercises with real data lead to a change in their conceptual, social and epistemic framing of the practices of geoscience. The interviews and reflections by teachers also pointed on challenges faced by preservice teachers learning Plate Tectonics using key scientific practices. The study has a significant impact by 'teaching the teachers' and empowering preservice teachers to overcome the challenges of the practices of geoscience such as reading maps and using argumentation in science classrooms.

Science Writing Heuristic: An Inquiry-Based Laboratory Approach to Promote Science Achievement in General Chemistry Laboratory

Jale Ercan, Gazi University, jaleercan@gazi.edu.tr

Hilal Yanis, Gazi University

Meltem Irmak, Gazi University

ABSTRACT: The aim of this study is to determine whether there is a correlation between science writing heuristic laboratory report and freshman pre-service science teachers' achievement in chemistry laboratory. The research question investigated in this study is: Is there a significant correlation between SWH laboratory report scores and achievement scores of freshmen pre-service science teachers? Correlational research design was used. The scores of 32 participants who enrolled in Gazi University in Turkey were used in data analysis after elimination of inappropriate data. The instruction based on SWH lasted ten weeks and ten experiments were carried out. At the end of the semester, an achievement test was implemented to assess the students' academic achievement in the topics covered during the semester. The achievement test was also analyzed according to the rubric prepared by the researchers. In order to analyze the data collected from SWH laboratory reports and achievement test, Pearson correlation test was conducted. The data were imported to PASW18 Predictive Analytics Software. the result of Pearson correlation test has revealed that there is a positive high correlation between the SWH laboratory report scores and achievement test scores of freshmen pre-service science teachers at $\alpha = .01$ with $r = ,686$, $p = ,000$.

Strand 7: Pre-service Science Teacher Education

Beliefs, Attitudes, and Perspectives on Science Teaching

8:30am-10:00am, Río Mar Salon 9

President: Todd Hunter, University of Texas at Austin

Promoting Activity Evaluation and Teacher Efficacy among Future Elementary Teachers Using the Science Teaching Toolkit

Joe Covert, North Georgia College & State University, jscovert@northgeorgia.edu

Paul Baldwin, North Georgia College & State University

ABSTRACT: In this presentation, we are reporting the results of the implementation of a new instructional intervention for pre-service elementary school teachers, called the K-5 Science Teaching Toolkit Checklist. This intervention was designed to increase the ability of pre-service teachers to evaluate and adapt widely available science instructional materials for use in classrooms. The current study focuses on work done with pre-service teachers taking an integrated science class for elementary school teachers, in which students evaluated and critiqued readily available science instructional materials based on the presence of a specific list of characteristics (vocabulary, hands-on/minds-on, observations/measurements, systematic recording of observations/measurements, and collaboration) within the activity. A qualitative analysis of written discussions was conducted and student changes in self-efficacy were tracked using the Revised Science Attitude Scale. A common trend noted in the analysis of student discussions was the need for more focused treatment of science vocabulary within the lesson. Overall, the RSAS results indicate a very positive change in self-efficacy over the course of the study.

Preservice Science and Social Studies Teachers' Perspectives on Science and Society: An Integrated Methods Course

Lisa A. Borgerding, Kent State University, ldonnell@kent.edu

Alicia Crowe, Kent State University

Andrew Hostetler, Vanderbilt University

Rajlakshmi Ghosh, Kent State University

ABSTRACT: Within the field of science education, several diverse approaches and lines of inquiry emphasize how science is impacted by and impacts society. These approaches/lines of inquiry include nature of science, science-technology-society, and socioscientific issues. Although all these perspectives emphasize interrelationships between science and society/culture, researchers from these diverse lines of inquiry have reported how preservice and inservice teachers struggle to teach science as a social/cultural enterprise. In this project, a novel combined science/social studies secondary methods course was developed to better prepare preservice teachers to integrate these disciplines. The present proposal documents how preservice secondary science and social studies teachers' ideas about interrelationships between science and society changed throughout this pilot integrated teaching methods course. The sample included six of thirteen students enrolled in the first iteration of the combined science/social studies methods course at a large Midwestern university. The data collection consisted of three interviews, document/artifact collection, and classroom field notes from the methods class. Data analysis employed a grounded theory approach wherein data were open-coded to develop emergent themes. Preservice teachers' made several connections between science and society and moved away from simplistic views of the disciplines of science and social studies being merely "different" or "the same."

The Effects of Course Instructions on Implementation of Assessment for Students' Learning and Pre-Service Science Teachers' Beliefs

Hye-Eun Chu, Nanyang technological University, hyeeun.chu@gmail.com

ABSTRACT: The aims of this research is to develop an effective Assessment for Learning(AforL) program for pre-service science teachers based on findings from investigation of how pre-service science teachers implement AforL during their practicum teaching and how their beliefs on assessment influence practicum teaching. A total of sixty pre-service science/physics teachers in PGDE (Post Graduate Diploma in Education) program participated in this research. The PGDE program aims to prepare university graduates to become secondary school teachers. Student teachers' answers from open-ended questionnaire in each group, a total 15 groups, was collected to investigate student teachers prior understanding related to AforL and individual reflection writing during practicum teaching were analyzed to identify student teachers AforL implementation in their teaching practices and their beliefs on AforL strategies. The findings indicated that student teachers prefer to implement AforL strategies related to constructive and inquiry based teaching

approach. However, they showed more negative beliefs on AforL when the teaching approach embedded with AFL include classroom discourse. It implies that the AforL program should be redesigned based on the local contexts.

Improving Preservice Elementary Teacher Attitudes Towards Science: A Comparison of Informal and Formal Field Experiences

Gail L. Dickinson, Texas State University, dickinson@txstate.edu

ABSTRACT: Little research has been done to examine how informal field placements affect preservice teachers' views of content and pedagogical content knowledge. This mixed methods study compares the effects of field experience in formal and informal settings on undergraduate preservice teachers' attitudes towards learning and teaching science. Pre and post Colorado Learning Attitudes about Science Surveys were analyzed using paired t-tests and ANCOVA and emergent coding was used to analyze guided teaching reflections. There were no significant between group differences on the CLASS however both groups exhibited significant within group increases in CLASS scores on the post test. Teaching reflections in the informal field group focused on a wider variety of issues suggesting the need to process the unfamiliar environment.

Strand 8: In-service Science Teacher Education

Experiences of Teachers in the Induction Years

8:30am-10:00am, Río Mar Salon 4

Presider: Huseyin Colak

Beginning Teachers' Use of Video Annotation in an Online Teacher Induction Program

Gillian Roehrig, University of Minnesota, roehr013@umn.edu

Barbara Billington, University of Minnesota

Joshua Ellis, University of Minnesota

Justin McFadden, University of Minnesota

Tasneem Anwar, University of Minnesota

ABSTRACT: In this presentation, we will explore how an online induction program promotes reflection on classroom practices for beginning secondary science teachers through the use of video annotation tools that allow teachers and mentors to reflect directly on classroom practices. Until recently, developers of online mentoring programs have used lesson plans as a proxy for direct observations of classroom practice. However, recent developments in video annotation methods and tools make the use of video for examining and improving reflective practices increasingly viable within online environments. Through the strategic development and use of video annotation tools, our beginning teachers' reflections on their classroom teaching are linked directly to evidence through video as documentation. Using the Learning to Notice Framework of van Es and Sherin (2002), we analyzed the annotations of beginning science teachers enrolled in the induction program. Over 100 annotations were analyzed and the following themes were found to be illustrative of the issues on which beginning teachers chose to reflect: Starting a lesson, wrapping up a lesson, connecting to learning goals, classroom management, groupwork, questioning, and checking for understanding.

Beginning Secondary Science Teachers' Laboratory Practices: A Five-Year Study

Sissy S. Wong, University of Houston, sissywong@uh.edu

Jonah B. Firestone, Washington State University-Tricities

Julie A. Luft, University of Georgia

Charles Weeks, Arizona State University

EunJin Bang

ABSTRACT: This research study examined the frequency and types of laboratories beginning secondary science teachers (N=61) implemented during their first five years in the classroom. This study explored the laboratories the teachers implemented by level of inquiry, science discipline, grade level (middle vs. high school), class schedule (traditional vs. block), technology use, and type of induction program the teachers participated in. Quantitative analysis revealed teachers in this study implemented more laboratories during their first two years of teaching than during years three through five. Neither the type of science content taught in the classroom, nor the grade level had an impact upon the frequency or the types of laboratories implemented. Results indicated technology and professional laboratory equipment use increased over time. Also, teachers in science-specific induction programs implemented more laboratories than teachers in electronically-based science-specific induction programs or general induction programs provided by schools or districts. By understanding the laboratory practices of beginning secondary science teachers, researchers and teacher educators may gain insight into how to prepare and support beginning science teachers in implementing purposeful inquiry-based laboratories.

A Science Teacher Without a Room: The Affordances and Constraints of Floating

Shannon L. Dubois, University of Georgia, sdubois@uga.edu

Julie A. Luft, University of Georgia

ABSTRACT: While there is some general understanding of early career teacher development and science instruction in the United States, little is known about how traveling to different classrooms impacts science teacher development and science teaching. To increase the knowledge in this area, this study looks at how moving among different classrooms creates affordances and constraints on first year teachers and science instruction. This study is a case study that focuses on three first-year moving (floating) science teachers, or teachers who did not have their own classroom. The data collected consisted of observations, general interviews about beliefs and practices, and follow-up interviews specifically focusing on moving to multiple classrooms. The data revealed a compilation of affordances and constraints to being a floating science teacher, and the importance of unofficial mentoring. Additionally, a floating science teacher spectrum, where moving either positively or negatively impacted science instruction, emerged from the data. This study suggests that if science teachers must move to different classrooms, there is a need to create a way to support science instruction and science teacher development, and it implies that all teachers and supervisors should have a deeper understanding about how the school community can impact the floating science teacher's experience.

How Understanding Neuroscience Impacts Teachers' Pedagogical Beliefs

Selcen Guzey, University of Minnesota, selcenkendir@yahoo.com

Char Ellingson, University of Minnesota

Gillian Roehrig, University of Minnesota

Janet Dubinsky, University of Minnesota

ABSTRACT: This qualitative study explores the beliefs of 12 teachers about teaching and learning before and after a teacher professional development program on neuroscience. Data were collected through semi-structured interviews. The analysis of interviews demonstrated that teachers' beliefs about teaching and learning were impacted at different levels. No correlation was found among the degree of change in beliefs, years of teaching experience, and teaching subject. Teachers' beliefs about student learning were clustered in more instructive and transitional categories and learning about brain plasticity had positive effects on teachers' beliefs and classroom practices. Contextual factors such as mandated district curriculum were found to have strong influences on teachers' beliefs and instructional decisions they make. The findings of this study contribute to the understanding of the effects of learning of neuroscience on teachers' beliefs about teaching and learning.

Strand 10: Curriculum, Evaluation, and Assessment

Related Paper Set - Assessing Scientific Argumentation: Challenges and Future Directions

8:30am-10:00am, San Cristobal

ABSTRACT: During the last two decades, science educators have increasingly recognized the importance of argumentation in the development of scientific knowledge and have advocated for its central role in classrooms. One

challenge that educators continually face, however, is the difficulty of assessing the nature and quality of students' argumentation. In order to change classroom practices, there is a need for comprehensive, effective, and scalable classroom tools and assessments for argumentation. In response to this challenge, the contributors to this session address several important issues in designing assessments of scientific argumentation drawing on a range of theoretical and empirical approaches. The five papers in this set focus on: 1) the development of assessments for a learning progression in scientific argumentation, 2) the design of argumentation assessments that reflect the uncertainty of science, 3) the development of rhetorical and epistemic argumentation assessments across the modalities of talking and reading 4) the design of a context-specific argumentation assessment about carbon-transforming processes and 5) the effect of task goals on students reading and critiquing arguments in everyday settings. We believe these different perspectives are important not only for assessing students' arguments, but also in guiding responsive teaching inside and outside of science classrooms.

Developing Assessment for a Learning Progression in Argumentation: Lessons Learned

Jonathan F. Osborne, Stanford University, osbornej@stanford.edu

Bryan Henderson, Stanford University

Anna MacPherson, Stanford University

Evan Szu, Stanford University

Measuring Students' Scientific Argumentation Associated with Uncertain Current Science

Hee-Sun Lee, University of California, Santa Cruz, hlee58@ucsc.edu

Amy Pallant, The Concord Consortium

Sarah Pryputniewicz, The Concord Consortium

Ou Lydia Liu, Educational Testing Service

Developing a Framework for Inquiry and Argumentation About Carbon-Transforming Processes

Jenny M. Dauer, Michigan State University, dauerjen@msu.edu

Hannah K. Miller, Michigan State University

Charles W. Anderson, Michigan State University

Assessing Students' Ability to Argue Across Multiple Modalities

Suna Ryu, Lawrence Hall of Science, UC Berkeley, sunaryu@ucla.edu

Seth Corrigan, Lawrence Hall of Science, UC Berkeley

Amanda M. Knight, Boston College

Katherine L. McNeill, Boston College

Effects Of Task Goals on Individuals' Engagement with Claims and Evidence in Everyday Settings

Jacqueline Wong, University of California, Los Angeles, writejackie@gmail.com

William A. Sandoval, University of California, Los Angeles

Strand 10: Curriculum, Evaluation, and Assessment

Innovations in Assessment and Evaluation in Science Curriculum

8:30am-10:00am, Río Mar Salon 2

President: Min Li

Gathering Multiple Sources of Content Validity Evidence to Guide Development of a Genomics-Bioinformatics Assessment

Chad Campbell, The Ohio State University, campbell.742@osu.edu

Ross H. Nehm, The Ohio State University

Brian Morton, Columbia University

ABSTRACT: Over the past decade, hundreds of studies have introduced genomics and bioinformatics (GB) curricula and laboratory activities at the undergraduate level. While these publications have facilitated the teaching and learning of

cutting-edge content, one key aspect of evidence-based practice has been left behind: the development of assessment tools capable of generating valid and reliable inferences about student learning. Content validity is an important facet of construct validity, and must be used to guide item development. Our study reports on: (1) the correspondence of content validity evidence gathered from independent sources and (2) the process of item development using this evidence. Two methods were used to gather content validity evidence: (1) an expanded survey of GB experts (n=61) and (2) detailed content analyses of genetics and GB textbooks (n=9). By including only the subtopics that were shown to have robust support from these sources, 24 GB subtopics were established for inclusion in our assessment. An expert panel subsequently developed two multiple-choice items to align with each subtopic, producing a pool of 48 items. These items are being reviewed for clarity by a student panel, and will be pilot tested with samples of varying content exposure during the autumn semester.

The Link Between Sequence of Item Context and Students' Performance in Science Assessment

Ting Wang, University of Washington, tingwang@uw.edu

Min Li, University of Washington

Maria Araceli Ruiz-Primo, University of Colorado Denver

Phonraphee Thummaphan, University of Washington

Derek Y. Zhao, University of Washington

ABSTRACT: Contextualized items have been widely used in science testing as part of recent reform efforts. Despite the common use of item contexts, it remains unclear how a chosen context leads to reliable and valid inferences about students' scientific understanding based on their test scores. In this paper, we focus on a particular characteristic of item contexts—sequence of contextual information, referring to the order of events involved in contextualized items. We hypothesize that the sequence of information presented should allow students to make sense of and follow the logic of an item rather than distracting them from scientific thinking. We ask two research questions: Do items with contexts differ from items without contexts? And, how does the sequence of contextual information impact students' performance? We propose an approach for capturing information on two aspects of the sequence of contextual information: sequence of events, and sequence of effect and cause factors. Empirical evidence is provided about the effects of the role of sequence of contextual information on students' performance measured by the percentage of correct responses. We found that the addition of contexts do not necessarily increase the item difficulty.

Comparing Item Formats of Instructionally Sensitive Assessments

Min Li, University of Washington, minli@u.washington.edu

Maria Araceli Ruiz-Primo, University of Colorado Denver

Ting Wang, University of Washington

Michael Giamellaro, University Of Colorado, Denver

Kellie Wills, University of Washington, Seattle

Derek Y. Zhao, University of Washington, Seattle

ABSTRACT: Assessments have been pervasively used in classrooms by educators and researchers for various purposes to detection and study of educational innovations. A concern has been recurrently brought up by scholars about the interpretation and use of assessment scores: Are assessments sensitive enough to detect student achievement differences? In this paper we examined the instructional sensitivity of two formats of assessment items, open-ended and multiple-choice, in order to answer the research question, do multiple-choice and open-ended formats differ in their instructional sensitivity?. Using the pretest and posttest design with booklets including pairs of two item formats, items varying in instructional sensitivity were administered to 427 students from nineteen 5th grade classes. We applied the item-specific coding systems to score student responses of open-ended items. By comparing the scores of two item formats, preliminary results from one module indicate that with respect to instructional sensitivity, the psychometric indicators of instructional sensitivity based on open-ended items were relatively comparable to those of multiple-choices. However, students performed significantly poorly on open-ended items than on multiple-choice item, showing lack of understanding or incorrect understanding.

Evaluation of a New Multiple-True-False Concept Inventory for Diagnosing Mental Models of Natural Selection

Meghan Rector Federer, The Ohio State University, federer.21@osu.edu

Ross H. Nehm, The Ohio State University
 Elizabeth P. Beggrow, The Ohio State University
 Minsu Ha, The Ohio State University
 John Opfer, The Ohio State University

ABSTRACT: Empirical studies have revealed three major limitations with multiple-choice Concept Inventories (CIs) designed to measure thinking about natural selection. First, although oral interviews indicate that students' mental models of natural selection are comprised of mixtures of naïve and scientific ideas, current multiple choice CIs only allow students to only choose a right or a wrong answer. Second, while surface features are known to constrain evolutionary thinking, many CIs ignore the effects of surface features. Third, in comparison to measures produced by recall tasks, recognition tasks tend to overestimate the knowledge stored in students' long-term memory. We report on a multidisciplinary effort to design a new Multiple-True-False formative assessment instrument. The instrument attempts to reveal students' cognitive models of natural selection; document reasoning across surface features (e.g., gain, loss, plants, animals); and to approximate knowledge recall tasks. Overall, the new MTF instrument covers comparable content (scientific and naïve) as the Conceptual Inventory of Natural Selection (CINS), but can be completed in less time (<20 min.); places fewer extraneous cognitive demands on test takers; and is capable of detecting mixed models and contextual reasoning abilities. However, scores derived from the MTF instrument were not found to robustly mirror recall task scores.

Strand 10: Curriculum, Evaluation, and Assessment

Symposium - Assessment and Next Generation K-12 Science Standards

8:30am-10:00am, El Morro 1 & 2

President: Cari Herrmann Abell, American Association for the Advancement of Science

Discussant: Nancy B. Songer, University of Michigan

Presenters:

Gavin W. Fulmer, National Institute of Education (Singapore)
 Jerome Shaw, University of California, Santa Cruz
 Knut Neumann, Leibniz-Institute for Science and Mathematics Education (IPN), University of Kiel
 Richard Lehrer, Vanderbilt University

ABSTRACT: With development of Next Generation Science Standards (NGSS) underway, attention is turning now to assessments appropriate for measuring students' mastery of disciplinary core ideas, cross-cutting concepts, and scientific practices. This invited session will focus on potential issues and open questions relevant to assessment of NGSS. Issues that may arise in the development of such assessments include methods for assessing students on multiple dimensions using common items, the use of interactive technologies for assessment of complex skills, and methods to ensure validity and cultural relevance for English Learners and non-majority students. The session will also provide opportunities for presenters and the audience to discuss promising directions for further research and development in standards-based assessment.

Strand 11: Cultural, Social, and Gender Issues

Symposium - Unequal Distribution of Resources for K-12 Science Instruction: Data from a Major National Study

8:30am-10:00am, Río Mar Salon 8

President: Patrick S. Smith, Horizon Research, Inc.

Presenters:

Patrick S. Smith, Horizon Research, Inc., ssmith62@horizon-research.com
 Michele M. Nelson, Horizon Research, Inc.
 Eric R. Banilower, Horizon Research, Inc.
 Peggy Trygstad, Horizon Research, Inc.

ABSTRACT: Equitable science education opportunities are shaped by factors originating inside and outside schools. Resources for science instruction—for example, laboratory equipment and course offerings—have historically been allocated unequally across schools serving different student communities. This symposium addresses the equity of

instructional resource distribution for K-12 science education in the United States. Data from a current, nationally representative sample of teachers and schools indicate some disparities in the distribution of three key resources: well-prepared teachers, material resources, and instructional practices. Statistical analyses show imbalances in resource allocation by school poverty level and/or minority student body composition, consistent with historical trends. Other data suggest few differences in the distribution of instructional resources by school community type (urban, suburban, and rural). Overall, the findings shed light on the national science education landscape, and provide food for thought and discussion among researchers, practitioners, and policymakers alike.

Strand 12: Educational Technology

Related Paper Set - Authentic Bioinformatics Tools and Database in the Biology Classroom: Affordances, Challenges, and Implications for Learning

8:30am-10:00am, Río Mar Salon 3

Presider: Anat Yarden, Weizmann Institute of Science

Discussant: John R. Jungck, University of Delaware

ABSTRACT: Bioinformatics, an emerging interdisciplinary field, is now an integral part of modern biology. Considerable resources are now being devoted to incorporate this exciting field and its related databases, computerized tools and information technologies into science classrooms. Integrating scientific practices, crosscutting concepts and core ideas, according to recent scientific standards, in real world inquiry-based activities for bioinformatics learning and instruction is necessary but not sufficient. To practically realize the vision and full potential of bioinformatics education, research on curriculum design, enactment, and assessment is required. This related paper set seeks to gain a shared understanding on technology-based learning and training of bioinformatics. It brings together 4 groups from across the world to present and discuss innovative programs on learning and training of contemporary bioinformatics and the practices and knowledge employed by scientists today. The benefits, challenges and implications for the design, development, and enactment of bioinformatics and technological tools in science education, from school classrooms to research laboratories will be discussed. Insights from this related paper set might contribute bridging the gap between high-school science education and cutting-edge bioinformatics research, which hold great opportunities to support students' and graduates understanding and elicit their interests and motivations to learn and do science.

Implications of Nature of Technology for Tool Enactment in Precollege Science Classrooms

Fouad Abd-El-Khalick, University of Illinois at Urbana-Champaign, fouad@illinois.edu

Noemi Waight, University at Buffalo

Bringing Bioinformatics into High School Biotechnology Curriculum through a Scientifically Authentic Learning Environment

Yossy Machluf, Weizmann Institute of Science, machluf.yossy@weizmann.ac.il

Hadas Gelbart, Weizmann Institute of Science

Anat Yarden, Weizmann Institute of Science

Embedding Bioinformatics within Independent Student Research

Amy Nisselle, DNA Learning Center Cold Spring Harbor Laboratory, NY, anissell@cshl.edu

Oscar Pineda-Catalan, DNA Learning Center Cold Spring Harbor Laboratory, NY

David Micklos, DNA Learning Center Cold Spring Harbor Laboratory, NY

Bioinformatics for Life Scientists: Why It's so Important to Train the Trainers

Maria Victoria Schneider, European Bioinformatics Institute, Cambridge, UK, vicky@ebi.ac.uk

Pedro L. Fernandes, Gulbenkian Institute, Oeiras, Portugal

Strand 12: Educational Technology***Related Paper Set - Connecting and Assessing Informal and Formal Understanding in Digital Games and Virtual Worlds***

8:30am-10:00am, Caribbean Salon 1

ABSTRACT: According to the National Research Council (Duschl et al., 2007) and international comparison studies (e.g., TIMSS), science is often taught at a superficial level of definitions. Digital games and virtual worlds offer a potential medium to allow students richer access to deeper authentic understandings of science. Many video games and virtual worlds focus on concepts, skills, and processes critical to physics, ecology, engineering, and other critical STEM domains at their core. This related paper set brings together researchers who investigate the potential of games to support and assess conceptual change in core science concepts, and will shed light on three core issues in terms of data collected to date. First, do data support the claim that games can effectively support valuable science learning? Second, how can we leverage the affordances of a digital game to both support and assess deep conceptual change? Third, what design principles can we distill from these findings in terms of supporting science learning in games and virtual worlds?

Using a Virtual World to Reveal Students' Intuitive Causal Assumptions about Ecosystems

Tina Grotzer, Harvard University, Tina_Grotzer@harvard.edu

M. Shane Tutwiler, Harvard University

Amy Kamarainen, New York Hall of Science

Shari Metcalf, Harvard University

Chris Dede, Harvard University

The Impact of a Serious Educational Game Design and Development Project on High School Science Students

Len Annetta, George Mason University, lannetta@gmu.edu

Richard Lamb, George Mason University

David Vallett, George Mason University

Rebecca Cheng, George Mason University

Games, Collaboration, and Physics: How the Structures of Informal Collaboration Affect Learning

Douglas B. Clark, Vanderbilt University, doug.clark@vanderbilt.edu

Blaine Smith, Vanderbilt University

Caroline Wilson, Vanderbilt University

Joy Ssebikindu, Vanderbilt University

Stephanie Zuckerman, Vanderbilt University

Leveling Up: Measuring Tacit Science Understanding through Gameplay

Jodi Asbell-Clarke, EdGE at TERC, jodi_asbell-clarke@terc.edu

Elizabeth Rowe, EdGE at TERC

Teon Edwards, EdGE at TERC

Jamie Larsen, EdGE at TERC

Using Data from Virtual Environment-Based Assessments to Scaffold Student Demonstration of Learning and Teacher Practice Change

Diane Jass Ketelhut, University of Maryland, College Park, djk@umd.edu

Uma Natarajan, Temple University

Angela Shelton, North Carolina State University

Strand 13: History, Philosophy, and Sociology of Science***SSI and Argumentation***

8:30am-10:00am, Heron Room

President: Catherine M. Koehler

STEM Education as a Deficit Framework: A Sociocultural Socioscientific Perspective

Dana L. Zeidler, University of South Florida, zeidler@usf.edu

ABSTRACT: Challenging scholars and educators to envision what STEM learning entails for the daily lives of citizens, not only in formal and informal settings, but what form it may take throughout life-long development, blurring the sharp edges of discipline and cultural boundaries, is, no doubt, a laudable aim. In order to achieve such an aim, however, necessarily requires framing STEM learning research within the broader socio-cultural-political contexts of the needs and concerns of the larger global society. Thinking about STEM from a socio-cultural-political perspective aligns with the broader socio-cultural-political contexts of the larger global society. I will argue that this perspective holds a place of primacy for STEM research and science education. Failing to recognize or willfully ignoring the primacy of socio-cultural and related humanistic perspectives will inevitably result in a deficit model of STEM initiatives. This paper attempts to frame STEM learning research within the broader socio-cultural-political contexts of the needs and concerns of the larger global society.

The Relationship between College Students' Epistemic Beliefs and their Socio-Cultural Views of Science

Brendan E. Callahan, Kennesaw State University, bcallah7@kennesaw.edu

Samantha R. Fowler, Clayton State University

ABSTRACT: There is an uneasy relationship between many college students and science. In some cases, this uneasiness is a result of perceived conflict between science and their personal views. The field of epistemology studies the nature of human knowledge, which has the potential to impact students' views on science. We conducted a pilot study in order to quantify the relationship between college students' epistemological views and their socio-cultural views of science. 37 undergraduate students (both science majors and non-majors) completed both the Epistemic Beliefs Inventory (EBI) and the Thinking about Science survey Instrument (TSSI). The EBI is designed to measure students' views on five factors of knowledge, while the TSSI measures nine dimensions of scientific beliefs. We found a positive correlation between belief in an omniscient authority and certain knowledge. We also found these same students had a generally negative attitude towards science in general. This paper provides evidence that there is a relationship between students' epistemological views and how they perceive the scientific enterprise.

Socio-Scientific Issues as a Transformative Approach: Based on Activity Theory Perspectives

Hyun Ok Lee, Ewha Womans University, philian@empas.com

Hyunju Lee, Ewha Womans University

Kyunghee Choi, Ewha Womans University

ABSTRACT: The purpose of this research is to identify systemic tensions with respect to students as subjects in SSI classrooms, using cultural-historical activity theory as our theoretical lens and an analytical framework, which avoids the disadvantages of previous researches' methodology. We developed a SSI program, which had 7 lessons on genetic modification technology for 132 9th grade students over 3-4 weeks including various small group discussion strategies to reveal conflicts and disturbances. Data collection relied on various sources: classroom observation, field notes, audio and video recordings, semi-structured interviews, and students' artifacts. Identified systemic tensions are categorized into two groups: the first group has conflicts and disturbances of students that arose from unfamiliar characteristics of SSI in contrast to the current education approaches; the second group has conflicts that occur from students' transformation of the original program's objective to conform with their own arbitrary interpretation. Systemic tensions that we identified in this study inform the evolution of the SSI system and let us have an overview of the SSI framework and its attributes in contrast to the current education environment.

The Role of Scientific Evidence in Socio-Scientific Deliberation

Jan Alexis Nielsen, University of Copenhagen, janielsen@ind.ku.dk

ABSTRACT: This paper critically discusses the conspicuous focus that teachers and researchers have had on students' use of evidence and their ability to make evidence-based decisions in socioscientific activities. It is argued that the fundamental features of socioscientific argumentative should persuade us to revise or tone down our expectations regarding students' use of scientific evidence. The upshot is that teachers and researchers are advised to focus on how students use evidence rather than on whether they use evidence. The talk will (i) present that argument in detail; (ii) provide an analogous example from the scholarly discussion about evidence-based political decision-making; and (iii)

point to lessons learned from a number of recent empirical studies. Against that background the talk will present suggestions as to how teachers, researchers, teacher educators, and educational planners could proceed regarding the planning, implementation, and assessment of socioscientific activities.

Strand 14: Environmental Education

Sociocultural Approaches to Researching and Teaching Environmental Education

8:30am-10:00am, Río Mar Salon 7

Environmental Identity Development through Social Interactions: Investigation of an Overseas Environmental Education Program

Sarah R. Stapleton, Michigan State University, skriggs@gmail.com

ABSTRACT: The field of environmental education has spent considerable time focusing on how environmental attitudes, knowledge, and values impact actions (Kitchell et al., 2000). However, anthropological research (Kitchell et al., 2000; Kempton & Holland, 2003) has found that environmental identity development may actually follow participation in environmental groups. My study explores the effects of social interactions across a number of contexts within and among a diverse group of American teens participating in a month-long overseas climate change program. Qualitative data was collected through group interviews, participant observation, and individual interviews. All participants interviewed were greatly affected by the program, both in terms of environmental actions and behavior and identity development. In terms of changes in individuals' actions, interactions between participants seemed to be most significant. In terms of larger identity changes, interactions between the participants and host country citizens most affected by climate change and between participants and their host families appeared to be most salient. This analysis explores an innovative and efficacious environmental education program while exploring new theoretical lenses.

Using the Natural Environment as Text as an Integrating Context for Teaching and Learning

Joan M. Chambers, Lakehead University, joan.chambers@lakeheadu.ca

Christy Radbourne, Lakehead Public Schools

ABSTRACT: In an effort to examine the notion of the environment as text and further substantiate ecosocial theory, the authors and teacher-researchers engaged in a year-long action research project that used the environment as the integrating context for teaching critical literacy, science and math. The project revealed connections between students' abilities to engage in far transfer and complex critical thinking skills, as well as increased ecological understanding and ethic of care. Professional insights included efficacy in ecological education and its methodologies, as well as building a compendium of best practices that supported the development and expansion of critical literacy skills. The unexpected gains included insight on better methods of differentiating instruction and content to engage marginalized learners (i.e. kinesthetic learners, boys, and aboriginal learners). The insights gained through the study demonstrate the potential of ecosocial theory in explaining how our interaction with the social and physical world dialogically shapes our perspective of and relationship with that world.

Plenary Session #2***Research on Ecological Context and Place: Investigating the Landscape of STEM Opportunities***

10:30am – 11:50am, Río Mar Ballroom 5 and 6

Presider: Lynn A. Bryan**Keynote Presenter:** William F. Tate IV, Washington University in St. Louis

ABSTRACT: This lecture seeks to describe how “place” warrants attention by scholars and practitioners interested in improving access to and opportunity in science, technology, engineering, and mathematics (STEM) education. Thinking conceptually about place has been a part of intellectual traditions in the social sciences for decades. Similar to other fields of study, such as economics, sociology, and political science, the treatment of schools, neighborhoods, and communities as geospatial constructs in terms of sites of intervention and policy reform has a history in STEM education, but the aligned research and development strategy is best characterized as nascent. More specifically, many studies of academic performance and attainment fail to consider geography and the context of community. Many social scientists have argued that geographic factors and mechanisms in the neighborhood and community have largely been ignored within the prominent paradigm of individual-level analysis in education research. William Julius Wilson posited that the individualistic framework is not typically conceived in a fashion that accounts for the influence of relational, organizational, and collective actions that influence the social formation of inequality. These actions and processes include the following institutional factors that affect mobility and opportunity: the nature and quality of schools; patterns of residential segregation and of social isolation in highly concentrated poor communities; explicit forms of discrimination in employment and in other pathways to upward mobility; financial markets; governmental policies concerning taxation, service, investment, and redistribution; and private-sector decisions related to the location and mobility of industries and related services. Wilson’s position suggests the need for context-based research projects. This scholarship would focus on capturing the nature and extent to which educational outcomes and disparities are shaped by the ecological context and the geography of opportunity. This lecture aims to explore this possibility using STEM education as a central focus.

Concurrent Session #8**2:15pm – 3:45pm****International Committee Sponsored Session*****Contributions from European Science Education Research Association - Related Paper Set - Students' Choices of, and Transition into, STEM Programmes in Higher Education***

2:15pm-3:45pm, Canary Room

Presiders:

Sibel Erduran, University of Bristol

Manuela Welzel-Breuer, University of Education Heidelberg, Germany

Discussant: Kenneth G. Tobin, The City University of New York

ABSTRACT: The five papers present results from a European Commission funded research project which studied young people's choices of, and engagement with, higher education (HE) Science, Technology, Engineering and Mathematics (STEM). The quantitative studies are analyzed using the expectancy-value model of achievement-related choices. The qualitative dimension involves narrative inquiries of how students' choices are related to their identities and sense of belonging. Students' ideas of future careers turned out to have more direct impact on their STEM choices than did the curriculum. This indeed is interesting since it turned out that upper secondary school students hold poor opinions of the available physics-related careers. Also HE physics students held narrow perspectives of their career possibilities. Finally students' sense of place and identities turned out to affect their choices, and involved a series of negotiations while navigating the process of defining themselves. This process continues after students entered HE. Here the students struggled to bridge the gap between their expectations and experiences using different negotiation strategies. The papers contribute to a general discussion of how to support students' choices of, and transition into, HE STEM.

*European Students, Motivations and Expectations in STEM Studies*Giuseppe Pellegrini, Observa Science in Society, Italy, pellegrini@observanet.it*The Influence of School-Related Factors on Students' Choice of Science Courses*Jaume Ametller, University of Leeds, J.Ametller@education.leeds.ac.uk

Jim Ryder, University of Leeds

*Belonging and a 'Place' in STEM at University: A Focus Group Study of Undergraduate Students' Degree Choice*Justin Dillon, King's College London, justin.dillon@kcl.ac.uk

Elaine Regan, King's College London

*Students' Negotiation Strategies when Meeting STEM. A Longitudinal Study of Students' Transition to Higher Education*Henriette T. Holmegaard, University of Copenhagen, Denmark, hh@ind.ku.dk

Lene M. Madsen, University of Copenhagen, Denmark

Lars Ulriksen, University of Copenhagen, Denmark

Strand 1: Science Learning, Understanding and Conceptual Change***Exploring and Assessing Students' Reasoning***

2:15pm-3:45pm, Río Mar Salon 1

President: Savannah E. Lodge-Scharff*The Effect of the Learning Content Nano Size-Effects on Students' Ideas about Matter*Sebastian Ritter, Universitaet Duisburg-Essen, sebastian.ritter@uni-due.de

Elke Sumfleth, Universitaet Duisburg-Essen

Eckart Hasselbrink, Universitaet Duisburg-Essen

ABSTRACT: Contents of the emerging nanotechnology have the potential to allow us develop a deeper insight into the nature of matter. This study aims to partially answer the question if this alleged promise can be used at school level to improve students' ideas about matter. In this study two groups of high school students were confronted with self-learning materials explaining the substance features of gold. The first group (N=86) was instructed considering the nano-size-effects of gold properties, the second group (N=82) was instructed the same content with the mere atomic focus omitting the size-effects. Statistical analysis of a pre-post-test suggests that students taught the size-effects outperform the traditionally taught students in respect to the knowledge of the properties of the atomic dimension. As weak statistical evidence suggests the size-effect seems suitable to have potential closing the bridge between the atomic and the substance level.

Exploring the Use of Students Self-Explanations when Exploring the Particulate Nature of Matter

John C. Bedward, Buena Vista University, bedward@bv.edu

Eric N. Wiebe, North Carolina State University

ABSTRACT: Elementary model-based inquiry (MBI)—student constructed models, kit-based science, collaboration, discourse, and instructional scaffolds—offer a way forward in supporting scientific thinking. A mixed methods multi-case semiotic approach was used to engage Grade 3 (N=22) students in Soils curriculum. A Science Learning Trajectory Assessment Instrument was developed to assess student explanations across several modalities—graphical, textual and verbal. Students' descriptive statistics revealed distinct patterns in student model-based discourse and sign use across the three modalities. Sixty-six percent of students' demonstrated improvement on their pre-posttest while 54 percent demonstrated no improvement. Scores pertaining to soil and water interactions showed slight improvement in their graphical, textual and verbal responses. Within-case analysis representing a subset of students (N=11) was used to describe and explain their verbal responses. Two students showed promise incorporating **ABSTRACT** science conceptions with their macroscopic observations. As a result of individual case analysis, a cross case synthesis of student metamodeling and graphic editing was generated. The majority of students leveraged the modeling tools to clarify, emphasize or "add to" their existing explanation. However, students' graphical representations remained at a macroparticulate level.

Development of a Test Instrument to Investigate Students' Learning Trajectories in Chemistry Contents

Nora Ferber, University of Duisburg-Essen, nora.ferber@uni-due.de

Markus Emden, University of Duisburg-Essen, Department of Chemistry

Elke Sumfleth, Universitaet Duisburg-Essen

ABSTRACT: This study aims to provide empirically based insight into learning trajectories in typical content areas of chemistry content at the lower level of secondary schools. Therefore, a test instrument for a longitudinal study will be developed and validated. The item construction bases on a suggested competence model that contains three dimensions: complexity, content and level of representation. In addition to a significant increase of person ability from grades 7-9 ($F(2,1077) = 96$; $p < .001$; $\eta^2 = .15$), further analyses indicate a significantly growing chemistry expertise over the three academic years to solve more complex test items. Results with regard to the level of representation show a highly significant increase in the ability to solve more complex items over the academic years and a highly significant increase to solve items at the atomic level.

Strand 2: Science Learning: Contexts, Characteristics and Interactions

Symposium - PROFILES- Reflections on Motivational Science Education for 21st Century Scientific Literacy

2:15pm-3:45pm, Caribbean Salon 2

ABSTRACT: This symposium reflects on an approach to develop teacher ownership of motivational, 21st century science education, through teachers' continuous professional development, to reflect on classroom observations, based on a theoretically driven, 3-stage teaching and learning model. While the frame for the project is student centered learning, within an inquiry-based science education (IBSE) setting, this project identifies its success in addressing science teaching issues, especially when reflecting at an adolescent level, such as the irrelevance of current science learning with its lack of student interest, the **ABSTRACT**ness of the learning and the difficulty this brings to the learning in the eyes of students. This symposium encompasses six presentations covering - the theoretical basis presented as a 3-stage model;

success of the project continuous professional development (CPD) model, based on teacher needs; implementing teaching modules based on the 3-stage model; the interrelationship of PROFILES with stakeholder views on the purpose and direction of science education; evidence-based teacher ownership of the project philosophy and approach and student gains, and teacher identified roles for networking establishing 'grassroots' support and furthering 'bottom-up' developments.'

Presenters:

Jack Holbrook, University of Tartu, jack@ut.ee
 Miia Rannikmae, University of Tartu
 Claus Bolte, Freie Universitaet Berlin
 Avi Hofstein, The Weizmann Institute of Science
 Rachel -. Mamlok-Naaman, The Weizmann Institute of Science
 Franz Rauch, Alpen Adria Universitaet, Klagenfurt
 Sabine Streller, Freie Universitaet Berlin
 Tuula Keinonen, University of Eastern Finland

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

Teaching Science in the Early Years

2:15pm-3:45pm, Río Mar Salon 3

Presider: Charlene M. Czerniak, University of Toledo

Science: The Creation of a Coding System to Evaluate Early Childhood Science Teaching

Joan N. Kaderavek, University of Toledo, joan.kaderavek@utoledo.edu

Tamala S. North, University of Toledo

Regina Rothshtein, University of Toledo

Hoangha Dao, University of Toledo

Nicholas Liber, University of Toledo

Geoff Milewski, University of Toledo

Scott S. Molitor, University of Toledo

Charlene M. Czerniak, University of Toledo

ABSTRACT: This paper describes and gives examples of the development and piloting of the Systematic Coding Inventory of Inquiry In Early Childhood Education (SCIENCE). The SCIENCE coding system was designed to objectively capture the presence and frequency of specific best practices outlined in the K-12 Science Frameworks as they occur within a science lesson; it focuses exclusively on teacher behaviors. The goals of the SCIENCE system are to (a) provide a standardized tool for assessing the quality of science instruction in a classroom setting for children grades PK-3, (b) capture the instructional practices that engage students in the lesson, promote scientific studies, encourage higher-level thinking, and (c) provide a feedback mechanism for guiding professional development of PreK-3 teachers. Participants will be able to apply this coding system to teacher behaviors and use the data to improve classroom inquiry instructional methodology.

Promoting Conceptual Change Using an Inquiry-Based Professional Development with In-Service Preschool Teachers

Mandy M. Smith, The Ohio State University, smith.7810@osu.edu

Heather L. Miller, The Ohio State University

Kathy C. Trundle, Ohio State University

Mesut Saçkes, Balıkesir University

ABSTRACT: Four case studies describe preschool teachers' astronomy conceptions, including misconceptions. Preschool in-service teachers from two different school sites participated in the study (n=4), and the focus of the project was two-fold: 1) teachers' understandings before and after an inquiry-based professional development (PD), 2) the efficacy of the instructional implementation with preschool children. Data were collected through pre/post interviews and video-taped classroom observations. Prior to the PD, only half of the teachers understood the times of day celestial objects can be observed, and misconceptions included that the moon could only be observed at night. None of the teachers had a

scientific understanding of the shapes, sequences, or cause of moon phases. Post instruction, all teachers maintained their understandings of the preschool concepts of observable differences of day and night skies. And three of the teachers (75%) understood the times of day the sun, moon, and stars can be observed, with one teacher improving her understanding and one maintaining her misconception. Three of the four teachers (75%) developed a scientific understanding of moon shapes and sequences. All participants were able to effectively implement the preschool lessons, and the majority of children improved their understanding of the targeted preschool concepts.

Towards a Conceptualisation of the Application of Dramatic Approaches to Support Successful Learning in Science

Deb J. McGregor, University of Wolverhampton, debsmcgregor@googlemail.com

ABSTRACT: This paper summarises findings from an action research (AR) project designed to help teachers re-develop their pedagogic repertoire and subsequently affect better learning in science. The AR provided demonstrations, resources and various materials that illustrated novel ways to teach science through drama. Over a 1000 children aged five to eleven and 40 teachers in 16 schools were involved in trialling these innovative approaches in UK classrooms. The findings indicate that multifarious dramatic strategies can mediate different kinds of scientific thinking and understanding. This paper attempts to conceptualise the variety of learning outcomes that can result from the application of theatrical techniques in primary science classrooms that educators could apply. It appears to be possible to hone scientific comprehension and the development of process (inquiry) skills by applying particular dramatic approaches. Improvisation strategies such as on-the-table, miming movement, freeze frame, modelling and mini-historical plays appear to work well with all children from five to eleven. The skilled use of monologues, however, appears to substantially augment the development of higher order process skills for the older children.

"But There's so Much I Could Do!": How Context Impacts Elementary Science Instruction

Julianne A. Wenner, University of Georgia, jakent@uga.edu

Julie M. Kittleson, University of Georgia

ABSTRACT: Research on science instruction in the elementary grades indicates that little time is allotted to science and when science is taught the quality of instruction tends to be low. Thus, it is imperative to improve elementary science, but this goal can be complicated by a number of factors. To better understand how to approach the issue of improving elementary science, researchers need to recognize the complex systems within which teachers work. Using a Cultural Historical Activity Theory lens we sought to explore how the components of and contradictions within three elementary teachers' contextual systems impacted their science instruction. Key findings include: 1) Teachers develop a variety of coping mechanisms in order to deal with competing initiatives; 2) The more a teacher sees the value of quality science instruction, the more unsatisfactory the external context seems; 3) The more a teacher sees the value of quality science instruction, the more they push for change; and 4) Teachers have different motivations for teaching in the same (traditional) manner. These findings have implications for stakeholders in elementary science education, as they illuminate the consequences of concurrent reform implementations in schools as well as possible motivations for elementary teachers teaching science in non-reform-oriented ways.

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

Context and Teacher Influence

2:15pm-3:45pm, Pelican Room

President: Todd Hunter, University of Texas at Austin

STEM Integration: Opportunities for Using Imagination and Creativity to Apply STEM Knowledge in Life Science

Hui-Hui Wang, University of Minnesota, wangx773@umn.edu

Gillian Roehrig, University of Minnesota

Tamara J. Moore, University of Minnesota

ABSTRACT: Spurred by specific attentions to STEM education from professional societies, such as the National Science Foundation and National Research Council, many states emphasize STEM education by legislating or advocating for the addition of engineering standards to the existing science standards. As nationwide calling for the integration of engineering concepts under the umbrella of science standards, science teachers are faced with challenges in their

classroom. Research on teachers' perceptions and classroom practices about STEM integration is the essential first step in exploring the provision of the effective and best practices of STEM integration professional development in science education. To provide in depth understandings for life science teachers' perceptions and implementation of integrated STEM contexts into 6-12 science classrooms, this research focus on exploring two life science teachers' perceptions and classroom practices of STEM integration. The finding suggests that life science teachers believed (1) STEM integration is a process to solve problems, (2) STEM integration is application, (3) ethical issues are important in STEM integration, and (4) the focus of STEM integration is life skills. This research provides useful information for educators who are interested in STEM integration in methods of instruction and also curriculum design in 6-12 science classrooms.

The Wicked Problem of Multimedia Simulation Integration: A Case from High School Chemistry

Catherine E. Milne, New York University, cem4@nyu.edu

Jan Plass, NYU

Bruce Homer, Graduate Center, City University of New York

Trace Jordan, NYU

Ruth Schwartz, New York University

Steve Yavner, NYU

Mubina Kahn, NYU

Yolanta Kornak, CUNY

Meagan Bromley, NYU

Anna G. Brady, New York University

ABSTRACT: We report a qualitative study that addresses the wicked problem of teacher integration of a sequence of interactive multimedia simulations designed to support learning of kinetic molecular theory and associated topics in high school chemistry classroom. Using the construct of core elements, we explore how five teachers with variable experience with the simulations integrated them into their practice. We identified two sets of pedagogical actions that were key to the integration of scaffolded simulations: 1) the level of adoption, including the extent of the teacher's adaptation of materials, and 2) the level of pedagogical engagement, including the teacher perceptions of agency and whether the teacher or the materials were responsible for doing the pedagogical work. We reflect on the implications for student learning as specific teachers adopted and adapted the simulations for their purposes.

The Status of Secondary Science Teaching: Factors that Predict Teachers' Practice

Patrick S. Smith, Horizon Research, Inc., ssmith62@horizon-research.com

Michele M. Nelson, Horizon Research, Inc.

Peggy Trygstad, Horizon Research, Inc.

Eric R. Banilower, Horizon Research, Inc.

ABSTRACT: New K–12 science education standards emphasize teaching and learning grounded in authentic scientific practices. A first step toward supporting teachers' adoption of scientific practice-based pedagogies is to develop a clear picture of how teachers are currently teaching science, and what factors predict their pedagogical choices. A recently concluded, major study gathered data from a nationally representative sample of secondary science teachers. Among the topics studied were five sets of teacher-level predictors of traditional versus reform-oriented science instruction: teacher attributes, teacher beliefs, instructional resources, context-related factors, and inservice support. School-level factors (e.g., student demographics, community type, science expenditures) were also examined as potential predictors of classroom practice. This paper explores the relationships among these potential predictors and between the predictors and teachers' reported practices. The findings describe the national secondary science education landscape, and provide insight into the readiness of the field to implement the upcoming Next Generation Science Standards.

Epistemic Network Analysis of High and Low Innovators in High School Science Classrooms

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Anita M. Martin, University of Illinois

Janet Gaffney, University of Illinois at Urbana-Champaign

Raymond Price, University of Illinois at Urbana-Champaign

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

ABSTRACT: In this study, we examine entrepreneurial teacher leadership from the perspective of connectedness. To accomplish this, we conducted interviews with 21 science teachers and adapted Epistemic Network Analysis techniques to characterize the connections between and among pieces of teacher knowledge related to important aspects of innovation. This proposal discusses results from two teacher leaders, one high innovator and one low innovator. The results suggest that high and low innovators connect different elements in different ways. Thus, professional development aimed at improving science teaching and student learning and engagement might consider modeling a curriculum around the ways in which high innovators build and maintain connected networks of understanding rather than on only building science knowledge.

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

Community Learning in Science Education

2:15pm-3:45pm, Parrot Room

Presider: Carrie J. Boyce

Undergraduates' Perceived Gains from Participating in Science Education Outreach Programs

Stacey Carpenter, University Of California At Santa Barbara, scarpenter@education.ucsb.edu

Danielle B. Harlow, University Of California At Santa Barbara

ABSTRACT: We investigated what undergraduate students gain from participating in university science education outreach programs. Undergraduates were interviewed individually about their experiences with outreach programs and what they learned about science teaching and learning. Emergent themes were initially identified during the interviews and further explored with a content analysis of field note data. Identified themes were academic gains, personal gains, and gains in communication skills. Academic gains included improved understanding of science and unique opportunities to work with university faculty. For personal gains, participants reflected on the enjoyment and rewarding nature of working in outreach and expressed increased interest in future outreach participation or teaching as a career. Undergraduates also described outreach as a legitimate break from schoolwork. Gains in communication skills included improved knowledge and skills of communicating in a classroom and abilities to explain science concepts to general audiences. Documenting the benefits of participation in outreach could help place outreach participation as an integral component of undergraduate science education. The results of this study can promote research-based development, refinement, and dissemination of effective university outreach programs.

Building Communities of Practice: A K-20 STEM Professional Development Effort

Shelly Micham, University of Cincinnati, s_micham@yahoo.com

Kathie Maynard, University Of Cincinnati

ABSTRACT: This research study occurred between a large, public, urban university and a high-needs suburban school district participating in a U.S. DOE MSP grant. State and federal agencies support improving math and science education in K-12 schools. Over 200 million dollars spent annually on K-20 partnerships, little is known about their effect. The purpose of the research was to describe the K-20 partnership effort from the perspectives of the STEM faculty. The following questions guided this study: 1) How do the STEM faculty members describe the K-20 partnership effort? 2) What do the STEM faculty members identify as challenges or successes in providing K-12 workshops that focus on deepening teacher content knowledge? 3) What value, if any, has been received by the STEM faculty from participating in the K-20 partnership? This research study suggests that structured opportunities such as engaging in a community of practice with other faculty to provide professional development for K-12 teachers can nurture collegiality, collaboration, and experimentation for the faculty. These communities of practice provide opportunities for the faculty to build relationships that serve as change agents for K-12 school systems and universities, developing a culture of continued professional growth and learning for all.

A Physics Education Community of Practice Implementing Innovation

Patrick J. Enderle, The Florida State University, pje07@my.fsu.edu

Sherry A. Southerland, Florida State University

ABSTRACT: Undergraduate science education continues to garner more attention from educators and scientists as efforts seek to improve science teaching and learning. The SCALE-UP model originates from Physics education research and involves the physical redesign of the classroom space and timing to encourage more meaningful interactions among the students and instructors. Researchers have called for more research exploring the sociological and situational factors influencing the transformation of undergraduate teaching. The research presented here describes the efforts of a group of four university physics faculty members to initiate, implement, and maintain a restructuring of their department's introductory physics course sequence using the SCALE-UP model. Employing Wenger's Communities of Practice (CoP) framework to make sense of this group's dynamics, group and individual interviews, classroom and social observations, and relevant documents were collected for over a year. Findings suggest that faculty CoPs focused on improving science education provide a social learning space for members to discuss their ideas and develop their teaching practice. The lasting implementation of the SCALE-UP model described here demonstrates the need for change efforts and those enacting them to align in their fundamental approach to the teaching and learning of science.

Strand 6: Science Learning in Informal Contexts

Effective Facilitation and Pedagogy for Out-of-School Time Experiences

2:15pm-3:45pm, Sea Gull Room

President: Maritza Macdonald

The Nature of Teaching in Nature: Pedagogical Content Knowledge in the Outdoors

Tali Tal, Technion, rtal@cc.technion.ac.il

Nirit Lavie-Alon, Israel Institute of Technology

Orly Morag, Technion - Israel Institute of Technology

ABSTRACT: Field trips are complex and expensive events. They are perceived as good educational experiences, but rarely do teachers and administrators question their effectiveness in terms of learning and developing attitudes toward the environment. Unlike school based learning, field trips are not evaluated and quite often they are viewed as missed opportunities due to unclear expectations or because of gaps between what is viewed as good school teaching and the common practice in the field. In this study of outdoor-education in nature, we aimed at investigating nature guides' practice in general and their pedagogical-content-knowledge (PCK) in particular, and scrutinizing student self-reported outcomes with respect to guides' practices. We followed-up 34 field-trips provided to grades 4-8 by various carriers through observations and interviews with students, teachers and guides. We found a range of practices in few domains: active learning, physical experiences, environmental action etc. We suggest that the use of the idea of PCK could add a valuable lens to look at outdoor-education as well as inform our understanding of field trips and preparation of professional guides. As many field trips are planned to support school based teaching, improving teaching practices in field trips can positively affect school-based learning as well.

Mentor Vision and Student Behavior: A Case Study of Two Robotics Teams

Nathan R. Dolenc, University of Virginia, nrd3fp@virginia.edu

Robert H. Tai, University of Virginia

ABSTRACT: Mentors play important youth development roles in out-of-school activities. The FIRST Robotics Competition is one such activity that stresses the importance of mentor contributing to the program's success. This research uses a comparative case study method of two robotics teams to analyze how mentors define the vision of their robotics team and how students behave under their mentor's vision. The findings create a mentor-student behavioral model for out-of-school robotics programs where students fall into an apprenticeship or an autonomous model. The apprenticeship model conforms students into learning predetermined outcomes and knowledge while inspiring them to enter into STEM fields. The autonomous model allows students self choice and develops problem solving skills and creativity while also inspiring them to enter into STEM fields.

Informal Science Educators' Views of Science Teaching and Learning: A Case Study

Marc Behrendt, Ohio University, fossilprep@aol.com

Danielle E. Dani, Ohio University

ABSTRACT: For science learners to benefit from the opportunities afforded to them in informal settings, effective facilitators must lead learning. Effective facilitators assist learners in noticing and explaining the scientific principles associated with an activity and encourage learners to actively explore and reflect. Because of the paucity of research in this area, a qualitative case study was used to explore the views of science teaching and learning of six informal science educators (ISEs) based at Lake Biological Field Station (pseudonym). ISEs reported clear ideas about what good science teaching looked like in practice, and the type of environment good teachers create for their students. They cited several goals for their students at LBFS, including increasing awareness of local and regional environmental issues. ISEs also cited several perceived barriers to learning science at LBFS, including scheduling, chaperones, and student characteristics. The findings presented in this paper offer insights useful to (a) the preparation of science education professionals and (b) collaboration among formal and informal educators to ensure that informal learning experiences are designed to promote deep science learning.

Strand 7: Pre-service Science Teacher Education

Science Teaching Efficacy

2:15pm-3:45pm, Río Mar Salon 9

President: Jale Ercan

Pre-Service Teachers' Understanding and Perceptions of Science Inquiry and Self-Efficacy

Cathy Northcutt, Western Michigan University, cathy.k.northcutt@wmich.edu

Renee S. Schwartz, Western Michigan University

ABSTRACT: Teacher education has been the source of great research in relation to scientific inquiry and teacher self-efficacy. Studies show that most teachers are not prepared to teach scientific inquiry in their classrooms and have low self-efficacy about their abilities to do so. This study follows 13 pre-service teachers through a 10-week long research internship during the summer at a university. During this study teachers are given the opportunity to work with a scientist mentor in a laboratory designing their own experiments, carrying them out, and presenting the results. The pre-service teachers will also make observations of inquiry teaching and apply it to their own inquiry laboratory experience. Through the collection of survey instruments, interview transcripts, and journal entries our study will aim to measure the affects that the research experience has on the pre-service teachers perceptions of scientific inquiry and how these perceptions relate to teacher self-efficacy. Through an ongoing analysis of the data and future opportunities to gather similar data more progress can be made in the field of science education.

Exploring Preservice Elementary Teachers' Teaching Efficacy and Classroom Teaching in Science

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ABSTRACT: The purpose of this study was to examine elementary preservice teachers' self-efficacy in science teaching and the level of inquiry in science teaching in their classrooms as a result of completing the elementary science methods course and teaching an internship program. The following research questions were explored: (1) How do preservice elementary teachers' self-efficacy beliefs in science teaching change and (2) To what extent do preservice elementary teachers demonstrate inquiry-based teaching in their science teaching. The study employed one-group, pretest-posttest design and used a mixed-methods research design. Fifty-two preservice elementary teachers were volunteered for this study. Results of this study indicate that the majority of the elementary preservice teachers showed improved confidence in teaching science and performed inquiry-based science instruction effectively in their field placement classrooms after concurrently completing the science methods course and teaching an internship program. However, some of them still found challenges of delivering science content knowledge and formulating thought-provoking questions and handling students' questions during their science instruction. The findings from this study have implications for the design of the elementary science methods course and teaching internship experience.

Exploring Science Teaching Efficacy of Early Childhood Majors in a Mixed-Reality Virtual Classroom

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ABSTRACT: Self-efficacy beliefs of elementary teachers play an important role in their ability and willingness to teach

science in the elementary classrooms. Research studies report that real classroom teaching experiences help elementary teacher candidates increase their self-efficacy the most. However, opportunities for the candidates who are seeking early childhood (P-3) license to practice science teaching has become difficult over the last decade as a result of increasing emphasis on English language arts and mathematics instruction in early grade levels. This study responded to this challenge and investigated the effectiveness of a virtual classroom teaching experience, called TeachLivE™ Lab, in increasing Early Childhood Education (ECE) majors' self-efficacy beliefs in the context of science. Sixty-two preservice ECE majors participated in the study in Spring 2012. Analysis of the quantitative (STEBI-b and ABCC) and qualitative (journals) data revealed that the candidates' perceived self-efficacy and classroom management beliefs significantly increased over the semester. The virtual teaching experience made them aware of their lack of conceptual understanding of the science content and of the importance of knowing the content in-depth and preparing for it before planning a lesson. This study has implications for science teacher educators.

Effects of Pre-Service Science Teachers' Tutoring Experiences in Introductory Physics: Teachers' Self-Efficacy, Teaching Strategies, and Careers as Science Teachers

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Shin Young Lee, Ewha University

Kevin Insik Hahn, Ewha Womans University

ABSTRACT: This study explores pre-service science teachers' tutoring experiences on introductory physics. The guiding research questions were as follows: How about the pre-service science teachers (PSTs)' science teacher efficacy? Do PSTs change their teaching strategies as going through tutoring? If so, what are the main reasons for the change? If not, what are the reasons? How do the tutoring experiences affect PSTs' career? Seven PSTs who acquired above A grade at introductory physics class participated as tutors in this study. Tutoring program was organized 7 teams which were composed of one tutor and 4 or 5 tutees, and it ran 10 times during one semester. Data collection was conducted by mixed methods. One is a survey using a questionnaire (STEBI-B) for measuring the PSTs' science teaching efficacy, the other is an individual in-depth interview. The results are as follows; (1) All participants had similar motivations, i.e. personal needs for self-learning about physics and for making good relationship with tutees, and confirming career aptitude as a science teacher. (2) From the analysis of Science teaching efficacy measurements, we found three types of PSTs (Type A-Type C). And we tried to explain the three types related to the PSTs' change of teaching strategies and to decision about the PSTs' career.

Strand 8: In-service Science Teacher Education

Promoting Change in Beliefs and Practice

2:15pm-3:45pm, Río Mar Salon 4

President: Dionysius T. Gnanakkan

The Impact of a Higher Education Summer Internship Program on K-12 Science Teachers

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Meltem Alemdar, Georgia institute of technology

Jessica Gale, Georgia Institute of Technology - CEISMC

ABSTRACT: Research suggests that the quality of the teaching workforce is the single most important factor in predicting student achievement (Darling-Hammond & Ball, 1997). "Quality" has many dimensions, however. Effective teachers must have a solid knowledge of academic content, a high mastery of different pedagogical techniques, an understanding of student developmental issues and different ways of learning, and a strong sense of professionalism. The primary goal of this study is to examine the impact of a summer internship program on science teachers' classroom instruction. Specifically, the change in science teachers' beliefs about common Inquiry-Based instruction, and enactment of inquiry-based instruction were examined.

Biology Teachers' Beliefs About Teaching and Learning and the Consistency with their Classroom Practices

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Norman G. Lederman, Illinois Institute of Technology

Hernan Cofre, Illinois Institute of Technology & Universidad de Santiago de Chile, Santiago Chile

ABSTRACT: This study investigated the beliefs and classroom practices of three biology teachers in Chile. Teachers' beliefs about science teaching and learning, and their classroom practices were characterized, and the relationship between the beliefs and classroom practice they performed were also studied. The methodology used to obtain the information included three different techniques: semi-structured interview, quantitative analysis of videotaped classroom practices and Stimulated Recall interview. The most significant results of this study showed that: all teachers held different kind of beliefs about teaching and learning science. One teacher had traditional conceptions of teaching and learning, another teacher presented views that were a mix between traditional and constructivist views, and the third teacher had ideas primarily constructivist. However, teachers showed mostly traditional classroom practices. The teacher with the most traditional beliefs showed most consistency between her views and her practice, while the other two teachers were mostly inconsistent because they were not able to create a constructivists classroom practice like they wished. The implications of study for science teacher education were also discussed.

Variations in Secondary Biology Teachers Transfer of Content and Teaching Strategies from Institute to Classroom

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Victoria May, Washington University in St. Louis

Rachel Ruggirello, Washington University in St. Louis

ABSTRACT: This study reports how teachers transfer new learning from professional development to classrooms. Biology teachers attended a three-week content rich institute, from which they chose an area of interest and designed a plan for implementing new content and/or teaching strategies into their classroom. Using action research they enacted their plan, studied its impact on students and presented their results in a report. Researchers analyzed reports by coding themes and patterns in teacher choice of transfer, analyzed video of instruction, and then developed a model of intensity of transfer. Results indicated variation in duration and type of knowledge transferred and placement in instructional sequence. The teachers demonstrating strong transfer had a greater impact on student learning than those demonstrating weak transfer. Those with content-focused transfer impacting high performing students and those with strategies-focused transfer impacting lower performing students.

Investigating what Pedagogical Practices Persist when Professional Learning Institutes End

Lori Rubino-Hare, Northern Arizona University, lori.hare@nau.edu

Jennifer Claesgens, Northern Arizona University

Nena Bloom, Northern Arizona University

Kristi Fredrickson, Northern Arizona University

Carol Henderson-Dahms, Southwest Evaluation Research

James C. Sample, Northern Arizona University

ABSTRACT: From 2009-2011, educators, geologists, and geographers within (masked) University partnered to offer professional learning experiences for pairs of interdisciplinary secondary teachers, focusing on teaching with project-based instruction (PBI) integrating geospatial technologies (GST). Evidence from this project suggests that during professional development, participating teachers increased knowledge, skills, and confidence with PBI integrating GST, and their students demonstrated learning gains; yet, did teachers persist in the practice following the project? In order to determine what the teachers sustained from the professional development (PD) institute data was collected one- to two- years post PD to implementation into sustainability. Based on teacher interviews, three categories of implementation emerged – reformed implementers, mechanical implementers and non-implementers. Findings from this study indicate that school contexts were less of a factor in level of implementation than teachers' beliefs and philosophy of teaching and technology integration, which has implications for future PD institutes. Suggestions for encouraging pedagogical practices beyond the institute are presented.

Strand 9: Reflective Practice***Symposium - The Next Generation of Science Education Research: The Importance of Collaboration and Interdisciplinary Research Agendas***

2:15pm-3:45pm, Heron Room

Discussant: Angela Calabrese-Barton, Michigan State University, acb@msu.edu**Presenters:**

Julie A. Luft, University of Georgia, jaluft@uga.edu

Takumi Sato, Michigan State University

Felicia M. Mensah, Teachers College, Columbia University

Amelia W. Gotwals, Michigan State University

Hui Jin, Ohio State University

Edna Tan, University of North Carolina at Greensboro

ABSTRACT: This symposium session aims to bring together scholars from across the spectrum of science education research and join in conversations that explore and imagine possibilities for the next generation of research in science education. The goal is to identify the intersections of our work and to engage the audience in a rich conversation about the ways our research can support and build on each other rather than working on separate “academic islands”, or as we organize ourselves into strands and research perspectives. This symposium is a space to push on the boundaries that confine us into our niches and begin to explore how we can collectively and collaboratively inform science education across perspectives and work toward meaningful, lasting systemic changes in the way we envision research. We define the problem space broadly as the next generation of science education research to intentionally be inclusive of all strands and perspectives in a conversation that leads to development of new, innovative research agendas that are multi-dimensional. We believe this will be a unique, crosscutting proposal and of high interest to NARST as an organization and its membership.

Strand 10: Curriculum, Evaluation, and Assessment***Related Paper Set - Exploring Next Generation Curriculum Models Implementing the Vision in the NRC Framework and NGSS***

2:15pm-3:45pm, San Cristobal

ABSTRACT: With the release of the vision described in the NRC Framework for K-12 Science Education which is being realized in the Next Generation Science Standards in development, curriculum design teams are exploring how to design and implement instructional experiences that align and realize that vision. The new vision calls for significant changes in how science curriculum and learning experiences are traditionally conceptualized and supported. Curriculum research teams tend to design from specific, coherent pedagogical perspectives and communicate their design knowledge and research findings from that perspective. We have observed that this can lead some to believe that there is only a single curriculum / instructional model that is advanced by the NRC Framework. However, the argument we advance through this related paper set is that although a particular curriculum should be designed from a coherent pedagogical perspective, the NRC Framework vision actually accommodates multiples pedagogical perspectives and we need this repertoire of ‘next generation curriculum models’ to make progress on understanding how to best support meaningful science learning for all learners across diverse learning environments. This session includes a variety of such pedagogical perspectives—being implemented in the context of different curriculum development models.

A School District-University Partnership for Enhancing Elementary Science Teaching and Learning

Nancy Vye, University of Washington, nancyvye@uw.washington.edu

Angie DiLoreto, Bellevue School District

A Cultural and Cognitive Model for High School Biology Course Development and Implementation

Katie Van Horne, University Of Washington, katievh@uw.edu

Leah A. Bricker, University of Washington

Philip L. Bell, University of Washington

Navigating Novel Problem-Based Pedagogy and Practice: Science Teachers Connecting Problem-Based Science to Students and Standards

Elizabeth Wright, University of Washington, ewright@uw.edu

Paul Sutton

Andrew W. Shouse, University of Washington

Bill Palmer, Sammamish High School

Suzanne Reeve, Sammamish High School

Deep in Science: Deep, Experiential, and Engaging Practices in AP Environmental Science

Diem Nguyen, University of Washington, diem9@u.washington.edu

Lisé Whitfield, University of Washington

Strand 10: Curriculum, Evaluation, and Assessment

New Instruments and Approaches for Assessing Affective and Behavioral Variables for Students and Teachers

2:15pm-3:45pm, Río Mar Salon 2

President: Sarah A. Haines

A Review of STEM Research Instruments for Assessing Teacher Practices, PCK, and Content Knowledge

Daphne D. Minner, Abt Associates, daphne_minner@abtassoc.com

Alina Martinez, Abt Associates

ABSTRACT: This paper presents information gathered through a review of STEM instruments that assess teacher practices, pedagogical content knowledge, and content knowledge. The instruments were identified through a review of the National Science Foundation's Discovery Research K-12 (DR-K12) program funded proposals from 2008 to 2012. These instruments represents commonly used tools for gathering information about educational innovations in the U.S. given that the DR-K12 portfolio is the nation's largest STEM educational intervention research and development fiscal investment. Across the 75 studies that proposed to assess teacher outcomes, 82 extant instruments were identified. Findings discuss the variables measured across these instruments, and provide a detailed analysis of evidence on reliability and validity of instruments assessing instructional practices and pedagogical content knowledge.

Development, Validation and Use of New Instrumentation for Assessing Student Interest in Science

Morgan L. Presley, University of Missouri, mlp446@mail.missouri.edu

Troy D. Sadler, University of Missouri

William L. Romine, University of Missouri

ABSTRACT: International assessments have revealed that students in the United States lag behind students in other countries in terms of proficiency in science, technology, engineering, and mathematics (STEM). There also seems to be a lack of interest in STEM fields and as STEM educators, it is important to understand our students' interest toward STEM because of relationships between interest, learning and achievement. However, there are relatively few valid instruments for assessing student interest in science, especially individual interest, which has been shown to have a greater impact on long-term choices compared to situational interest. In this paper, we describe the development and validation of a new instrument for assessing student individual interest in science learning and interest in careers in science and biotechnology, and how a biotechnology intervention affects student interest in science and biotechnology. Results indicate that the Survey of Ideas about Technology and Science gives valid, reliable measures of individual interest related to learning science, pursuing careers in science, and biotechnology from CTT, IRT and two-parameter perspectives. Results also show that the biotechnology intervention had varying effects on interest towards STEM in relation to the aspect of interest being assessed and student prior knowledge.

Examining Fidelity Through Two Lenses: Teachers' Implementation of a Year-Long Curriculum In 9th Grade Physics

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Carina Rebello, University of Missouri

Somnath Sinha, University of Missouri

Ya-Wen Cheng, University of Missouri
 Nilay Muslu, University of Missouri
 Jaimie Foulk, University of Missouri
 Meera Chandrasekhar, University of Missouri

ABSTRACT: Curriculum materials play a key role in improving science education; however, curricula alone will not lead to enhanced student learning. Factors such as students' opportunity to learn and the way in which teachers present science content can influence student learning. Therefore, attention to teachers' fidelity of implementation of new curricula is an important consideration in understanding the impact of new reforms on student learning. As part of an NSF-funded Math and Science Partnership, thirty-seven school districts throughout a Midwestern state were engaged in the implementation of a year-long course in freshman physics. We examined teachers' curriculum implementation and use of pedagogical practices for modeling emphasized in an intensive three-year professional development program. Results yielded four profiles or typologies of implementation, based on teachers' implementation of and adherence to the curriculum, as written: Picker & Choosers, Local Adapters, Curriculum Users, and Curriculum Discounters. While teachers' profiles appear to be a result of influences in district policies and mandates, as well as teachers' own preferences for particular activities and laboratories, their implementation was not statistically related to their implementation of pedagogical practices consistent with modeling instruction. This suggests further need to explore teachers' pedagogical design capacity when considering student outcomes.

The Development of the STEM Career Interest Surveys (STEM-CIS)
 Meredith Kier, North Carolina State University, mgweaver@ncsu.edu
 Margaret R. Blanchard, North Carolina State University
 Jason W. Osborne, Old Dominion University
 Jennifer Albert, NC State University

ABSTRACT: There is a shortage of well-qualified individuals to meet the needs of growing STEM fields. To spark interest in these fields, national scientific and educational organizations recommend focusing efforts with students prior to entering high school. Review of the literature in science education and career development suggests there is a need for instruments that are theoretically driven, content-specific and worded appropriately for middle school students. In this study, we developed STEM career interest surveys for middle school students and asked: Are the STEM Career Interest Surveys reliable and valid instruments for measuring middle school students' interest in science, technology, and mathematics courses and careers? We describe our validation process; including conducting a literature review, creating and piloting an initial item pool, conducting a structural analysis, and performing a factor analysis. Alpha for the mathematics version of the scale was $\alpha = 0.86$, science was $\alpha = 0.80$, and technology was $\alpha = 0.86$, all of which are within acceptable or good ranges. Therefore, the three individual versions of the scale had a strong single-factor structure with acceptable internal consistency. A companion engineering scale will be validated in Fall, 2012. We expect these to be useful for STEM education researchers.

Strand 11: Cultural, Social, and Gender Issues

Worldview of Science

2:15pm-3:45pm, Río Mar Salon 8

President: Katherine A. Welsh

Translanguaging Practices and Language Ideologies in Puerto Rican University Science Education

Catherine M. Mazak, University of Puerto Rico Mayaguez, catherine.mazak@upr.edu

ABSTRACT: The undisputed position of English as the "international language of science" has resulted in a push for its use in college science classrooms in non-English-dominant contexts around the world. The University of Puerto Rico at Mayaguez is a bilingual, land-grant university where no official policy exists on the language of instruction, materials, texts, or assessment. This study uses classroom observation and interviews to examine the use of Spanish and English in college science classrooms. Using an ecology of languages framework, and particularly drawing on Hornberger's Continua of Bilinguality for the study of learning in bilingual contexts, analysis of 19 class observations and interviews showed that professors used multiple academic translanguaging practices (or regularized use of more than one

language, i.e., code-switching key terms) to teach science. At the same time, they held strongly to the ideology of English as “the language of science” and believed it was important for all science students to use English. Thus, professors’ practices and their ideologies rested on opposing ends of the Continua of Bilingual Context. This study begins to fill the gap in research about bilingualism in science education at the college level.

Scientific Literacy and Curricular Goals in Contemporary East Africa

Nicole Beeman-Cadwallader, Indiana University, nbeeman@uemail.iu.edu

Gayle A. Buck, Indiana University

ABSTRACT: This study sought to elucidate the presence and nature of goals for scientific literacy in formal science education in an East African country. Recognizing that several views of scientific literacy exist, what Brown, et al. (2005) call a “sociocultural-centered perspective” is of primary interest because it attends to relationships between science and local traditional practices. Two questions focused this study: 1) To what extent do the national science syllabi attend to sociocultural-centered scientific literacy? 2) In what ways do they promote a cross-cultural scientific literacy that seeks to improve the well-being and social action of its citizenry? Data for this study included: the national primary and secondary science syllabi, observational field notes, and interview transcripts with science teacher educators. Data were analyzed using narrative thematic and structural analytic techniques (Cain, 1991; Gee, 1991). Findings revealed that objectives in the national science curricula are connected to local knowledge, and become progressively less so through developmental levels. Structural analyses indicated that some local aspects relevant to the socioculturally-situated view of scientific literacy are present in fewer, but more specific ways. Science educators described several tensions between what they see as science utilized in the everyday lives of people and school science.

Loving Perception, Loving Playfulness and "World"-Traveling in High School Science

Jean Rockford Aguilar-Valdez, University of North Carolina, Greensboro, msrockford@gmail.com

ABSTRACT: This study introduces the story and practices of an African-American high school science teacher, Ms. Green (pseudonym), that have met with much success with all her students, especially her Latin@ students, as measured and lauded by estimations of science learning achievement, standards, and high-stakes testing, in her Title 1 school in the deep South. And yet, Ms. Green embodies practices and values that go beyond Eurocentric, androcentric notions of what is considered best practices for science content teaching and standardized testing success. This study shows that Ms. Green’s personal history and sociopolitical context growing up in the same oppressive situations as many of her students in the deep South, emerge in embodied teaching practices that evoke major themes in Maria Lugones’ (2003) ideas of World-Traveling, Loving Playfulness, and Loving Perception, as she creates safe places for her students to cross the borders of traditional meanings of school science and speak the language of the self as well as the language of the dominant, in decolonizing ways. In her classroom, students traverse many marginalized and dominant cultures, in a code-switching dance that the students and teacher mutually learn together, and from each other.

"Step Up and be Parents!" Science Teachers' Expectations for Family Involvement for Latino/a ELL Middle School Students

Kathryn Scantlebury, University of Delaware, kscantle@udel.edu

Beth A. Wassell, Rowan University

Sarah Braden, University of Utah

ABSTRACT: Family involvement plays an important role in ELL students’ science and mathematics achievement and supporting aspirations toward a STEM career. However, few science teachers are prepared to work with the families of ELL students. In this study, we used an ethnographic approach to understand urban charter middle school STEM educators’ perspectives on ELL family’s involvement. Teachers described several barriers that prevented parents from participating in school events or in communicating with them about student progress. These barriers included: (1) busy schedules; (2) intimidation or a lack of trust in the school; (3) language differences; (4) a lack of formal education in the sciences; (5) the economy; and (6) a lack of trust or relationships with teachers. The school provided the following resources to support communication: (1) flyers that were translated into Spanish; (2) orientation/information sessions; (3) a homework hotline; (4) online grade access, and (5) a few bilingual staff members. The teachers in this study expected the families to participate in their children’s schooling in White, middle-class ways. These narrow views of familial involvement in STEM served as structures to impede ELL student agency, which in this case meant access to resources to support STEM learning.

Strand 12: Educational Technology
Curriculum, Design and Development

2:15pm-3:45pm, Caribbean Salon 1

Presider: Virginia W. Snodgrass Rangel*A Randomized Trial of Open Source STEM Education Software (Smartgraphs)*

Rachel E. Kay, Concord Consortium, rkay@concord.org

Andrew Zucker, Concord Consortium

Carolyn Staudt, Concord Consortium

ABSTRACT: SmartGraphs is open-source, web-based software designed to help students understand graphs and the concepts (such as velocity) illustrated by graphs. The software allows students to interact with graphs, for example by clicking on a portion of a graph to answer questions. SmartGraphs was developed in HTML5 and runs directly in a web browser. SmartGraphs can be used in many STEM subjects. In this paper we summarize first-year results of a two-year randomized experimental trial involving 35 teachers and nearly 2,000 students. During fall 2011, all the teachers taught a unit about the motion of objects in a physical science course. The experimental group used four SmartGraphs activities, while the control group, which used the same textbooks, did not. Results from the first year show that the experimental students gained more on pre/post tests than the control students, with $p < .05$. In addition, the experimental teachers reported that the activities matched the learning goals of the unit of study and helped students achieve those goals. In 99% of the cases, the experimental teachers reported they would use the SmartGraphs activities again, either as is or with minor changes.

Addressing Environmental Issues through Social Networking Technologies and Media Design Projects

Engin Karahan, University of Minnesota, kara0210@umn.edu

Gillian Roehrig, University of Minnesota

ABSTRACT: This study investigated the impacts of two constructivism-based frameworks, constructionism and social constructivism, on students' awareness and activism in solving environmental problems, and their motivation and engagement. Additionally, social networking technologies were integrated into the process to improve the effectiveness of the frameworks employed in this study. A convergent mixed methods design was implemented for this research to triangulate the methods by directly comparing and contrasting quantitative results with qualitative findings for corroboration and validation purposes. Twenty-two 10th to 12th graders were recruited from their environmental science class to participate in this study. The findings of the study indicated that students' environmental attitudes, awareness and activism were improved throughout the constructionist and social constructivist learning processes. In addition, constructionist and social constructivist methods and tools positively affected student motivation and engagement by providing social presence of the students throughout the learning process via video designing and social networking technologies.

Knowledge Organization and Collaborative Argumentation: A New Online Platform and Two Illustrative Cases

Bahadır Namdar, University of Georgia, baha@uga.edu

Ji Shen, University of Georgia

ABSTRACT: Argumentation and collaboration have been advocated as one of the core practices in science education (NRC, 2012). Socio-scientific issues (SSI) can serve as great science education tools for collaborative argumentation as these issues are relevant to students' lives and promote interest in learning science (Kolsto, 2001; Sadler & Zeidler 2004). However, little is known about how students organize their knowledge during the collaborative argumentation processes. In this study we report the design of a new knowledge organization tool and findings from a pilot study conducted with six learners. We also report two illustrative cases in order to depict how students use modes in the system to organize their knowledge. Our results indicate that students use their knowledge entries in the system as bases for their arguments.

The Use of Cloud Applications for Identifying 21st Century Skills In STEM Education

Sigal Morad, Beitberl Academic College, sigalm@beitber.ac.il

Miri Barak, Technion, Israel Institute of Technology

ABSTRACT: In recent years, cloud applications are integrated into work, daily-life, and the academia. Our goal was to examine the use of cloud applications for STEM education and identify key skills necessary in the 21st century. The study included 86 participants: lecturers (N=32) and students (N=54) from two higher education institutions. The mix method research model was applied in the collection and analysis of two research tools: an online survey and semi-structured interviews. Findings indicated that in the context of STEM education, cloud computing is not only a model for delivering ICT services, but it may change the way lecturer perceive their teaching and students perceive their learning. Along with the necessary skills that were indicated in the 20th century, such as creative thinking, critical thinking, problem solving, and inquiry-based learning; in this study, we identified three essential skills and competences needed for work, citizenship, and self-actualization in the 21st century: a. Acclimatizing to frequent changes and uncertain situations, b. Communicating in decentralized and nonhierarchical environments, c. Generating shared knowledge and managing information multiplicity.

Strand 13: History, Philosophy, and Sociology of Science

Nature of Science: We Know the Past, but What About the Future?

2:15pm-3:45pm, El Morro 1 & 2

Presiders:

Catherine M. Koehler, Southern Connecticut State University

Valarie L. Akerson, Indiana University

Presenters:

Norman G. Lederman, Illinois Institute of Technology

Michael Matthews, University of New South Wales

William McComas, University of Arkansas

Fouad Abd-El-Khalick, University of Illinois

Christine V. McDonald, Griffith University

Ian Binns, University of North Carolina, Charlotte

ABSTRACT: Research on the nature of science (NOS) has been ongoing since the mid 1950's. For the past 30 years, the researchers exploring aspects of NOS have made strides in science education by: (1) defining the construct, (2) measuring conceptions of it in multiple populations, (3) creating strategies to teach it in a variety of classrooms, and (4) exploring ways to integrate it into curriculum. Lederman (2007) has advocated several lines of research yet to be explored, and many NOS acolytes have pursued these lines of research with vigor and renewed interest. However in recent years, there appears to be a silent voice in opposition to this valued line of investigation. One example is within the recent US National Science Frameworks and Standards documents where explicit references to NOS were excluded. In this administrative symposium, we have gathered a panel of experts who actively engage in NOS research to discuss its future in science education, and how we can embark on perpetuating this line of research for years to come.

Strand 14: Environmental Education

Out-of-Classroom Contexts for Environmental Education

2:15pm-3:45pm, Río Mar Salon 7

President: Jennifer Adams

Families' Science Conversations at a Nature Center: Prior Learning Experiences as Shapers of New Knowledge

Lucy R. McClain, Penn State University, lbr118@gmail.com

Heather T. Zimmerman, Pennsylvania State University

ABSTRACT: Using family learning groups as the analytical focus, the study presented here adds to the field of informal learning, environmental education, and science education by focusing on an understudied setting: designed outdoor learning spaces. The employment of ethnographic methods sought to observe and analyze 15 families participating in nature walks at a local nature center. Each family's prior informal science learning experiences, conversations, and actions provided learning strategies for learning together as a social group and making meaning out of the local environment. Three main findings include: (1) families readily connect prior experiences to new information they

encounter in an outdoors setting, (2) families have extensive and diverse informal education experiences from which to draw from in order to make meaning about the local environment, and (3) school-based science knowledge may not necessarily be preferable for family learning about the environment during an informal, outdoor-based program. Implications from this study emphasize the importance of adequately designed outdoor learning spaces in order to enhance a family's environmental educational experiences within an outdoor context.

The Role of Contact with Nature in Students' Emotional Well-Being: Implications for Education

Carolina Castano, Australian Catholic University, carolina.rodriquez@acu.edu.au

ABSTRACT: Contact with nature is considered to be necessary for the correct development of children and to have a positive impact in their attitudes and behaviours. There is enough evidence to support the role that contact with nature has in human emotional and physical well-being. Moreover, empirical research has shown that children with challenging behaviour could be benefited by direct contact with nature and with other animals. Yet, many schools lack green spaces, and in many communities, opportunities for direct contact with nature are decreasing. In this paper I discuss how contact with nature could contribute to reduce feelings and emotions which are linked with aggressive behaviour. I present findings from two field trips that were organized as part of a science class for students that came from a socio-economic disadvantaged population and who were presenting high levels of aggression. I describe the attitudes and perceptions from the students regarding their experiences of contact with nature and animals during the two excursions. Implications for science and environmental education and its role in the wellbeing of children are also examined.

Zoo Conservation Messages: How do Visitors to Zoos Interpret the Messages it Intends to Convey

Chagit E. Tishler, Ben-Gurion University of the Negev, tishler@post.bgu.ac.il

Orit Ben-Zvi Assaraf

Michael N. Fried

ABSTRACT: Zoos, as institutions of leisure, and education, are in an ideal position to play an active role in raising public awareness to nature conservation. They are designed informal learning environments that provide a safe and comfortable atmosphere for people to experience learning. This paper is the summation of a broader qualitative study that aims to investigate the extent and the means by which conservation messages are conveyed and the processes by which they are received by the visitors. A special focus is given to the different visitor populations. Here we report on the first stage of the study. Our research questions focus on how the visitor interprets the intended messages conveyed by the zoo. The research takes place at the Tisch Family Zoological Gardens in Jerusalem. Our findings show significant differences between the way Jewish and Arab visitors understand the messages that were intended to be conveyed to them. Findings shows that conservation is not seen as a prominent message of the zoo by its visitor and the way it is perceived depends on the degree of religiosity. Our results may add to zoos' ability to develop improved means for conveying general environmental and more specific conservation messages.

Strand 15: Policy

Science Education and the STEM Pipeline

2:15pm-3:45pm, Río Mar Salon 10

Presider: Sharon J. Lynch, George Washington University

Do Preparation and Inspiration During High School Increase the Likelihood of Pursuing a STEM Degree?

Martha C. Bottia, UNC Charlotte

Roslyn A. Mickelson, University of North Carolina at Charlotte

Elizabeth Stearns, UNC Charlotte

Ashley Parker, UNC Charlotte

Stephanie Moller, UNC Charlotte

ABSTRACT: This study examines how high school experiences of inspiration and preparation in science and mathematics, influence students' decisions to pursue STEM majors in college. We conceptualize inspiration and preparation as students' exposure to science and math during high school, and the quality and quantity of science-

related classes, respectively. We argue that awakening and reinforcing students' interest early, providing high quality instruction, and systematic exposure to STEM materials, differentially increase the likelihood of joining a STEM discipline for males and females from different races and ethnicities. We employ a longitudinal dataset that includes information from fifteen thousand students in the North Carolina university system. Utilizing multilevel multinomial logit models, we find that both inspirational and preparatory experiences are significant predictors of students' likelihood of pursuing a STEM field. Findings suggest that experiences of inspiration and preparation interact with demographic variables (race/ethnicity and gender) to moderate students' interest in STEM areas. In general, experiences of inspiration and preparation are more strongly related to pursuit of STEM disciplines for females and Whites. We find evidence that inspiration and preparation experiences in high school influence the likelihood of following a STEM major in college both directly and indirectly through high school math achievement.

The Achievement Gap in Science: A Turkish Perspective

Mustafa S. Topcu, Mugla Sitki Kocman University, msamitopcu@gmail.com

ABSTRACT: Turkey is a highly developing country with a booming economy and the youngest population ratio in Europe. Despite this young population rate, the achievement levels of most students in science are below expected levels. In terms of general science achievement ranking, Turkey was 29th among 30 OECD countries in the Programme for International Student Assessment (PISA) 2006 and was 32nd among 34 OECD countries in PISA 2009. In addition to low achievement levels of Turkish students in international context, there are also achievement gaps in national context. In general, achievement gaps exist in the Turkish education system because of four reasons: large quality differences in school types, extremely competitive nationwide examinations, teacher-centered science teaching, and the effects of large socioeconomic background differences on science achievement. In response to these challenges, the Ministry of National Education (MONE) has taken many precautions. The number of nationwide examinations, especially at elementary school levels, has decreased. Moreover, MONE continues to decrease the number of school types, especially at high school levels, because the biggest achievement gaps in science exist between high school types. As a last effort, in order to decrease the effects of socioeconomic background differences on science achievement, studies continue by MONE.

Charting Community College Pathways in System-Wide Efforts to Promote College Persistence and Attainment in STEM

Felisha A. Herrera, University of California, Los Angeles, fherrer1@gmail.com

ABSTRACT: Community colleges have a growing role in STEM education. More attention must be devoted to this sector of higher education to strengthen this pipeline considering the diverse student populations entering STEM pathways through two-year colleges. This session highlights recent national data on community college students to examine the key indicators influencing STEM persistence and completion. Multilevel modeling is used to explore a longitudinal sample of students who began postsecondary education at two-year public colleges and pursued majors in STEM fields. Salient findings relate to the experiences of historically underrepresented racial minority students and conclusions point to the role of first year interventions and early academic involvement in advancing two-year students in the STEM pipeline. Findings from this study help to solidify a better understanding of the student characteristics, experiences, and institutional contexts that influence community college students' persistence and attainment in STEM. Connecting these results to recent policy and national efforts, implications for education administrators, practitioners, and researchers are discussed.

Defining the U.S. Federal Perspective on STEM with a Process Model

Kent J. Crippen, University of Florida, kcrippen@coe.ufl.edu

Julie C. Brown, University of Florida

Kristen Appleby, University of Florida

Rich Busi, University of Florida

Derya Evran, University of Florida

Cheryl A. McLaughlin, University of Florida

Matthew Peace, Florida Gateway College

Ali Temurtas, University of Florida

ABSTRACT: This presentation will address The S in STEM Education: Research, Policy and Practice by engaging attendees

with a model for the national conversation on science, technology, engineering, and mathematics (STEM) education. Currently, the concept is not well defined and this limits our collective ability to create programs and situate our work in a broader context. The authors have completed an exhaustive review of the published material related to the topic of STEM education. This material included empirical research, policy documents, and commentary. The goal of this pursuit was to develop a conceptual framework that would afford a more detailed discussion, including themes for situating current and future work involving all interested stakeholders. This presentation will overview our framework, engage the audience in a discussion of our findings, and conclude with an ongoing opportunity to further collaborate and comment on our ideas as we prepare to more broadly disseminate them.

Concurrent Session #9**4:00pm – 5:30pm****Publications Advisory Committee Sponsored Session*****Celebrating Fifty years of JRST: Editors' Perspectives on its Past, Present, and Future***

4:00pm-5:30pm, Caribbean Salon 1

Presiders:

Carolyn S. Wallace, Indiana State University

Danielle J. Ford, University of Delaware

Presenters:

William C. Kyle, Jr., University of Missouri - St. Louis

Angela Calabrese-Barton, Michigan State University

Joseph S. Krajcik, Michigan State University

J. Randy McGinnis, University of Maryland

Dale R. Baker, Teachers College

Charles W. Anderson, Michigan State University

Ron G. Good, LSU

James A. Shymansky, University of Missouri – St. Louis

Mike D. Piburn, Arizona State University

ABSTRACT: In this session sponsored by the Publications Advisory Committee, current and former editors of the Journal of Research in Science Teaching will gather to discuss past, present and future issues and trends in science education research. The moderated discussion topics will include the editors' reflections on the prominent themes in science education, key articles and accomplishments, and possible missed opportunities during their tenure as editors. They will also share their perspectives on current research trends. The panel will conclude with an interactive discussion of the editors' perspectives on the future of our field, its publications, and the ways in which we share research among the international science education community and broader audiences in light of rapidly changing information technologies and expectations for research.

Research Interest Group CADASE & Equity and Ethics Committee Sponsored Session***Symposium - A response to the Horizon Research Symposium - Unequal Distribution of Resources for K-12 Science******Instruction: April 8, 8:30am-10:00am, Río Mar Salon 8***

4:00pm-5:30pm, Río Mar Salon 8

Presiders:

Felicia M. Mensah, Teachers College, Columbia University, fm2140@tc.columbia.edu

Jomo W. Mutegi, Indiana University, Indianapolis

Mary M. Atwater, University of Georgia

Presenters:

Pamela Fraser-Abder, New York University

June George, The University of the West Indies

Audre M. Green, University of South Alabama

Peter A. Okebukola, Lagos State University

Meshach B. Ogunniyi, University of the Western Cape

Jerome Shaw, University of California, Santa Cruz

ABSTRACT: This past year the NARST Board approved the establishment of NARST's first Research Interest Group (RIG). The RIG (the Continental and Diasporic African in Science Education - CADASE) is committed to promoting the study of science teaching and learning for people of African descent. Horizon Research Group has conducted a large-scale study examining the distribution of resources (human and other kinds) across K-12 schools and classrooms nationally. They will present this research at the 2013 NARST Meeting. Members of the CADASE/Equity and Ethics will serve as panelists and are asked to respond to Horizon Research Group's research.

Strand 1: Science Learning, Understanding and Conceptual Change***Structural Features and Characteristics of Physics that Impact Students' Learning***

4:00pm-5:30pm, Río Mar Salon 1

Presenter: Knut Neumann*Refinement of Logico-Mathematical Intelligence in the Context of Physics Education*

Lina Vinitsky Pinsky, Achva Academic College, lina.vinitskypinsky@gmail.com

Igal Galili, The Hebrew University of Jerusalem

ABSTRACT: Refinement of Logico-Mathematical Intelligence in the Context of Physics Education Physics and Mathematics are deeply interwoven causing complexity of their curricular relationship in science education. The span of perspectives spreads from their identity to opposition. Gardner's (1983) multiple intelligences do not suggest more than one relevant category of logico-mathematical intelligence, and testing intelligence (e.g., IQ and SAT) does not distinguish between the skills required in mathematics and natural sciences. Our study investigated the interrelation of mathematics and physics in view of physics teachers. Twenty individual interviews were performed using the constructive-qualitative research method. The constructed profile of teachers' views on the virtues required in learning physics reveals the complexity of different and in a way, complementary views. Although, mathematics preparation apparently correlates with students' performance in physics one cannot state that it univocally stipulates their success in learning physics. The particular dependence on mathematics requires refinement. It is clear that physics demands specific internal and external psychological features suggesting reexamination and refinement of the concept of logico-mathematical intelligence currently accepted as a prerequisite in learning physics. Confusing the difference between mathematics and physics in our system of education implies far-reaching distortion and shortcomings of physics education.

Investigating Student Mental Models at the Intersection of Mathematical and Physical Reasoning in Science

Savannah E. Lodge-Scharff, University of Maine, s.lodgescharff@gmail.com

Jonathan Shemwell, University of Maine

ABSTRACT: A significant challenge in learning science and mathematics is coordinating different types of mental models, such as mathematical and physical mental models, that represent different aspects of a given phenomenon. This challenge is illustrated in the present study, in which we observed a small number of college students thinking about forces as both physical and mathematical quantities as they reasoned about a physical system. Using video analysis of the students' speech and gestures as they reasoned about the system, we documented the construction and coordination of participants' physical and mathematical mental models. We found that participants readily constructed mathematical mental models as imagined vector arrows or lines, but they less readily constructed force mental models as imagined pulls. Moreover, students rarely exhibited coordinated vector (mathematical) and force (physical) mental models needed to represent the force vector component which was key to understanding the overall system. Taken together with the assumption that coordinated mathematical and physical mental models support robust understanding, these findings suggest that instruction in physical-mathematical quantities, such as force vectors, would benefit from greater emphasis on building mental models of physical aspects of such quantities and coordinating these with mental models of mathematical aspects.

Examining the Consistency in Eighth Grade Students' Mental Model Representations about Magnetic Interactions

Tugba Yuksel, Purdue University, tyuksel@purdue.edu

Lynn A. Bryan, Purdue University

ABSTRACT: We investigated eighth grade Turkish students' mental models about the nature of magnets and magnetic interactions. Thirty-one middle school students, who had not had prior formal magnetism instruction, responded to questions about the structure and functionality of magnets and the interactions between magnets and a nail. Students' responses were analyzed according to the consistency of their mental models across the two different contexts. The findings indicated that the students' mental models about magnets and magnetic interaction reflect some accuracy, but are incomplete. Almost half of the students (42%) had scientifically accepted answers, but a non-scientific and lower

sophistication level of explanation. Furthermore, 35.5% of students showed partial understanding and consistency in their mental models while 27% represented inaccurate and inconsistent mental models about the same phenomena given in two different contexts. In addition, students' responses indicated that the much of the terminology used by students was not quite scientifically appropriate.

Elementary Pre-Service Teachers' Sources of Existing Alternative Conceptions about Weight and Gravity

Rex N. Taibu, Western Michigan University, rex.taibu@wmich.edu

Lloyd M. Mataka, Western Michigan University

ABSTRACT: This is an interpretive study aimed at exploring the sources of pre-service elementary and middle school teachers' alternative conceptions in weight and gravity. Written responses to 18 open ended questions from 34 students enrolled in the physics course (Inquiry and Insights) were analyzed using thematic content analysis. Data was collected before the dynamics section of the course was taught to the students. The questions involved weight and gravity concepts and some explicitly asked students the origin of their ideas on weight and gravity. Analysis of results indicated that pre-service elementary and middle school teachers' alternative conceptions in weight and gravity are partly as a result of missing (or faulty) physics principles and partly due to how they experience and interpret the world. The missing (or faulty) physics principles include Newton's second law, third law and Newton's law of gravitation attraction.

Strand 2: Science Learning: Contexts, Characteristics and Interactions

Related Paper Set - The Impact of Classroom Discourse on Engagement in Scientific Practices and Student Learning

4:00pm-5:30pm, Río Mar Salon 10

ABSTRACT: Modern science curricula have moved from inquiry based on "the scientific method" to engagement in a variety of authentic scientific practices including explanation and modeling. However, research has shown that different teachers' enactments of the same curricula can vary widely. The sixth grade classrooms studied in this paper set all use the same science curriculum (IQWST); these papers look at how the enactments of that curriculum vary across teachers. Specifically, we investigate how differences in discourse practices impact both student engagement in the scientific practices and student learning over time. We find differences in the way the teachers take up students' everyday ideas, connect student ideas back to the practices, and frame the practices for students, and these lead to differences both in the consensus explanations and models that students construct as a group and those that students construct on their own in written assessments.

The Use of Students' Everyday Knowledge and Evidence in Generating Explanations

Mon Lin Ko, Northwestern University, monlinko2008@u.northwestern.edu

Connecting Students' Everyday Ideas to Scientific Investigations and Explanations

Christina Krist, Northwestern University, ckrist@u.northwestern.edu

Mon Lin Ko, Northwestern University

Using Classroom Discourse to Account for Differences in Written Explanations

Brandy L. Buckingham, Northwestern University, brandy@u.northwestern.edu

Mon Lin Ko, Northwestern University

The Effect of Teacher Framing on Students' Engagement in Scientific Modeling

Abraham Lo, Northwestern University, alo@u.northwestern.edu

Strand 2: Science Learning: Contexts, Characteristics and Interactions

Intersections among Culture, Cultural Practices, Diversity, and Science Learning

4:00pm-5:30pm, Caribbean Salon 2

Presider: Mercy Oqunsola-Bande

Teacher Quality and School Culture: How do Highly-Diverse High Schools Close the Science Achievement Gap?

Carol L. Stuessy, Texas A&M University, c-stuessy@tamu.edu

Dane Bozeman, Texas A & M University

ABSTRACT: Percentage differences in high- and low-minority schools within a large southwestern state indicate a significant achievement gap in high school science. Only 2% of high schools are classified as both high-minority (<75%) schools and "highly successful" using an aggregate measure of science achievement and college readiness; 25% of high schools have high-minority student enrollment proportions (MSEP). In comparison, 16% of the state's lower-MSEP schools are highly successful on the same measure of success. These differences begged the question: What makes the small number of high-MSEP schools able to "close the science achievement gap" when so many others did not? Was success a matter of teacher quality, or was there more to the picture, as suggested by recent literature? This study investigated the school cultures of ten "achievement gap schools" in comparison to 50 other schools representing the entire population of high schools in the state. School culture variables included schools' levels of professional support, teachers' professional activities and job satisfaction, and science teacher retention rates. We report results regarding the unique qualities of highly successful high-diversity schools in the state, leading to a deeper understanding of the culture of schools successful in narrowing the science achievement gap.

Longitudinal Analysis of Science Program Experiences to Design a Science Partnership Program Model

Megan E. Faurot, Illinois Institute of Technology, mfaurot@hawk.iit.edu

Norman G. Lederman, Illinois Institute of Technology

Stephen Bartos, Illinois Institute Of Technology

ABSTRACT: Science programs for high school students have been one of many efforts to increase the representation of women and minorities in science career trajectories. The purpose of this study was to examine the influence that science program experiences have on academic and career paths and to design an initial science program model. The sample consisted of 40 females (62%) who participated in a science program (2007-2010) in the U.S. Midwest. The majority of the sample was African American (78%) and whose mothers (56%) and fathers (81%) did not have college degrees. The academic and career survey revealed that the majority of degrees (86%) and careers (80%) the participants were pursuing were in science and health-related fields. The other survey measured the influence (5-point Likert scale) of nine program experiences, related to learning, relationship-building, and personal development, that students had with the high school, university, and family partners. Most experiences were rated as being somewhat to very influential on the participants' academic and career paths. Addressed in the initial design of the program model were partners' shared and distinct roles. Further research to develop this initial design into an established science partnership program model would have numerous benefits on science education.

Reshaping Interactions in Urban Science Learning Environments: The Peer Enabled Restructured Classroom

Leslie S. Keiler, The City University of New York, lkeiler@york.cuny.edu

Sarah Bonner, The City University of New York

Pam Mills, The City University of New York

Linda Gerena, The City University of New York

ABSTRACT: The Peer Enabled Restructured Classroom (PERC) model places average-performing students as peer instructors (called Teaching Assistant Scholars or TAS) at the head of collaborative learning teams, leveraging the power of peer-to-peer motivation and scaffolding to create student-centered learning environments. The main objectives of PERC are to close achievement gaps in science performance, high school graduation rates, and college readiness. Pilot study results show consistently higher outcomes in PERC classes compared to traditional classes. The PERC model radically alters interactions among students and between teachers and students. In PERC-Science, the teacher begins class by providing a conceptual context, then at least 30 minutes of each class each day is spent in small group work led by TAS. In a well-implemented PERC class, students stay on task and discuss biology, guided by TAS. They follow instructions provided by TAS, ask TAS questions when they are confused about content or task requirements, answer scaffolding questions posed by TAS, and have TAS check the quality of their work before moving on to a new task. Teachers act as managers of their instructional team and assessors of understanding. These new classroom roles and relationships are explored and analyzed to explain the model's outcomes.

Strand 3: Science Teaching--Primary School (Grades preK-6): Characteristics and Strategies***Symposium - The Status of Elementary Science Education: Are We Ready for the Next Generation Science Standards?***

4:00-5:30, Río Mar Salon 3

Presenters:Eric R. Banilower, Horizon Research Inc., erb@horizon-research.com

P. Sean Smith, Horizon Research Inc.

Peggy J. Trygstad, Horizon Research Inc.

Michele M. Nelson, Horizon Research Inc.

ABSTRACT: The forthcoming Next Generation Science Standards (NGSS) aim to reshape K-12 science education, but making the vision a reality will require changes throughout the education system. What teachers ultimately do in the classroom depends on a host of factors, including state and district policies, school structures and supports, preservice preparation, inservice learning opportunities, parent/community expectations, and availability of instructional resources, among others. This symposium will share results about the current status of elementary science education from the 2012 National Survey of Science and Mathematics Education, which gathered data from a nationally representative sample of schools and teachers of science about many of these factors. The symposium will focus on topics such as school and district policies to support science instruction, teacher attributes (e.g., experience, college preparation), teacher beliefs about teaching and learning, instructional resources, professional development opportunities, and instructional practices. Results from an analysis of how these factors predict teachers' instructional practices will also be discussed. The audience will engage in a series of small-group discussions about the results and how they compare to their own experiences. Panelists and attendees will also consider implications for future research and for preparing the K-6 science education system for the NGSS.

Strand 4: Science Teaching--Middle and High School (Grades 5-12): Characteristics and Strategies***Symposium - A Report on the PCK Summit: Current and Future Research Directions***

4:00pm-5:30pm, Pelican Room

President: April L. Gardner, Biological Science Curriculum Study**Presenters:**Julie Gess-Newsome, Willamette University, jgessnew@willamette.edu

Janet Carlson, BSCS

Amanda K. Berry, Monash University

Andreas Borowski, University Duisburg-Essen

Hans E. Fischer, University Duisburg-Essen

Ineke Henze, Radboud University, Nymegen

Sophie Kirschner, University Duisburg-Essen

Elizabeth Mavhunga, University of Witwatersrand

Soonhye Park, University of Iowa

ABSTRACT: Definitions and measurement of pedagogical content knowledge (PCK) have diverged in the past 25 years. This session examines the results of a five-day international PCK Research Summit where 14 research teams examined the variations in conceptions of PCK models, measurements, and results. The goal of the Summit was to catapult research in the field through either consensus or purposeful divergence in models and measurement tools. This session will provide an orientation to the PCK Summit, presentations by six of the participating teams, an overview of the conclusions of the Summit, and a discussion of next steps including the identification of the most fruitful lines of research identified.

Strand 5: College Science Teaching and Learning (Grades 13-20)***Improving Student Learning in Chemistry***

4:00pm-5:30pm, Parrot Room

Presider: Abdulkadir Demir*Improving Student Understanding of Ionic Compounds with Pogil Instruction*

Abdi M. Warfa, University of Minnesota, moham489@umn.edu

James Nyachwaya, University of Minnesota

Gillian Roehrig, University of Minnesota

Jamie L. Schneider, University of Wisconsin River Falls

ABSTRACT: Students often use molecular framework to represent ionic compounds at the particulate level. To address this issue, we developed POGIL (Process-Oriented Guided-Inquiry Learning) activities that specifically target student misconceptions related to molecular versus ionic bonding. We used a mixed methods approach with a concurrent triangulation strategy in which one-group pretest-posttest quantitative data is coupled to qualitative data analysis to explore the effects of the intervention. Our preliminary data suggests the POGIL activities we developed improved student representation of ionic compounds in aqueous solutions. Our study provides proof of concept that targeted instructions inspired by evidence-based pedagogies can improve student's conceptual knowledge growth and reduce preconceived and alternate conceptions about chemical ideas. The preliminary findings and analysis of the data will be discussed.

Exploring Computerized Lexical Analysis to Predict Calibrated Peer Review Ratings of Student Writing in Chemistry

Kevin Haudek, Michigan State University, haudekke@msu.edu

Arlene A. Russell, University of California, Los Angeles

Mark Urban-Lurain, Michigan State University

ABSTRACT: Writing in undergraduate science courses represents an authentic scientific task and allows insight into student thinking, but is often limited in large enrollment courses due to resource constraints. We are investigating the combination of two approaches for evaluating student writing to overcome these constraints: Calibrated Peer Review (CPR) and computerized text analysis. We investigate the possibility of computerized analysis of long (approximately 1900 characters), highly-structured essays, which have been scored by multiple trained, student peer reviewers. We extended and revised resources created in previous lexical projects for an assignment about buffer systems given in a general chemistry course. Our analysis revealed that students used many ideas in their writing. Over 90 lexical categories were created to capture the ideas in student writing, with each student's response placed into about 30 categories. We used these lexical categories as independent variables in statistical models to predict peer ratings. The resulting scoring model used eighteen independent variables and had little shrinkage between training ($R^2=0.281$) and testing ($R^2=0.234$) sets of data. The independent variables selected by the scoring model align well with the scoring rubric used by the peer reviewers, providing face validity for the lexical analysis.

Developing a Learning Progression on Benefits, Costs, and Risks in Chemical Design

Hannah Sevia, University of Massachusetts Boston, hannah.sevia@umb.edu

Steven Cullipher, University of Massachusetts Boston

Vicente A. Talanquer, University of Arizona

ABSTRACT: The development and implementation of strategies to analyze and synthesize chemical substances are fundamental goals of chemistry. But as chemistry has transformed the way we live, it has also opened up environmental and social problems. An understanding of ideas, practices, and implications of chemical design is critical to the education of students who are expected to make decisions about using chemical products in their lives and professions. We take a learning progression (LP) approach to studying student reasoning about benefits, costs and risks in chemical design, characterizing likely pathways of the development of understanding in terms of the evolution of implicit assumptions about the nature of entities and processes in a domain. Through research phases involving the development of initial descriptions based on literature review, refinement and enrichment via data collection with students, and generation of hypotheses about critical steps in the evolution of implicit assumptions from novice to more sophisticated, we propose a hypothetical LP. The LP is organized by candidate progress variables along which reconceptualizations are hypothesized

to occur. This hypothetical framework can serve as a starting point for iterative validation involving the study of strategic use of instructional and learning resources for which the framework holds implications.

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

Argumentation in College Science Teaching

4:00pm-5:30pm, San Cristobal

Presider: Yasemin Ozdem

Exploring University Students' Understanding of Science Process Skills and Arguments Appeared in Introductory Chemistry Laboratory Reports

Eulsun Seung, Indiana State University, esseung@gmail.com

Aeran Choi, Ewha Womans University

Beverly C. Pestel, Indiana State University

ABSTRACT: The purpose of this study is to explore university students' understanding of science process skills and to develop criteria for evaluating the quality of the claim-evidence relationship that appears in the process-oriented chemistry laboratory reports. Based on the belief that an introductory chemistry laboratory course could best serve students by having them develop an understanding the nature of chemical knowledge and how chemical knowledge and products are acquired, we have developed a process-oriented chemistry laboratory curriculum to replace a traditional recipe-style curriculum. As the main data source, we collected written laboratory reports, which included the components of scientific argument (i.e. claims, evidence, and reflection), from eighty students over the course of two semesters. By analyzing the students' written laboratory reports, we have identified the patterns of process skills they developed. We also developed criteria to evaluate the claim-evidence relationship that appeared in their laboratory reports. The results of this study show that university students developed various patterns of science process skills throughout the semester. The process-oriented curriculum also contributed to improving students' scientific argument which cites appropriate evidence to their claims in their laboratory reports.

Conceptual Knowledge, Argumentation and Scientific Reasoning Gaps of Low and High Scientific Reasoners in an Argumentation Based Inquiry Instruction

Ömer Acar, Kocaeli Universitesi, omer.acar@kocaeli.edu.tr

Bruce Patton, The Ohio State University

ABSTRACT: This study investigated if an argumentation based inquiry course helps to close the conceptual knowledge, argumentation, and scientific reasoning gaps between low and high scientific reasoners. For this aim, 41 undergraduate students were categorized under low and high scientific reasoners according to their score at scientific reasoning pretest. Student conceptual knowledge, argumentation, and scientific reasoning were assessed before and after the instruction. Argumentation tasks were incorporated to physics by inquiry curriculum using competing theories strategy. Results showed that high scientific reasoners scored higher than low scientific reasoners on situational knowledge and rebuttal skill. Although rebuttal skill gap closed after the instruction, situational knowledge gap still existed. In addition, despite a scientific reasoning gap was found between the two groups after instruction, this gap was less than that of at the beginning of the instruction. Implications were discussed according to the findings.

Exploring the Effects of Scaffolding on College Students' Solutions and Argumentation Quality on Conceptual Physics Problems

Carina M. Rebello, University of Missouri, cp5xc@mail.missouri.edu

Lloyd H. Barrow, University of Missouri

ABSTRACT: Prior studies have revealed students' difficulties in problem solving in physics due to poor reasoning skills. Research has shown that inclusion of argumentation tasks can improve these skills. Through a mixed-methods approach, I focus on the development and implementation of alternative forms of argumentation scaffolds (to construct or evaluate an argument) integrated within physics problems, and their impact on conceptual and argumentation quality of students' written solutions across multiple physics topics. Additionally, I investigate how physics students solve problems supporting argumentation. Results suggest that the scaffolds, not mere inclusion of "explain your reasoning"

prompts, can improve students' argumentation skills. Additionally, how students approach solving problems supporting argumentation may affect the quality of argument constructed.

A Comparison of Biology Majors' Written Argumentation Skills across the Curriculum

Melissa Schen, Wright State University, melissa.schen@wright.edu

ABSTRACT: Argumentation in science is the process of coordinating theory and evidence to support conclusions. This scientific practice is the heart of scientific journal writing and communication, but little is known regarding the argumentation abilities of college science majors, our future scientists. Studies on written argumentation at the college level have focused primarily on non-majors and upper level students. To investigate these skills throughout the biology curriculum, majors at four levels of undergraduate biology courses and beginning graduate courses were assessed using a short, written argumentation instrument based on a hypothetical data set and scenario. Using Toulmin's argumentation pattern (1958) to assess the instruments, very few differences were found in the scores across the course levels. Students were able to generate simple arguments. In addition, the ability to provide scientific principles to connect evidence and claims was positively correlated with course level. Advanced argumentation skills, such as creating alternative explanations and rebuttals, were lacking across all course levels. These findings imply the need for explicit attention to argument construction throughout the undergraduate biology curriculum.

Strand 6: Science Learning in Informal Contexts

Symposium - Understanding Interactions at Science Centers and Museums - Approaching Sociocultural Perspectives

4:00pm-5:30pm, Sea Gull Room

President: Helene Sorensen, University of Aarhus

Presenters:

Eva Davidsson, Malmö University, eva.davidsson@mah.se

Anders Jakobsson, Malmo University

Doris B. Ash, University of California - Santa Cruz

Jennifer DeWitt, King's College London

Tali Tal, Technion

ABSTRACT: There is an increased interest in approaching visitors' learning from exhibition environment through studying their interactions with each other and the accessible artefacts. Within sociocultural theories, research seeks to explore issues such as in what ways people acquire knowledge and experiences or how people learn to use this knowledge in different contexts. The focus is thus not on the individuals and their capacities, but sociocultural perspectives instead centre the interactions between individuals, society and resources such as technical devices put at their disposal in their society. In this symposium, we approach and use sociocultural perspectives and theories for exploring interactions at different levels and in different contexts at STCs and museums. This implies that the focus of the individual presentations is related to different empirical studies concerning understanding interactions at science centres and museums in the context of school visits, museum educators, family visits, or from a theoretical perspective.

Strand 7: Pre-service Science Teacher Education

Preservice Teachers' Conceptions and Challenges About Biology Education

4:00pm-5:30pm, Río Mar Salon 9

President: Sarah A. Haines

Without the Light of Evolution: Resistance and Avoidance in Learning to Teach High School Biology

Douglas B. Larkin, Montclair State University, larkind@mail.montclair.edu

Gail Perry-Ryder, Montclair State University

ABSTRACT: In order to explore the implications of teacher resistance and avoidance to the topic of evolution, we present the case of a prospective high school biology teacher named Michael whose avoidance of evolution in his own education led to further disengagement with evolution in his methods coursework and in his student teaching practice. His use of the discourse of evolution in coursework and in student teaching activities also helped to obscure his

opposition to learning evolution, even as his cooperating teacher and university supervisor praised his teaching. Kohl's (1994) concept of "not-learning" is used to analyze Michael's resistance. This research has implications for both the admissions process and curriculum of biology teacher preparation programs. We argue that proficiency for teaching biology means not only tolerating evolution as a topic to be covered in class, but also advocating for evolution as a foundational theme in the discipline.

A Comparison of Elementary Education Major's Acceptance and Understanding of Evolution with Other Majors

Ronald S. Hermann, Towson University, rhermann@towson.edu

ABSTRACT: This study seeks to better understand the extent to which elementary level teachers are willing and able to teach evolutionary concepts. University students participated in pre- and post-test surveys which included demographic information, measures of religiosity, eight questions from the CINS (Anderson, Fisher & Norman, 2002), and the twenty item MATE (Rutledge & Warden, 1999). The hypothesis that elementary education majors understand and accept evolution at the same level as non-science majors, but below the level of science and engineering majors was not supported. Elementary education majors were more religious ($p=.42$), significantly less understanding ($p=.01$) and significantly less accepting of evolution ($p=.00$) than arts, humanities or social science majors. The same trend was apparent when comparing elementary education majors to other majors surveyed. The results suggest that there is a relationship between understanding and acceptance of evolution among the entire sample ($r=.43$, $p=.00$) and among elementary education majors specifically ($r=.37$, $p=.00$). RASCH analysis indicated elementary education majors more readily endorsed statements indicating an acceptance of evolution and less readily endorsed statements indicating they don't accept evolution. To break the cycle, science educators must work diligently to better prepare pre-service elementary teachers to teach science in general and evolution specifically.

Assessing Pre-Service Teachers' Professional Knowledge in Biology: The Project KiL

Jörg Großschedl, University of Kiel, Germany, grossschedl@ipn.uni-kiel.de

Miriam Waldmann, University of Kiel, Germany

Ingrid Glowinski, University of Kiel, Germany

ABSTRACT: Shulman (1986) distinguished three core components of teachers' professional knowledge: content knowledge (CK), pedagogical content knowledge (PCK), and pedagogical knowledge (PK). This knowledge is to be acquired in teacher education, but there is a lack of instruments to assess these kinds of knowledge validly. The KiL project (Measuring Professional Competence of students studying to become science and mathematics teachers), an interdisciplinary research project on professional knowledge, aims at filling this gap by developing instruments to assess students' PK, CK and PCK in science and mathematics. In the KiL project, students' CK and PCK in biology are conceptualized in two models. Both models are 2-dimensional; in each one dimension is referring to the content of knowledge, the other is referring to cognitive processes. For biology 120 items were developed for CK and PCK, respectively. The developed items were evaluated in a pilot study ($N = 345$ students; average age = 22.78 [$SD = 2.31$]) in 2012. Item examples, item fit, and model fit will be presented at the conference. The final item pool provides a variety of options for further research on the development of students' professional knowledge in biology in different tracks and phases during university education (e.g., longitudinal studies).

American, German, Korean, and Indonesian Pre-Service Teachers' Evolutionary Acceptance, Knowledge, and Reasoning Patterns

Ross H. Nehm, The Ohio State University, nehm.1@osu.edu

Minsu Ha, The Ohio State University

Jörg Großschedl, Biology Education, Leibniz Institute for Science and Mathematics Education (IPN), Germany

Ute Harms, Leibniz Institute for Science and Mathematics Education (IPN), Germany

Fennyroshayanti Roshayanti, IKIP PGRI Semarang, Indonesia

ABSTRACT: Several studies have suggested that American students and teachers are exceptional in their low knowledge and acceptance of biological evolution. Nevertheless, few international comparison studies have been conducted that utilize published and validated instruments capable of capturing rich portraits of student and teacher reasoning. Our study employed three validated instruments (CINS, ACORNS, MATE) to study cross-sectional (4-year) samples of pre-service biology teachers ($n = 717$) from Western (US, Germany) and Asian (Korea, Indonesia) nations characterized by

different socio-cultural contexts. We examined evolutionary knowledge, acceptance, and reasoning patterns in explanation tasks differing in contextual features (gain, loss, animal, plant), and the structures of evolutionary explanations. We found knowledge and acceptance to be significantly (but moderately) associated ($r \sim 0.3$) in all countries except Indonesia. US students had comparable acceptance levels as those from Germany, and greater levels than Korea and Indonesia. Misconception magnitudes were only slightly different among nations ($\eta^2 = 0.04$). Corroborating past work, US, German, and Korean students were significantly more successful at explaining animal than plant evolution, and reasoning about trait gain than reasoning about trait loss. Our results suggest that similar evolutionary reasoning challenges face students in all of the nations that we studied.

Strand 8: In-service Science Teacher Education

The Scaffolding Role of Community in Professional Development

4:00pm-5:30pm, Río Mar Salon 4

Presider: Italo Testa, University of Federico II Napoli

Science Teachers Difficulties when Dealing with Socio-Scientific Discourse

Italo Testa, University Federico II Napoli, italo@na.infn.it

ABSTRACT: This qualitative study explores the extent to which in-service Science teachers are able to exploit Socio-Scientific Issues (SSI) to address content knowledge. Data were collected with 75 Italian teachers enrolled in a three-days training program. During the training sessions the following themes were addressed: decisions about a SSI scenario and identification of the content knowledge relevant for the issue; construction of a SSI scenario for a chosen Science content; design of a task to teach content knowledge using an assigned SSI scenario. Worksheets served as training materials and research instruments. The teachers' answers to the worksheets' tasks were analysed using a grounded theory approach. Findings show that most of the teachers did not use content knowledge to reason about SSI; moreover, the great majority had some difficulties in identifying the contents addressed in the proposed SSI scenarios and in developing suitable SSI tasks to teach Science contents. Main factors affecting teachers' difficulties may be related to: scarce familiarity with context-based Science teaching; scarce awareness of the role of Science in social controversies and of the role of argumentation and decision-making processes in scientific reasoning. Implications for teacher education aimed at spreading SSI approaches in school practice are discussed.

The Role of Science in Promoting Critical Collegueship in a Mixed-Content Professional Learning Community

Amelia W. Gotwals, Michigan State University, gotwals@msu.edu

Dawnmarie Ezzo, Michigan State University

Increasing Science Achievement in an Urban School District Through Science Teacher Collaborations with Paraprofessionals

Kimberly A. Staples, Kansas State University, kstaples@ksu.edu

ABSTRACT: This proposal presents a case study from one professional learning community (PLC) that was part of a statewide professional development aimed at improving teachers' knowledge about and implementation of formative assessment. The PLC was composed of middle school teachers from multiple disciplines. The members of the PLC spent over half of their meeting time developing learning targets and associated formative-assessment prompts with the two science teachers in the PLC who were teaching an earth science unit. An analysis of the video of the PLC meetings throughout the year revealed that when the PLC members focused their discussion on the science content and the ways in which the science teachers were preparing to teach the science content, they moved from non-critical, general discussion of formative assessment and sharing of classroom examples to become critical colleagues (Lord, 1994) who asked probing questions and made each other clarify their thinking and planning for science instruction. The findings suggest having content as a key component of PLC discussions about formative assessment can allow teachers the opportunity to delve into their practice and provide concrete ways of changing their formative assessment strategies.

Learning about Formative Assessment: Science Teachers' Experiences in a Community-Based Professional Development

Dante Cisterna, Michigan State University, cisterna@msu.edu

Amelia W. Gotwals, Michigan State University

ABSTRACT: This study describes the learning experiences of two in-service secondary science teachers who participated in a community of practice in the context of a statewide professional development program. Drawing on a sociocultural perspective and using videotapes of meetings and lessons, this study illustrates the different ways that the teachers engaged in the community of practice's meetings and leveraged their new understandings, experiences, and reflections to begin implementing formative assessment in their science courses. Teachers were able to connect formative assessment understanding and classroom practices as well as to negotiate this new learning in a context framed by the tensions and demands of the school culture. Higher understanding of formative assessment contributed to teachers' improvement in classroom assessment practices, especially when teachers realized that the use of formative assessment provided instructional coherence and promoted students' engagement in science. Moreover, collaboration within the community of practice helped both teachers deal with their perceived contradiction between implementing formative assessment and the school's strong emphasis on grading. This study provides insights about how teachers articulate and negotiate their professional development experiences into sound science instructional practices and to improve their professional knowledge.

Strand 10: Curriculum, Evaluation, and Assessment***Symposium - PROFILES - Promoting Inquiry-based Science Education in Germany and in Other Countries***

4:00pm-5:30pm, Río Mar Salon 2

Discussant: Wolfgang K. Graeber, Leibniz Institute (IPN), wgraeber@ipn.uni-kiel.de**Presenters:**

Claus Bolte, Freie University Berlin

Sabine Streller, Freie Universität Berlin

Theresa Schulte, Freie Universität Berlin

Vincent M. Schneider, Freie Universität Berlin

Tuula Keinonen, University of Eastern Finland

ABSTRACT: PROFILES (Professional Reflection-Oriented Focus on Inquiry-based Learning and Education through Science) is one of the European FP7-funded projects in the field of "Science in Society", promoting a student motivational approach to science teaching. The PROFILES Consortium consists of 20 partners from 19 different countries. PROFILES supports IBSE by raising the self-efficacy of science teachers to take ownership of more student-relevant ways of teaching in consideration of stakeholders' views. The project is based on 'teacher partnerships', implementing existing, exemplary, context-led, IBSE-focussed science teaching materials, guided by long-term teacher training, reflecting on challenges identified by participating teachers to improve their professional skills in developing creative, scientific problem-solving learning environments. PROFILES focuses on students' intrinsic motivation to learn science and aims at enhancing students' competencies in scientific inquiry and socio-scientific decision-making. In the proposed related paper session we will give a brief overview of the PROFILES project as a whole, introduce results from the International PROFILES Delphi Study and reflect on two teacher continuous professional development programmes and their evaluation. Finally we will focus on findings the working groups in Germany (FUB) and Finland (UEF) obtained by evaluating the PROFILES CPD courses impact on the student gains – especially on students' motivation.

Strand 13: History, Philosophy, and Sociology of Science***Symposium - Promoting Epistemic Practices in the Secondary Science Classroom***

4:00pm-5:30pm, El Morro 1 & 2

Presenters:

Andri Christodoulou, University of Southampton, a.christodoulou@soton.ac.uk

Maria-Pilar J. Aleixandre, Universidade De Santiago De Compostela

Jonathan F. Osborne, Stanford University

Aybuke Pabuccu, Abant Izzet Baysal University

Sibel Erduran, University of Bristol
 Beatriz Crujeiras-Pérez, University of Santiago de Compostela
 Jesus Piqueras, Stockholm University
 Karim M. Hamza, Stockholm University
 Per-Olof Wickman, Stockholm University
 Gregory J. Kelly, Penn State University

ABSTRACT: The aim of this symposium is to present and discuss ways in which framing science as epistemic practice might be effective in advancing epistemic, cognitive and social dimensions within science education at the secondary school level. It will be argued presenting science based on a framework of epistemic practices offers science teachers opportunities to present students with the transformative phases that knowledge claims undergo as they are communicated and justified to produce reliable knowledge. In particular, through qualitative studies of spoken discourse in educational settings across four different countries we discuss ways in which the epistemic practices such as constructing, justifying, evaluating and communicating knowledge claims can be made explicit to students, and the role of science teachers in facilitating their students' meaningful participation in these practices. Different contexts such as argument-based instruction, laboratory settings, and learning science through narratives will be explored.

Strand 13: History, Philosophy, and Sociology of Science

NOS in Elementary and Middle School

4:00pm-5:30pm, Heron Room

President: Christine V. McDonald

Evidence-Based Strategies for Teaching Nature of Science to Young Children

Valarie L. Akerson, Indiana University, vakerson@indiana.edu
 Ingrid Weiland, University of Louisville
 Khemmawadee Pongsanon, Indiana University
 Vanashri Nargund-Joshi, Indiana University, Bloomington

ABSTRACT: We provide a research-based model and teaching strategies for teaching nature of science (NOS) to young children (ages 5 to 9). The model describes an iterative teaching cycle that builds from the concrete to the **ABSTRACT**. The authors describe how to embed NOS teaching into existing curricula that do not already include NOS. The authors provide example evidence-based strategies for introducing NOS to young children, for connecting NOS to hands-on and inquiry investigations, and for debriefing the investigations to reinforce NOS connections to science content. The authors include an example of a NOS poster, and a sample list of children's literature for use in introducing and reinforcing NOS conceptions. Recommendations are made for the development of further NOS teaching strategies for young children, and for research that determines the most appropriate strategies, as well as the influence of teaching NOS throughout school careers on student NOS conceptions over time.

Investigating the Impact of Nature of Technology Instruction in a Middle School Science Course

Jerrid W. Kruse, Drake University, jerridkruse@gmail.com

ABSTRACT: The ubiquitous and ever growing emphasis on technology, both in the classroom and society, demands attention to promoting technological literacy in schools. Importantly, just as scientific literacy requires more than content knowledge, technological literacy encompasses far more than learning how to use technology (National Academy of Engineering, 2009; Postman, 1985; 1992; Selber, 2004). Issues regarding the nature of technology (NOT) — the philosophical and sociological understandings of technology — are far more important and far more difficult to grasp than simply using technology. Understanding the NOT is necessary to make truly informed decisions regarding technology. Because of the complex interplay between technology and science, and the emphasis already placed on the nature of science in science education, science courses provide excellent context through which to help students understand the NOT. This paper describes strategies to engage middle school students with the NOT within a middle school science course. The paper further assesses the impact of these strategies on students' views of the NOT. Students' increased knowledge provides evidence that students can be engaged in sophisticated NOT arguments and express more judicious thinking about the nature of technology after NOT instruction.

Teachers' Translation of Nature of Science Views to Instructional Practice

Bridget K. Mulvey, Kent State University, bmulvey@kent.edu

Randy L. Bell, University of Virginia

ABSTRACT: This study explored outcomes of a process skills-based teacher professional development (PD) intervention aligned with situated learning theory on middle school teachers' nature of science (NOS) instruction. Participants were 25 middle school teachers who completed a yearlong graduate course on NOS and scientific inquiry. Data sources included teachers' NOS/inquiry video-based reflections, interviews, and PD-discussion observation notes. Constant comparative data analysis was used to describe if, how, and why participants explicitly integrated NOS into their instruction and the degree to which they applied, adapted, and innovated on PD instruction. All participants taught NOS explicitly and most integrated explicit NOS instruction regularly. This instruction was student-centered and represented applying, adapting, and innovating on PD-based instruction. Indicating high-level transfer of NOS understandings and how to teach it to new contexts, most participants integrated explicit NOS instruction into non-PD-connected lessons. Participants identified as facilitating their effective translation of NOS views into instruction: learning through lessons they could teach themselves, trying to teach NOS followed closely by collaboration, coaching, and reflecting on their own video-recorded instruction. This study provides preliminary evidence that situated learning theory may supply an effective structure for facilitating teachers' integration of explicit NOS instruction.

Teaching Nature of Science and Scientific Inquiry to Diverse Classes of Early Primary Level Students

Judith S. Lederman, Illinois Institute of Technology, ledermanj@iit.edu

Selina Bartels, Illinois Institute Of Technology

Cheng Liu, Beijing Normal University

Juan Jimenez, Illinois Institute of Technology

ABSTRACT: This study examined if diverse primary students can learn Nature of Science and Scientific Inquiry which are key components of Scientific Literacy. The subjects were in three classes; one predominately English speaking, one predominately bilingual Mandarin speaking and another predominately bilingual Spanish speaking. The data about students' understanding of NOS and SI were collected by using a published, valid and reliable oral protocol administered both before and after explicit reflective inquiry oriented science instruction. Results show that young students are capable of developing scientific literacy through explicit reflective science instruction, regardless of prior knowledge, conceptions or demographics. Teachers of young students should understand that their students are capable of develop understanding of NOS and SI, and need to provide their students with opportunities to design their own investigations, write scientific questions, make observations, make inferences and draw conclusions. Also, primary teacher educators should provide experiences for their pre service teachers to prepare explicit and reflective lessons that clearly teach and build scientific literacy.

Strand 14: Environmental Education***Collective Identities and Critical Discourse in Environmental Education***

4:00pm-5:30pm, Río Mar Salon 7

Presider: Anne Kern*Undergraduate Understanding of Climate Change: Influences of Major and Environmental Group Membership on Knowledge Scores*

Joanna K. Huxster, University of Delaware, jhuxster@udel.edu

Ximena Uribe-Zarain, University of Delaware

ABSTRACT: The scientific community has reached a consensus about the occurrence of global climate change and its anthropogenic causes. This is an issue that will require the public support and political leadership in order to enact mitigation strategies. University students, as young, educated members of the United States public, are both current voters and highly invested in our future. This research focuses on undergraduate students at two universities in order to examine their understanding of climate change science. Surveys (n=853, completed=465) were conducted to determine the students' level of climate change knowledge and how students' mental models compare to the scientific model. A Knowledge Score was generated for each student based on his or her responses. It was found that, overall, students

continue to hold misconceptions about the causes of climate change and frequently confuse climate change with other environmental issues, most notably, ozone depletion. This research shows that students in science majors and environmental groups are more likely to have mental models of climate change that closely match the scientific model, and that environmental group membership is a greater determinant of climate change knowledge than enrollment in a science major.

Epistemological Viewpoints and Environmental Awareness: Personal Observation vs. Scientific Theories

Gokhan Ozturk, Texas A&M University, gozturk@tamu.edu

Elif Ozturk, Texas A&M University

ABSTRACT: Environmental problems are one of the main issues of the 21st century and require immediate action to keep our world as a safe place for future generations. The only solution to this problem again is the human action which caused it. In this sense, the purpose of this study is to understand how epistemological views of individuals affect their interpretation of the environmental issues and awareness. Six participants with different educational backgrounds participated in the study. For the data collection purposes interview technique was used. Transcribed interviews were analyzed through content analysis to understand participants' epistemological views and stand points regarding environmental issues, such as ozone depletion and global warming. Participant's answers were analyzed according to three dimensions, that were whether their explanations were theory-laden or not, what sources of the explanations are, and the role of the theory and observation in their explanations. Results revealed that participants' epistemological views affect interpretation of the environmental knowledge. Moreover, media was the main source of knowledge for the six participants. University graduates differ in their use of theory-laden explanations and perceptions about role of observation and theory. We conclude that possessing the knowledge is not the mere determinative factor of environmentalism.

"Thank You for Being Republican": Socio-Political Influences on Students' Learning of Climate Change Science

Elizabeth Walsh, San Jose State University, elizabeth.walsh@sjsu.edu

Blakely Tsurusaki, University Of Washington

ABSTRACT: Five case studies explore how the socio-political context of controversy influences students' learning of climate change science. Cases studies of students from a pilot enactment of an ecological impacts of climate change curriculum describe how five high school students' understandings of climate change science developed at the intersection of political and scientific values, attitudes, and ways of knowing. Case studies combine qualitative, ethnographic methods with quantitative pre/post-assessments of student conceptual understandings and weekly surveys of student engagement. Data indicate that students had a wide range of initial perceptions of climate change informed by the media and their families—both supporting and rejecting the scientific consensus—and these sources remained important throughout the unit. Furthermore, there were significant shifts in students' understandings of climate change science, even in students who were initially opposed to anthropogenic climate change. This work highlights how learners' pathways are shaped not only by their developing understanding of the scientific evidence but also by the political and social influences that learners navigate across the contexts of their lives. It underscores the need to support students as they engage with climate change across the contexts of their lives.

Rethinking "Good" Citizenship for Environmental Education

Alexandra Dimick, University at Buffalo, schindel.dimick@gmail.com

ABSTRACT: In this paper I examine the ways in which pro-environmental attitudes and behaviors that were promoted within a U.S. high school environmental science classroom engendered different conceptions of what it means to be a "good" environmental citizen. The paper draws from a qualitative research study in which I collected data for six months on an environmental science teacher's and students' experiences when the teacher enacted his conception of teaching environmental education for social justice. Using critical discourse analysis to examine the situated meanings of classroom discussions, I find that individualized, or private, approaches to enacting the "good" environmental citizen were primarily encouraged. However, working toward this teacher's intended outcome of social and environmental justice requires a balance of attention to both private and public justice-oriented actions. I describe these actions, provide examples of them, and suggest implications for the field of environmental education based upon this conception.

Tuesday, April 9, 2013**Concurrent Session #10****8:30am – 10:00am****Awards Committee Sponsored Session*****Symposium - Distinguished Contributions in Research***

8:30am-10:00am, Caribbean Salon 1

Presider: Jonathan Osborne, Stanford University**Presenters:**

Reinders Duit, University of Kiel

Charles W. Anderson, Michigan State University

Larry Yore, University of Victoria

ABSTRACT: In this symposium, Andy Anderson and Larry Yore, the winners of the 2012 Distinguished Contribution to Science Education through Research Award (DCA) will present the highlights of their research work in the context of what is happening in science education research internationally. In addition they will share their thoughts on what the future might and should hold for science education research. This is an opportunity to hear from two greatly respected international leaders in the field of science education and to honour their achievements. The DCA selection committee co-chairs will also be available to provide information on the selection process and award criteria.

Strand 1: Science Learning, Understanding and Conceptual Change***Identifying Students' Conceptualizations and Conceptual Change***

8:30am-10:00am, Río Mar Salon 1

Presider: Alla Keselman***How Do Deserts Form? Selected Results of an Empirical Study about Preconceptions of 12- And 13-Year-Old Students in Germany***

Jan Christoph C. Schubert, WWU Muenster, jcschubert@uni-muenster.de

ABSTRACT: Preconceptions are a crucial factor in the educational learning process. A learner usually interprets new input on the basis of their own preconceptions which are the result of various experiences made before being confronted with the educational learning process. Hence, the investigation of preconceptions is crucial for learning and teaching in the field of earth science. This study examines the preconceptions of 12- and 13-year-old students on the topic "desert" and focuses especially on preconceptions about the formation/origin of deserts. The students' preconceptions were collected by conducting half-standardized, problem-centered and guided interviews. These interviews were then evaluated using qualitative content analysis. Regarding the formation of deserts, four basic preconceptions were identified. All four preconceptions have two characteristics in common: the origin of sand is simultaneously their basic concept and a problem of comprehension when thinking about the formation of a desert. Additionally, in the students' imagination all deserts are sand deserts. In conclusion most students hold alternative conceptions that are not in line with scientific explanations. Implications concerning science teaching will be highlighted.

Secondary School Students' Explanations on Anomalous Data

Tobias Ludwig, Humboldt University of Berlin, tobias.ludwig@physik.hu-berlin.de

Burkhard Priemer, Humboldt University of Berlin

ABSTRACT: It is well known, that students' preconceptions influence learning in science classes, because of the discrepancies between the students' ideas and corresponding science concepts. It is one approach in physics instruction to shatter these preconceptions with experiments that trigger unexpected observations, which are in contrast to their

initial hypotheses or preconceptions (Duit & Treagust, 2003; Kanari & Millar, 2004; Chinn & Brewer, 1998). In this context, Chinn and Brewer (1993, 1998, see also Mason, 2001; Lin, 2007) proposed an eight-stage taxonomy of responses to anomalous data. These responses were gained through paper-pencil-tests and then subsequently evaluated. Experimental data was more propounded than self-collected, so that we argue the transferability into real science classes. Until now it is merely insufficiently investigated which explanations are given for and against holding or discarding an initial hypothesis on the basis of independently and experimentally gained anomalous data. We derived a system of argumentation categories from interviews with secondary school students confronted with self-collected anomalous data. The purpose of this study was to contribute to the understanding of students' behaviour, assessment and reasoning in experiments with contradictory data.

The Interaction Between Context and Young Children's Alternative Conceptions

Uyen A. Ly, UC Berkeley, email: uyenly@gmail.com

ABSTRACT: In recent years a large amount of research has focused on the alternative conceptions about evolution found among secondary and university students, but few studies have investigated younger students' ideas on this subject. The present study examines the alternative conceptions about evolution harbored by second and third-grade students who participated in a three-week instructional course that scaffolded the mechanisms of natural selection. In order to identify the categories of alternative conceptions that students expressed, 60 sets of pre- and posttest structured interviews were coded and analyzed. This analysis reveals that participants in the study expressed alternative conceptions closely related to those identified in earlier studies conducted with high school and college-age participants. The results demonstrate a variability of alternative conceptions across a range of interview items, and also suggest a link between contextual features in the assessment items and the patterns that emerged in students' responses. Contexts that represented a micro-evolutionary cases yielded a significant reduction of alternative conceptions from pre- to posttests. Whereas contexts that represented evolutionary change over a long period of time (i.e., hundreds, thousands of years) yielded a modest reduction of alternative conceptions from pre- to posttests.

Can Change in Facial Expression be Used as an Indicator of Conceptual Change?

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Chin-Cheng Chou, HungKuang University

Wen-Lung WU, National Taiwan Normal University

Hongming Liaw, National Taiwan Normal University

ABSTRACT: This paper explores whether changes in facial expressions can be an indicator for change in student understanding in science. With no studies utilizing facial expressions as a tool in science education and knowing that anomaly-generated cognitive conflicts can lead to conceptual change, the current research combined the two fields of research, namely science education and technology. High school and university students were involved in the two studies in this research. The results revealed a significant difference in the number of conceptual changes experienced by students with and without changes in facial expression. Alternatively, if no conceptual change occurred, it was less likely that facial expression change took place. Using change in facial expression as an indicator can be a readily accessible means for assessing conceptual change in science learning.

Strand 2: Science Learning: Contexts, Characteristics and Interactions

Models of Engagement Related to Science Learning and Teaching

8:30am-10:00am, Río Mar Salon 10

President: Ajay Shama

Using Mixed Methods to Exploring the Nature of High School Student Engagement with Science and Technology: Resulting Insights and Conundrums

Jennifer Hope, McKendree University, jmhope@mckendree.edu

ABSTRACT: In a mixed-methods study of high school student participants in the NSF-funded Science Literacy through

Science Journalism (SciJourn) project, the Youth Engagement with Science & Technology (YEST) Survey and classroom case studies were used to determine program impact on participant engagement with science and technology as well as describe the experience of SciJourn classrooms. Analysis of quasi-experimental administration of the YEST Survey showed surprising results: not only did SciJourn high school student participants not exhibit significantly higher engagement survey scores than their non-participant peers, but those participants in classrooms most closely involved with the project actually showed significantly lower engagement scores at the end of the study period. Contrasts between the post-SciJourn engagement scores as measured by the YEST Survey and qualitative data support the conclusion that a response-shift bias occurred especially among students in high implementation classrooms, due to greater student specificity in the nature of what they consider to count as science in their everyday lives. This study illustrates the complex nature of student engagement with science and technology as conceptualized in an inter-dependent model of student interest, action, and identification.

Photonarratives in an Online Master's Course: A Viable Way to Enhance Teacher Reflection and Build Community?

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Gail M. Jones, North Carolina State University

Margaret R. Blanchard, North Carolina State University

ABSTRACT: When professional development is offered via distance education, it can sometimes be a difficult environment to build community among teachers (Beldarrain, 2006). Synchronous online courses help to bridge the distance, yet it still is a challenge to help teachers connect with one another in meaningful ways, when they are physically distant and can't see one another during class interactions. One pedagogical strategy to help science teachers to reflect on their own teaching practices and interact with one another is through creating and sharing photonarratives. This study examined the use of photonarratives as a tool to encourage practicing science teachers enrolled in an online graduate course to be reflective in their practices and to contribute to a community of science teachers.

Designing Integrated Learning Environments to Promote Engineering Practices

Rob Rouse, Vanderbilt University, rob.rouse@vanderbilt.edu

ABSTRACT: Recently, there have been calls to integrate pre-college engineering content into K-12 science standards at points where disciplinary learning goals overlap. These calls for integration have raised concerns about how hybrid science and engineering learning environments will adequately emphasize the characteristics that constitute professional engineering. Here, I attempt to address these concerns by using Lehrer's Elements of Design framework to review design-based science literature. I located studies for this review by performing database searches using different keyword combinations, reading abstracts and papers from those searches, and mining the references from those papers to identify additional studies. Throughout the paper, I argue that some engineering characteristics are well represented in design-based science learning environments, and that to more fully engage students in professional engineering, additional engineering characteristics should be incorporated into hybrid science and engineering learning environments. This work has implications for classroom science teachers. Because the Next Generation Science Standards will require science teachers to instruct students in learning environments that place weight on both engineering and science, they need to be aware of how to incorporate professional engineering characteristics into these learning environments so that students have the opportunity to learn both science and engineering.

Student Navigation of Design-Based STEM Activities

Stephanie Hathcock, Old Dominion University, shath005@odu.edu

Daniel L. Dickerson, Old Dominion University

ABSTRACT: Design-based tasks, which are similar to inquiry, hold the promise of being excellent integrated STEM activities. This research was designed to determine the effects of the teacher/facilitator role in a design-based task, The Great Build-A-Buoy Challenge, which asks students to design a buoy that can hold as many golf balls as possible. We found that while students do innately attempt to go through the design strategy process, facilitated groups saw were much more successful than those without facilitation. Implications point to training science teachers in design principles and further research into students' understanding of the design process.

Strand 2: Science Learning: Contexts, Characteristics and Interactions
Argumentation, Reasoning, and Explanation within Science Learning

8:30am-10:00am, Caribbean Salon 2

Presider: Rainer Wackermann*Tracing Elementary Students' Use of Talk and Writing for Knowledge Development through Argument-Based Inquiry*

Ying-Chih Chen, University of Minnesota, chen2719@umn.edu

Soonhye Park, University Of Iowa

Brian M. Hand, University of Iowa

ABSTRACT: Talk and writing have been recognized as critical learning tools for promoting students' argumentation and ultimately their knowledge construction. This study examined how talk and writing support students' construction of scientific knowledge and cognitive processes through argumentation. This study was conducted in a fifth-grade argument-based inquiry classroom that consisted of 22 students while learning two science units over sixteen weeks. To trace students' knowledge construction through talk and writing over time, three students were selected as target students. Data were collected from multiple sources including classroom observations, interviews, students' writing samples and researcher's field notes. Data were analyzed using a purposeful approach called in-depth analysis of Knowledge Construction Trajectory (KCT). The results indicated that: (1) When both talk and writing were used, student knowledge construction occurred more than when only one learning tool was used, (2) When talk and writing were used in sequence or simultaneously, students' higher cognitive processes were facilitated more than when talk or writing was used alone, and (3) The more talk and writing were used together, the more student-centered the classroom was. Discussion centers on what implications these three findings provide for designing argument-based inquiry learning environment and for future research.

Charting Mechanistic Reasoning Across Aquatic Ecosystems

Suparna Sinha, Rutgers University, suparna.sinha@gse.rutgers.edu

Cindy E. Hmelo-Silver, Rutgers University

Catherine Eberbach, Rutgers University

Rebecca Jordan, Rutgers University

Wesley R. Brooks, Rutgers University

Yawen Yu, Rutgers

Crina Damsa, University of Oslo

ABSTRACT: Engaging in mechanistic reasoning is central to scientific inquiry in the natural sciences. However students need to develop dispositions to engage in such sophisticated inquiry practices. We propose the of the Components-Mechanisms-Phenomena (CMP) framework as a conceptual tool to promote mechanistic reasoning. In CMP, Phenomena are the problems under investigation. Components are the entities that display specific behaviors or mechanisms based on their properties. Mechanisms are characterized as causal explanations of how phenomena occur. Understanding CMP can facilitate mechanistic reasoning by encouraging learners to explain how behaviors of a set of components can lead to an outcome. The purpose of our study is to shed light on the extent to which middle school science students generalize mechanistic reasoning to conduct scientific inquiry in the field of aquatic ecosystems. We draw upon the Actor-Oriented-Transfer lens to illuminate experiences that lead students to view similarities between given problems and prior experiences and as a result engage in mechanistic reasoning to make sense of the new problem. Our results demonstrate that students do generalize the CMP approach to mechanistic reasoning from an actor-oriented perspective. We discuss further implications for designing science instruction.

Adjusting Claims as New Evidence Emerges: Do Students Incorporate New Information into their Scientific Explanations?

Ann M. Novak, Greenhills School, anovak@greenhillsschool.org

David F. Treagust, Curtin University

ABSTRACT: A multitude of documents, including the New Framework for K-12 Science Education, stress the importance of students' constructing scientific explanations. Students need opportunities to make claims based on available

evidence and then use science concepts to justify why evidence supports the claim. But what happens when new evidence emerges for the same phenomena? The “claim” portion of the claim, evidence, and reasoning framework is viewed as the easiest part for students to include. When new evidence suggests that students adjust their current thinking however, do students incorporate this new information and modify their claim? This research utilized a time series research design to explore how students modify their claims as new data are collected and analyzed to provide additional evidence. Findings indicate that many students found it challenging to adjust their claims when new evidence was provided, even with class discussion, teacher feedback, and written scaffolds. Several possible reasons exist to explain this phenomenon. Students could have 1) ignored the new evidence, 2) forgot to modify their claims, and 3) found “undoing” their initial idea too cognitively challenging. Providing students with experiences writing “evolving explanations” reflects what scientists do, while simultaneously preparing them to be more scientifically literate.

Year 2 Longitudinal Study of Effectual Reasoning Scores of High and Low Innovators

Anita M. Martin, University Of Illinois, abmartin@illinois.edu

Raymond Price, University of Illinois at Urbana-Champaign

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

ABSTRACT: As the term “entrepreneur” filters into education research, so do the skills and mindsets associated with successful entrepreneurial teacher leaders who create and implement innovations that have broader and richer impacts on science teaching and learning. This study found that teachers selected for a 5 year NSF study who were considered high innovators have higher effectual reasoning scores and provides evidence of a correlation between this kind of thinking and more substantial kinds of innovations that have the potential to fundamentally transform opportunities for K-12 students. Borrowing from the social and business entrepreneurship literature and clearly articulating its place in science education, this study brings together the notion of teacher change and those habits of mind more closely associated with substantive innovations by developing an Effectual Reasoning Survey whose scores correlate to level of innovation by teacher leaders in the project. While the majority of people use causal reasoning, it is thought that entrepreneurs choose to use effectual reasoning skills more frequently. In this study greater use of effectual reasoning was associated with higher levels of innovation.

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

Investigating Teaching and Textbooks in Secondary School

8:30am-10:00am, San Cristobal

President: Saouma B. Boujaoude, American University of Beirut

Assessing the Impact Participation in Science Journalism has on Scientific Literacy among High School Students

Cathy Farrar, University of Missouri-St. Louis, farrarc@gmail.com

ABSTRACT: This study was part of a large scale research and development initiative focusing on improving student scientific literacy using science journalism. A quasi-experimental design was used to investigate what impact incorporating science journalism activities had on students’ scientific literacy. Over the course of a school year students participated in a variety of activities culminating in the production of science news articles for a regional print and online high school science news magazine. Participating teachers incorporated activities focused on five aspects of scientific literacy: placing information into context, recognizing relevance, evaluating factual accuracy, use of multiple credible sources and information seeking processes. This study evaluates student scientific literacy using the Scientific Literacy Assessment (SLA) using The findings of this study including student results and Generalized Linear Mixed Modeling suggest that the incorporation of science journalism activities focused on STEM issues can improve student scientific literacy. Incorporation of a wide variety of strategies raised scores on the SLA. Teachers who included a writing and revision process that prioritized content had significantly larger gains in student scores. Future studies could broaden the description of high school student scientific literacy as measured by the SLA and provide alternative pathways for developing scientific literacy.

Analysis of the Chemical Representations in Secondary Chemistry Textbooks

Saadeddine Shehab, International College, Beirut, Lebanon, sss21@aub.edu.lb

Saouma B. Boujaoude, American University of Beirut

ABSTRACT: This study focused on the requirements that chemical representations meet in textbooks in order to enhance conceptual understanding. Specifically, the purpose of this study was to evaluate the chemical representations that are present in seven secondary Lebanese chemistry textbooks. To determine whether the chemical representations present in the chemistry textbooks enhance conceptual understanding and support the three levels approach to teaching chemistry (macro, micro, and symbolic), an instrument adapted from Gkitzia, Salta, and Tzougraki (2011) was used to analyze the textbooks. This instrument encompassed five basic criteria: type of the representation, interpretation of the surface features, their relationship to the text, existence and the properties of a caption, and the degree of correspondence between the components comprising a multiple representation. The results of the study revealed that the chemical representations used in the selected textbooks are focused on the macro level with either implicit or ambiguous labels. Moreover, the selected textbooks use very few multiple, hybrid or mixed representations. In addition, most chemical representations are accompanied by problematic or no captions. Recommendations for textbook writers and future research are discussed in light of these findings.

A Case Study Demonstrating the Use of Concept Inventories in the Secondary Biology Classroom

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Ryan Walker, University of Arkansas

Feng Jiang, New York University

Rebecca M. Price, UWB

Kathryn E. Perez, University of Wisconsin at La Crosse

ABSTRACT: To successfully teach concepts in evolution, it is essential for teachers to first identify preconceived ideas that students bring with them into the classroom. Then, these areas of faulty understanding must be challenged, so that students can interpret the new scientifically correct information. Finally, students need to apply this new understanding to novel situations in some form of authentic assessment. Concept inventories like those produced by the AAAS are an essential tool for classroom teachers. This case study outlines how concept inventories can be used in a secondary biology classroom to identify effective instruction techniques and to quickly assess student understanding of evolutionary concepts.

Investigating How Teachers Implement Model-Based Teaching

Christopher Bogiages, University of South Carolina, cbogiages@gmail.com

ABSTRACT: The importance of engaging students in learning opportunities that closely resemble authentic processes used by scientists has been at the forefront of the national dialogue among science education researchers for at least the past 15 years. Scientific modeling represents one of these authentic practices. This collective case study investigates the patterns of teacher growth following a professional development institute focused on the use of scientific modeling in middle and secondary science teaching. Although scientific modeling as a pedagogical strategy has been shown to be effective, implementing model-based pedagogy in the classroom is usually difficult for teachers. The findings of this study provide a rich description of the impact a teacher's classroom questioning and a teacher's knowledge of scientific models and the process of modeling have on their ability to successfully implement model-based teaching. Implications for professional development focused on improving teachers' ability to implement model-based teaching are discussed.

Understanding the Language of Middle-School Science: Comparing Discourse-Marker Usage in Science and Social Studies Textbooks

Diego X. Roman, Stanford University, dxroman@stanford.edu

Stephanie I. Hironaka, Stanford University

Hannah Rohde, University of Edinburgh.

ABSTRACT: In linguistics, discourse markers (DMs) have been described as an important element of coherent texts (McNamara, 2001). Building on the growing interest in developing subject-specific literacy strategies

(Jetton&Shanahah,2012), a large corpus of science and social-studies (SS) textbooks was created to investigate (1) how often sentences contain DMs and (2) the variation among the types of discourse relations (elaboration/contrastive/temporal/inferential) that are signaled overtly. Science texts showed a higher rate of DM usage and a greater increase of DMs across grade levels than SS ($p<0.001$). Inferential markers were more frequent in Science ($p<0.001$), whereas Contrastive and Temporal markers were more frequent in SS ($p<0.001$). Our findings could be used to refine professional developments for science teachers so they can tailor instruction appropriately for students' literacy development and comprehension. For instance, the significantly higher frequency of inferential markers and lower frequency of contrastive markers we found in science texts might mean that these texts present science mostly as a set of results rather than as processes in which differing opinions had to be reconciled. Thus, science teachers who want to address the crucial role that argumentation plays in scientific findings (Wellington&Osborne,2001) might need to supplement the textbook with instruction and additional printed-materials.

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

Effect of Teachers' Knowledge, Dispositions, and Beliefs on Teaching

8:30am-10:00am, Pelican Room

The Knowledge Needed for Teaching Science: A Study of in and Out-of-Field Science Teachers

Kathleen Hill, Arizona State University, kathyhill@asu.edu

Charles Weeks, Arizona State University

Sara Raven, University of Georgia

ABSTRACT: Science teachers are often certified in one content area, but teach in several content areas. For instance, middle school science teachers are highly qualified in one area and often teach at least two other science areas. This study looks at the content knowledge of science teachers who are teaching in and out-of-field, and classified as 'highly qualified' secondary science teachers. The teachers in this study were interviewed using probes that required both content and instructional knowledge. All teachers were interviewed with two probes; one in a teaching area aligned with their major, and one in a teaching area not associated with their major. The work of Ball, Thames, and Phelps (2008) guided both the development of the science probes, and the way in which the teacher responses were assessed. The analysis of the beginning teachers' responses revealed that out-of-field teachers struggled with the content and appropriate instructional approaches, and that the content knowledge of some teachers did change over time. From this study, we conclude there is a need for additional research in this area, as additional evidence could have implications for the design of preservice and induction programs, and policy that pertaining to science teacher certification.

Exceptional Science Teaching in Poor Schools: Exploring Dispositions through Narratives of Effectiveness

Annemarie Hattingh, University of Cape Town, annemarie.hattingh@uct.ac.za

ABSTRACT: Teaching science well in poor schools where motivation to learn science is often non-existent is a difficult and demanding task. In an under-resourced, overcrowded school equipment for science teaching barely exist. Here Departments of Education face the greatest gap between their expectations for students and creating opportunities for all to learn. Yet, some teachers excel in developing potentials for learning despite difficult working environments. Why? I interrogated this puzzle asking: 1) What are the dispositions (professional, personal) of effective teachers teaching science in poor schools? 2) Which patterns of innovation and creativity emerge in these contexts? The research is situated in a conceptual framework informed by a Dispositional Cluster Model (Faull, 2008) and the 'teacher as a person' indicator in Stronge's (2004) Teacher Qualities Framework. Four exceptional teacher cases (3 were finalists in a national STEM competition) were observed in classrooms and informal community engagements. Cross-case analysis highlight the dispositions that they demonstrate through their 'asset-based' vs 'deficiency-based' mindsets and how they creatively overcome the lack of laboratory equipment by networking with mines and newspapers. Another creatively mapped an indigenous curriculum from socio-cultural activities to give access to the western curriculum displaying deep knowledge of they value 'relevance' for their students.

A Science Teacher's Beliefs About NOS - Going Behind the Myths of Positivism

Birgitte Bjonness, Norwegian university of life sciences, birgitte.bjonness@umb.no

Erik Knain, Norwegian university of life sciences

ABSTRACT: A science teacher's beliefs about NOS - going behind the myths of positivism Science education reforms all over the world advocates a view of learning science that emphasis inquiry. Change in school practice depends heavily upon science teachers' capacity to integrate the epistemology and practices of a reform with their beliefs and existing practices. One of the major concerns relating to teaching scientific inquiry is that many teachers' show epistemological naïve views of the nature of science (NOS). In this paper we identify an upper secondary science teacher's positivistic epistemological beliefs and how they guide his decisions and actions in a situated school practice. The purpose is to understand why a positivist ideology and related myths concerning NOS are seemingly robust in school versions of scientific inquiry. We suggest that there are strong educational and personal sides to a teacher's framing of his or her practice of scientific inquiry, in addition to beliefs concerning NOS. In this case, what seemed to be a positivistic position toward NOS, turned out to be very much influenced by educational care for the individual student, and personal engagement drawing from own positive experience with research on natural phenomena

Reconstruction of Teachers' Strategies to Embed Practical Work into the Flow of Physics Classroom Instruction

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Gunnar Friege, Institute for Mathematics and Physics Education

ABSTRACT: A thoughtful integration of practical work into the flow of activities in classroom instruction is seen as an important quality criterion and the embedding of practical work builds an overall subject of science education. However, to-date very few findings about teachers' approaches and strategies to embed practical work into a sequence of lessons exist. To achieve teachers' strategies a strong orientation towards actual lessons situation is needed. This study provides a methodological approach which is in step with actual practice of science teaching and presents different strategies from teachers' to embed practical work arrangements across a sequence of lessons. Therefore a multiple-case study design with an integrated semi-structured interview that contains a stimulated recall of videotaped lessons was chosen. The results show that subsequent practical work phases may pursue superior objectives in the overall sequence of instruction. This provides the opportunity to seek for best practice sequences for specific lesson units.

Examining the Content Knowledge of Beginning Science Teachers through Concept Maps: An Exploratory Study

Kathleen M. Hill, Arizona State University, kathyhill@asu.edu

Charles B. Weeks, Arizona State University

Jonah B. Firestone, Washington State University-Tricities

Julie A. Luft, University of Georgia

ABSTRACT: With expressed concerns by policy makers about the content knowledge of science teachers, science teacher educators are looking for the fundamental ideas that science teachers should know, and novel ways to document science teacher knowledge. Concept maps are commonly used as a means of documenting what teachers' know and how they connect topics in their subject area. This pilot study explored the potential use of concept mapping and a scoring technique in assessing beginning teacher content knowledge in the area of biology. In this study, eight new biology teachers were asked to prepare concept maps during yearly interviews over five years. The biological knowledge of the beginning teachers was assessed by examining three distinct elements of their concept maps: correctness, connectedness, and complexity. The average scores of the teachers revealed that their complex understanding of biology increased over time. In addition, both the correctness and connectedness scores seemed to be low among the teachers. Findings indicated that a potential source of error had to do with the concept mapping skills of the participants themselves. Ultimately, having this method may help science teachers educators understand how correct, connected, and complex the content knowledge is of teachers.

Strand 5: College Science Teaching and Learning (Grades 13-20)***Improving Student Learning in Biology***

8:30am-10:00am, Parrot Room

Presider: Leslie S. Jones***Using Student Motivation to Construct Collaborative Groups in a Non-Majors Biology Course: Impacts on Critical Learning Outcomes***

Grant E. Gardner, East Carolina University, gardnerg@ecu.edu

Kristi Walters, East Carolina University

ABSTRACT: The document Vision and Change in Undergraduate Biology Education highlights the importance of post-secondary biology instructors providing students with active, personally-relevant, and inquiry-driven learning opportunities. Science education research has demonstrated that these teaching considerations lead to greater conceptual understanding as well as an increase in attitude and perceptual variables associated with students' biological literacy. Most inquiry learning is facilitated by peer-to-peer interactions; however, the most affective means of structuring collaborative groups in order to maximize student learning remains a source of debate. This study: a) furthers an understanding of the effects of collaborative group composition in undergraduate settings, and b) uses the construct of motivation to build collaborative groups. Non-major biology students (n = 250) enrolled in a single section of an introductory biology course at a large southeastern university. Using a pre-post design students' changes in attitudes toward biology, perceptions of the science of biology, perceptions of biologists, attendance rates, and achievement in the course were made. Significant changes were seen in many of these variables. Implications of these results for structuring collaborative groups in large lecture courses will be discussed.

Comparing Formative Feedback Reports: Human and Machine Analysis of Constructed Response Questions in Biology

Michele M. Weston, Michigan State University, westonmi@msu.edu

Joyce M. Parker, Michigan State University

Mark Urban-Lurain, Michigan State University

ABSTRACT: Constructed response questions can offer a detailed look into students' reasoning skills and understanding of key concepts, but take a considerable amount of time to analyze. This trade-off between the amount of time it takes to analyze constructed response questions and their ability to reveal student thinking has made them a desirable, but out-of-reach option, for instructors in large enrollment courses. Automated text analysis can alleviate the time burden of constructed response questions by speeding up the scoring process, while still revealing the level of detail a human reader looks for. This report compares the quality and time needed for an instructor's analysis of a hand-scored sample of responses to a constructed response question on cell metabolism with an analysis done by machine scoring. We found that the analysis done by machine scoring can give more information than a read of a sample can, and summarizes the entire set of responses. In this study the machine scoring process along with creating a feedback report took more time than an instructor's analysis of a subset of data, but most of the time consuming work would not need to be repeated with new data in the future.

Peer Led Team Learning in Introductory Biology: Effects on Critical Thinking Skills

Julia J. Snyder, Syracuse University, jjseymou@syr.edu

Jason R. Wiles, Syracuse University

ABSTRACT: This study evaluated the potential effects of the Peer-Led Team Learning (PLTL) instructional model on undergraduate, biology peer leaders' critical thinking skills. This investigation also explored peer leaders' perceptions of their critical thinking skills. A quasi-experimental pre-test/post-test control group design was used to determine critical thinking gains in PLTL/non-PLTL groups. Critical thinking was assessed using the California Critical Thinking Skills Test (CCTST) among participants who had previously completed and been successful in the second semester of an introductory biology course. Qualitative data from open-ended questionnaires confirmed that factors thought to improve critical thinking skills such as interaction with peers, problem solving, and discussion were perceived by participants to have an impact on critical thinking gains. However, no significant quantitative differences in peer

leaders' critical thinking skills were found between pre- and post-treatment CCTST measurements nor between experimental and control groups. Additionally, peer leaders' students attained significantly higher exam and final course grades in introductory biology than similar students not participating in PLTL. Finally, among introductory biology students who opted not to enroll in the associated lab course, those who participated in PLTL averaged more than a letter grade higher than those who did not, and this difference was statistically significant.

Learning Inquiry and Nature of Science Through an Open Investigation in a Field-Biology Course

Maya R. Patel, Ithaca College, mpatel@ithaca.edu

Daniel S. Kjar, Elmira College

ABSTRACT: We investigated students' learning of inquiry skills, the nature of scientific knowledge (NOS) and nature of scientific inquiry (NOSI) through participation in a field-based Biology course with a strong laboratory component involving a short-duration independent research project. Our research questions were: 1) what inquiry skills did students employ in their research projects compared to their prior undergraduate education; 2) what understandings about NOS and NOSI did students develop in the course; and 3) what discernable differences in outcomes were there for Biology majors and non-science majors in the course? We found that both majors and non-majors gained in practicing a variety of inquiry skills, including higher-order skills such as posing testable questions, designing methods and developing explanations. Many students also developed more sophisticated understandings of some aspects of NOS/NOSI, in particular the tentative and creative NOS, the roles of anomalies and justification in NOSI, and the distinction between data and evidence. These gains were often linked to personal experiences grappling with the indeterminate nature of conducting open inquiry in the field. Several themes highlighting the differences between the experiences of majors and non-majors and implications for future course development and research are also discussed.

Strand 6: Science Learning in Informal Contexts

Strand Sponsored Symposium - Designing New Bridges between Informal and Formal Science Learning and Why STEM Education Needs Them

8:30am-10:00am, Sea Gull Room

Discussant: Ellen McCallie, National Science Foundation

Presenters:

Philip Bell, University of Washington

David E. Kanter, New York Hall of Science

Shirin Vossoughi, Exploratorium

Elliot Washor, Big Picture Learning

Steven Zipkes, Manor New Technology High School

ABSTRACT: This paper set will explore the potential inherent in unifying designing, making, and playing approaches more common in informal environments with classroom lesson-based approaches more common in formal science learning environments in order to support both student engagement and learning. Drawing from the upcoming Routledge-published book "Design, Make, Play: Growing the Next Generation of STEM Innovators," this paper set will present an overview on how unifying informal and formal approaches can support the goals of STEM education followed by presentations of several new bridge designs, ranging from playground games that continue on in the classroom to teach physics to project-based high schools that train tinkerer-scientists.

Strand 7: Pre-service Science Teacher Education***Engagement into the World of Teaching Profession***

8:30am-10:00am, Río Mar Salon 9

President: Adem Tasdemir, Virginia Commonwealth University*Science Education Internships for the Professional Development of Pre-Service Teachers: Affordances and Constraints*

Andrea G. Van Duzor, Chicago State University, agay@csu.edu

Mel Sabella, Chicago State University

ABSTRACT: The internship component of our university's National Science Foundation Noyce Scholars program was expanded to enable Noyce Scholars to engage in summer and school-year internships. Internships for Noyce Scholars are intended to serve retention and professional development functions for our Scholars and are available through three local informal science institutions and an environmental organization, as well as with science education research faculty at the university. Two years of the internship program have highlighted successes and difficulties associated with the management of a multi-site internship program. Scholars cite that the internships have broadened their understanding of science education in the local urban environment but that logistical challenges compromise some of the educational benefits of the program. Implications and recommendations are discussed.

Engaging Pre-Service Teachers in a Community of Practice Through Socio-Scientific Inquiry

Kristin L. Cook, Bellarmine University, kcook@bellarmine.edu

ABSTRACT: As part of a semester-long undergraduate science course for pre-service teachers (PSTs), this study examined twenty-four undergraduate students' experience in which Community of Practice (CoP) ideals were sought through connecting PSTs and campus scientists through socio-scientific inquiry-based (SSI) instruction. The research questions guiding this study were: in what ways do pre-service teachers experience legitimate peripheral participation through their learning of SSI and how do the scientists in the community view this collaboration with pre-service teachers? Data from this study furthered our understandings of the students' perspectives in regards to: 1) dialoguing with the community, 2) collaborating with scientists, and 3) raising awareness across campus; as well as the scientists' perspectives on 1) setting boundaries, 2) upsetting hierarchies, and 3) the mutual benefits of collaborating. The results indicated that the PSTs were able to participate in a CoP engaged in authentic scientific inquiry and were able to move through levels of legitimate peripheral participation in varying degrees while maintaining their identities as future teachers.

Preservice Science Teachers Sharing of Knowledge and Understanding in a Journal Club

Karen A. Tallman, University of Massachusetts Amherst, kmtallman@comcast.net

Allan Feldman, University of South Florida

ABSTRACT: The purpose of this study was to examine if and how a journal club can establish a community of practice among preservice teachers, and to provide a forum for reflection on theory with practice. The study was a qualitative case study based on our previous research on journal clubs and the theoretical framework of communities of practice. Data sources included pre- and post- interviews of the preservice teachers, a focus group at the end of the journal club, audio recordings of the journal club, field notes, artifacts including research articles selected by the preservice teachers, and e-mail exchanges. Data were open-coded using grounded theory. We found that the preservice teachers shared problems, concerns, and questions about teaching through the critical discussion of the literature that they chose. The articles read in the journal club helped them deepen their knowledge of science teaching. It was through their discussions, that we describe as anecdote-telling, that they gained knowledge and understanding of the articles' implications for practice. This study suggests that journal clubs in science teacher education can help preservice teachers learn a new way to engage in discussions, to synthesize theory with practice, and help foster a community of practice.

Preparing Secondary Science Teachers to Engage Students in Scientific Explanations: A Practice-Based Approach

Kasey McCall, University Of Michigan, kaseyl@umich.edu

Deborah Peek-Brown, University of Michigan

R. C. Dersheimer, University of Michigan

ABSTRACT: The newly released Framework for K-12 Science Education recommends that students engage in scientific work, such as constructing evidence-based explanations, as they make sense of science content and principles. Though the new Framework redefines what teaching and learning should look like in science classrooms, examples of this type of complex teaching are rare. An opportunity exists to support beginning science teachers enrolled in teacher education programs (teacher interns), to act as critical participants in science education reform efforts by allowing them to learn early in their practice how to integrate scientific practices and content. This paper describes the structured opportunities for a cohort of beginning science teachers' to learn how to enact instructional practices around constructing scientific explanations in a university-based methods course and examine how individual novice science teachers draw on these experiences as they carry out reform-based science instruction in classrooms during their clinical experiences. Initial results indicate interns benefit from opportunities to rehearse instructional practices with peers and utilize feedback to modify their instructional practice in their clinical experiences of secondary classrooms. Closer analysis of the practices of two interns indicates both draw on practice protocols used during rehearsals, but incorporate these differently in clinical settings.

Strand 8: In-service Science Teacher Education***Reconciling with New Directions of Educational Reform***

8:30am-10:00am, Río Mar Salon 4

President: Miia Rannikmae*Teachers' Experiences with Reform-Based Instructional Resources: Coming to Terms with New Priorities for Science Learning*

Shirly Avargil, University of Maine, shirly.avargil@maine.edu

Jonathan T. Shemwell, University of Maine

Daniel K. Capps, University of Maine

Bill Zoellick, Schoodic Education & Research Center Institute

ABSTRACT: The new Framework for K-12 Science Education has established a vision in which the learning of scientific practices is integrated with the learning science core ideas. The present study addresses the challenge that enactment of the Framework's vision may be undermined by traditionally conceived expectations of progress in learning. The study took place during the second year of a NSF-funded project. Twelve middle school teachers enacted a physical science curriculum that is aligned with the new Framework's vision of integrating science content and practice. Data were collected through on-line reflections written by teachers as well as teacher interviews. Research questions relate to the extent the data exhibited students engaged in deep learning of integrated core ideas and science practices and about the tension that arose between deep learning and traditional conceptions of progress. Our findings showed that the enacted curriculum reflected the Framework with respect to deep learning. Second, teachers were concerned about progress in learning, thirdly, teachers expressed appreciation for deep learning and began to voice conceptions of progress that were consonant with it. Implications of these findings will be discussed.

Preparing for NGSS: Professional Development Model Based on Lessons Learned from Previous Standards Implementation Efforts

Marion Reeves, Georgia State University, marion-reeves@comcast.net

ABSTRACT: After twenty years of national standards for science teaching, experienced high school teachers continue to struggle to implement these in daily classroom work. Part of the difficulty is the need for experienced teachers to approach teaching with a new orientation toward instruction. Professional development (PD) models designed for large

group instruction and orientation have not proven to be effective at changing practice. Studies indicate that models that allow the PD to be embedded within the classroom practice, with opportunities for reflection have shown greater success at aligning teacher practice with standards. The study implemented an interactive, contextualized, and reflective model of PD with experienced Biology teachers in a large diverse school system. A cross-case analysis of the model was conducted based on the case studies of individual participants. This indicated that participation in the PD increased intentional development of student conceptual understanding through the use of scientific practices in instruction. As plans are made for preparing teachers to implement Next Generation Science Standards multiple models of PD will be needed. Analysis of the PD model of this study indicates its potential as one that could support changes in practice of experienced teachers.

Quebec's Problem-Based Learning Science Reform: A New Policy and its Effects on the Teaching Practice

Jessica L. Godin, McGill, godin.jessica@gmail.com

ABSTRACT: In this paper I introduce the concept of problem-based learning (PBL): an innovation introduced as a part of the science education reform that Quebec, Canada, underwent in the last ten years. Throughout my research, I explore various approaches that high school science teachers took to implement PBL into their own teaching of the science curriculum. This research is focused on a case-study of three high school science teachers. I begin by describing what the Quebec reform is asking of teachers. Three main findings emerging from the research are: 1) Teachers teach through some aspects of PBL but are unaware of the explicit mandate preventing them from creating lessons in line with this mandate. 2) Teachers are experiencing disconnect between the mandated PBL approach to teaching and the content-based mandatory final examinations. 3) Teachers cite a lack of proper financial resources and training as external barriers to the effective implementation of PBL. Personal resistance to change and fear of this new reform are cited as internal barriers. My research will inform curriculum developers, university professors and professional development organizers about how to develop effective approaches to preparing science teachers to effectively implement PBL and address the issues they face.

Teachers' Understandings of Inquiry and Use of Scientific Practices: A Survey of NSTA Conference Attendees

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Daniel Capps, University of Maine

Craig A. Mason, University of Maine

ABSTRACT: Although national standards call for teaching science through inquiry, many teachers do not understand what inquiry is. In an attempt to specify what is meant by inquiry, the new Framework for K-12 Science Education articulates eight scientific practices that scientists employ. To gain a better understanding of science teachers' knowledge and reported enactment of inquiry, we surveyed 149, K-12 science teachers at the 2012 National Science Teachers Association annual conference. Findings indicated the majority of these motivated teachers held uninformed views of inquiry. Few described inquiry as it or the scientific practices are conceived in reform documents. Those who did only mentioned a subset of these ideas. Surprisingly, few teachers had read key reform documents about inquiry. Results also suggest teachers had difficulty distinguishing between some of the scientific practices. Many factors predicted teachers' reported use of inquiry, including experience, school characteristics, and self-confidence. The data from this study can be used to inform the science education community about the use of inquiry in classrooms across the country and how these practices are influenced by teacher beliefs and other background factors. Additionally, results from this research will provide important information for teacher education programs and professional development.

Strand 10: Curriculum, Evaluation, and Assessment***Assessment and Observation Development and Validation Studies***

8:30am-10:00am, Río Mar Salon 2

Presenter: Daphne D. Minner*The Difficulty of Solving Physics Tasks in Realistic Stories*

Alexandra Dorschu, University Duisburg-Essen, alexandra.dorschu@uni-due.de

Heiko Krabbe, University Duisburg-Essen

Hans E. Fischer, University Duisburg-Essen

Alexander Kauertz, University Koblenz Landau

ABSTRACT: This study investigates the effect of contexts on solving assessment tasks. Contexts in assessment tasks are operationalized by three context characteristics: interestingness, familiarity and credibility. Additionally the identification of relevant aspects in the description of the context and linking them with physics knowledge establishes the connection between context and physics content which is called transformation. For investigating the effect of this context-content-transformation on item difficulty, respective tasks for a competence test are developed. It can be shown that the competence test is valid (through a comparison of other tests) and shows sufficient internal consistencies in a Rasch analysis ($\alpha_{\text{person}} = .69$ and $\alpha_{\text{item}} = .91$). No effect of the context-content-transformation is found, if the other characteristics are controlled by design. However, data can reveal that the topic of the context should be selected with care because it has significant influence on the difficulty of tasks besides the considered characteristics.

Assessing the Role of Curriculum Coherence in Student Learning about Energy

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LeeAnn M. Sutherland, University of Michigan

Brian J. Reiser, Northwestern University

Joseph S. Krajcik, Michigan State University

ABSTRACT: Curricular coherence is an indication of the alignment of content ideas, the depth at which they are studied, and the sequencing of ideas within and across grade levels and has been identified as an important predictor of student performance. The NGSS focuses on principles of coherence. This study examined the contribution of sequencing topics across middle school, to support the development of content and practice learning goals so that learners build a deeper and integrated understanding of core ideas over time. The concept of energy was a cross-cutting theme in 6 different units in a reform-based MS curriculum. The unit posttests of students from a national field test of the curriculum were analyzed using SEM to identify ways in which ideas learned in some units supported the learning in other units. Results indicate that inter-unit coherence enabled students to develop a deeper understanding of energy by providing repeated exposure over years rather than weeks, enabling knowledge constructed in one unit to become the prior knowledge to be built upon in subsequent units, and offering a broader range of contexts in which students' could apply their ideas than could be accomplished in stand-alone units.

Detecting Differential Item Functioning in a Brief Electricity and Magnetism Assessment (BEMA)

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ABSTRACT: Using published assessment instruments to measure student learning is a common practice in science education. Presumably, these instruments have been carefully validated and are appropriate for the target population. This fact notwithstanding, when they are used for comparisons between different student groups, caution must be taken to ensure that test items demonstrate equivalent functioning across all groups; in other words, it is crucial to examine if items are biased in favor of one group over the others. Only with this work completed, can meaningful inferences be made regarding the relative success of students. In this study, we use the framework of Rasch-based differential item functioning (DIF) to detect potential bias in a Brief Electricity and Magnetism Assessment (BEMA)—a 30-item multiple-choice test designed for measuring student basic understanding of electricity and magnetism concepts in introductory physics. Two student groups are compared: a content reformed physics course—namely Matter and Interactions (M&I)—and a traditional physics course. Results show that most BEMA items are of equivalent function for

both groups within the 95% confidence intervals; 7 items however display DIF either in favor of the M&I students or those in the traditional course.

The BEST Observation Protocol: Looking at Next Generation Science Standards' Crosscutting Concepts in the Classroom

Abigail J. Levy, Education Development Center, Inc., alevy@edc.org

Allison Scheff, University of Massachusetts Boston

Robert F. Chen, University of Massachusetts Boston

Pamela Pelletier, Boston Public Schools

Erica T. Fields, Education Development Center, Inc.

ABSTRACT: The National Research Council's release of A Framework for K-12 Science Education: Practices, Crosscutting Concepts and Core Ideas will require educators to rethink their instructional and professional development practices with a crosscutting concepts lens. Prior to the release of the Framework, the Boston Energy in Science Teaching (BEST) project initiated a study comparing concept-based to discipline-based professional development and its impact on instruction and student learning. As part of the research, the BEST project team developed an observation protocol to capture the presence of teachers' integration of energy concepts into their daily classroom instruction, as well as missed opportunities for connections to energy. The development process revealed larger issues around language, shared understandings, and scope of content knowledge relating to the concept of energy. The authors discuss the usefulness of their lessons learned and the observation tool, as educators implement the Next Generation Science Standards and are challenged with the incorporation of energy and six other crosscutting concepts into their instruction.

Strand 11: Cultural, Social, and Gender Issues

Gender and Science: The Impact of Museums, Attitudes, and Perceived Success

8:30am-10:00am, Río Mar Salon 8

Presider: Vanessa Wyss, Ball State University

Gender Differences: Development of Sixth Grade Students' Geometric Spatial Visualization within an Earth/Space Unit

Christa Jackson, University of Kentucky, christa.jackson@uky.edu

Jennifer A. Wilhelm, University of Kentucky

Amber Sullivan, University of Kentucky

Jeffrey Peake, University of Kentucky

Ronald Wilhelm, University of Kentucky

ABSTRACT: This study examined differences between two groups of sixth grade students' understanding of geometric spatial visualization from pre to post implementation of an Earth/Space unit at two middle schools. We investigated students' spatial development by gender within and between control and experimental groups. The control group utilized a regular Earth/Space curriculum and the experimental group used a NASA-based curriculum. The quantitative data sources included the Lunar Phase Concept Inventory, Geometric Spatial Assessment, and the Purdue Spatial Visualization-Rotation Test. The results indicate that both experimental males and females showed significant gains in their understanding of geometric spatial visualization from pre to post. But, for the control group, the significant gains were limited to the males. The findings reveal that support is needed for both genders so all students will have the opportunity to develop their spatial reasoning, which in turn, increases students' scientific understanding.

Strengthening from the Outside In: Promoting Success for Women of Color in Physics

Apriel K. Hodari, Council for Opportunity in Education, apriel.hodari@coenet.us

Rachel Kachchaf, TERC

Lily Ko, TERC

Maria Ong, TERC

ABSTRACT: We discuss themes in the life stories of women of color in physics, astronomy and astrophysics. These themes are taken from the NSF-funded project, Beyond the Double Bind: Women of Color in STEM, which focuses on 10

interviews and 41 extant texts (covering 23 women in varied life stages). Using intersectionality theory and narrative analysis, this study critically analyzes the intersection of gender and race as it affects women of color's experiences in STEM. Here we focus on two emergent themes: activism and work-life balance issues. Findings show that, in addition to very busy work schedules, women of color are continually involved in multiple forms of activism and outreach activities centered on diversifying the STEM climate. Women also commented on the crucial aspect of balancing work and life, and shared ways they prioritize and manage their time. These findings add to the knowledge base about strategies for retaining women of color—widely considered an untapped source of domestic talent that could fill the country's scientific workforce needs.

Beyond Biology: Altruism and the Impact on Choosing STEM across Gender

Vanessa Wyss, Ball State University, vlwyss@gmail.com

James Jones, Ball State University

Elena Polush, Ball State University

ABSTRACT: Women are still underrepresented in some higher intensity STEM fields. Some research points to a gender bias toward biological fields. Career development research indicates that women have a preference for jobs that will enable them to help others. This study analyzes survey data of middle school students in effort to uncover such a bias at the adolescent level. Preliminary results demonstrate that middle school girls do have a significant preference toward helping others, and biology. When compared with boys in the same age groups, girls demonstrated a statistically significant preference toward careers that enabled them to help others and biology.

Museum Programs and their Impact on Girl's Interest, Motivation and Ability to Persist in Science

Jennifer Adams, Brooklyn College- CUNY, jadams@brooklyn.cuny.edu

Alix Cotumaccio, American Museum of Natural History

Preeti Gupta, American Museum of Natural History

ABSTRACT: This is a qualitative study of the long-term participation of underrepresented girls in afterschool STEM programs and their pursuit of STEM careers. To learn about the role museum-based STEM programs can play in increasing the representation of women of color in STEM fields, we interviewed and held focus group discussions with young women alumni of museum-based afterschool STEM programs. We used the following questions to guide our inquiry: What activities are the most salient in supporting youth's long-term STEM participation? What were critical points in their continuum of participation? Through the process of restorying we looked for patterns of STEM participation in these young women in context of the research questions. The grounded theory analysis allowed us to generate themes about the science afterschool participation in these young women. We will present the key findings, data from the study and discuss areas for further research.

Body Worlds as Heterotopia: Unspoken Power Relations in the Science Centre

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Susan Jagger, OISE/University of Toronto

Erminia G. Pedretti, University Of Toronto

ABSTRACT: Body Worlds is a travelling exhibition that allows the visitor to view the human body through its display of plastinated cadavers. While the exhibition's stated goal is one of health education, this study examines the unspoken messages communicated through the content and context of the exhibition. Framed within Foucault's discourse on power relations and his description of the museum as heterotopia, we explore visitors' critical responses to Body Worlds related to sex, gender, body image, and God. Our examination reveals the complex relations of power between visitors, displays, designers and curators, and venues and we assert that much more attention needs to be given to the unspoken messages of museum exhibitions.

Strand 12: Educational Technology
Games, Simulations and Visualizations

8:30am-10:00am, Río Mar Salon 3

President: Miri Barak, Technion – Israel Institute of Technology*The Evidence Game -- Introducing Scientific Argumentation to Middle School Science Students*

James D. Ellis, The University of Kansas, jdellis@ku.edu

ABSTRACT: This paper reports the results of a quasi-experimental study of a three-year NSF-supported research project, the Evidence Game, to investigate the feasibility of a developing an on-line game to support middle-level science teachers in motivating and engaging students in developing the knowledge and abilities of scientific argumentation. Since August 2010, the Evidence Game team has been engaged in an iterative design and development process for a game to provide middle school students and their teachers with practice in Toulmin's (1984) model of argumentation as applied to science. The goal of the Evidence Game project is to develop and research the effect of a series of sub-games that together will increase middle school science students' and teachers' knowledge of and thinking related to scientific argumentation. The areas of argumentation addressed by the games include: understanding a claim, judging the evidence about a claim based on type (fact, opinion, theory, or data) and quality (bias, reliability, or validity), determining the reasoning applied to the claim (authority, analogy, correlation, causation, theory, principle, or generalization, considering rebuttals, and making judgments.

Visualizations on Physics and Chemistry Lessons: Potentialities for the Development of Competences

Dulce C. Pereira, Escola Secundária Anselmo de Andrade, dulce.campos1@sapo.pt

Luísa M. Lourenço, Professor

Mónica Baptista, Instituto De Educação Da Universidade De Lisboa

ABSTRACT: This presentation aims at describing the potentialities of the use of the visualization "Simulation about Chemical Equilibrium" on pupils' development of competences. The research reported in this study is qualitative, adopting an interpretative orientation. The participants are 23 pupils, who attend the Chemistry and Physics 11th grade. The results show that the use of simulation has contributed to the development competences, such as self-regulation and consolidation of learning, communication of relevant information for the understanding of the concepts under study and the dynamics of the group.

In-Game and Classroom Supports around a Concept-Integrated Digital Physics Game in Middle School Science Classrooms

Phillip M. Stewart, Teachers College Columbia University, pstewart@gmail.com

Ann E. Rivet, Teachers College Columbia University

ABSTRACT: Different scaffolds provided within a physics game were explored in a middle school classroom and analyzed in the context of additional peer and teacher scaffolds. Effectiveness of these scaffolds was gauged for 20 target students and an effective support score was tallied. There was as a correlation between the percentage of effective support and gain score on the posttest, $r = .597$, $p < .01$, with 35.6% of the variance in student scores accounted for by game support. We cannot conclude that effective uses of game support caused better performance on the posttest, but prior theory suggests that games are learning machines that teach the learner how to play the game. When game mechanics are a simulacra of normative physics processes, it is theorized that learning to play the game will improve physics understanding. This correlation supports both of these theories. When adding teacher and peer support into the overall effective support, the correlation improves, $r = .652$, $p < .01$. with 42.5% of the variance in student gains accounted for by effective uses of support in the classroom and the game. Implications for teachers, game designers, and researchers are explored.

Interface of Creativity, Fluency and Technology Using the Design of Science Serious Educational Games

Richard L. Lamb, George Mason University, lambri9137@gmail.com

Len Annetta, George Mason University

David B. Vallett, George Mason University

ABSTRACT: Creativity is the production of the new, original, unique and divergent products and ideas mediated through lateral thinking. Evidence suggests that high levels of creativity and fluency are important in the continued development of student interest, efficacy and ultimately career impact. In this study, 559 randomly selected students attended an eight-month long workshop on science-based videogame design as a learning tool in the classroom. Students were given the opportunity to design science-based video games exemplifying learned, key, science concepts on alternative energy. Upon completion of the workshop, all students were given the Torrance Test of Creative Thinking to aid in the development of an understanding of the relationship between creativity and related constructs. The authors also explore the implications of the trait relationships for teachers and students. Results suggest a significant difference between pretest and posttest outcomes and confirmation of a model for the role of creative, fluency and lateral thinking related to science learning.

Strand 13: History, Philosophy, and Sociology of Science

Subject Matter & Evolution

8:30am-10:00am, Heron Room

Presider: Dionysius T. Gnanakkan

Physics Teacher Use of the History of Science

Charles Winrich, Babson College, cwinrich@bu.edu

Peter S. Garik, Boston University

Luciana Garbayo, University of Texas-El Paso

Yann Benetreau-Dupin, University of Western Ontario

Andrew Duffy, Boston University

Nicholas Gross, Boston University

Manher Jariwala, Boston University

ABSTRACT: The School of Education and the Department of Physics at a large urban research university offer interdisciplinary courses for high school physics teachers. The courses combine physics content, the conceptual history of physics, and readings from the physics education research literature. The participants report a high level of impact from the study of conceptual history in the courses on their teaching. We present the results of ten case studies of teachers' use of the history of science in their classrooms, based on interviews, classroom observations and student work samples. The teachers use conceptual history with their students to teach physics content and aspects of the nature of science. The teachers also include anecdotes about scientists to increase their students' interest in physics. The teachers also discussed a lack of time and a lack of appropriate resources as barriers to a greater use of history in their classes.

Student Ontological Position Exposes Plagiaristic Knowledge on Cognition of Human Origins

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ABSTRACT: In this study, the narratives from a hermeneutical dialectic cycle of three high school Advanced Placement Biology students were analyzed to understand the influences of ontological position on the learning of human origins. The interpretation of these reveals the learning process from the perspective of worldview and conceptual change theories. The question guiding this research is if a student's ontological position is contradictory to scientific explanation of human origins, how will learning be impacted? All consenting students were interviewed in order to select three students who were categorized into three different ontological positions of a worldview: No Supernatural, Supernatural without Impact, or Supernatural Impact. Students were assumed to have an understanding of the concept of human origins at a comprehensive level, but not necessarily at an apprehension level. The interpretation exposed student's ability to alternating between two ontological positions and create a dichotomy between faith and school. Any comprehended concepts that occur within this dichotomy results in plagiaristic knowledge rather than conceptual change. The findings invite readers to consider the ontological position of a student's worldview because of the

potential influence on the construction of knowledge and conceptual change, especially about topics involving the theory of evolution.

The GAENE--Generalized Acceptance of Evolution Evaluation: Development of a New Measure of Evolution Acceptance

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Scott W. Snyder, University of Alabama at Birmingham

Randolph S. Devereaux, Mercer University School Of Medicine

ABSTRACT: The present study reports the development of a rigorously designed measure—the Generalized Acceptance of Evolution Evaluation (GAENE) to be used in place of the widely used Measure of Acceptance of Evolution (MATE), which is criticized on psychometric grounds. The validity of the new measure is evidenced by the extensive expert review procedures and multiple rounds of student pretesting. More than 14 national experts were involved in the multiple rounds of validation and input. Expert reviewers were not given global instructions but were asked to evaluate each of the initial items on five prescribed characteristics. Validity is also supported by an obtained Lawshe content validity index (CVI) of 0.72. To date, 151 high school and 249 university students have completed the online version of the survey. Preliminary data analysis resulted in a Cronbach alpha of 0.943, further supporting the reliability of the GAENE.

From Nature of Science Ideas into a Nature of Science Curriculum

Hagop A. Yacoubian, Haigazian University, Lebanon, hagop.yacoubian@haigazian.edu.lb

ABSTRACT: In this theoretical paper I argue for replacing nature of science (NOS)-related ideas in school science by a NOS curriculum. First, I draw upon the literature on NOS teaching and learning as well as on socioscientific decision making to suggest refining the purpose of NOS in school science. I propose two constructs, namely NOS as an educational end and NOS as a means for socioscientific decision making, and show how they can be helpful in the refining process. Second, I borrow from the literature in philosophy of education to propose critical thinking as the foundational pillar of NOS in school science. Third, I suggest placing NOS in school science across a developmental trajectory. Drawing from the literature on learning progressions in science, I show how a developmental pathway could be traced for NOS learning using critical thinking as a progression unit. Next, I argue that when these three suggestions are adopted, it would be legitimate to talk about a NOS curriculum in school science rather than NOS-related ideas in school science. Finally, I evaluate the relevance of the suggestions in the context of the transition from the previous into the new science education standards in the US.

Strand 14: Environmental Education

Symposium - How Places and Cultures Shape Science Teaching and Learning on Three Islands

8:30am-10:00am, El Morro 1 & 2

Presider: Pauline W. Chinn, University of Hawaii - Manoa

Alyson Barrows, Lihikai Elementary School, University of Hawaii

Matthew Kanemoto, Kahuku Intermediate and High School, University of Hawaii

Sabra Kauka, Kauai District Hawaiian Studies Coordinator, University of Hawaii

Kellie Kong, University Of Hawaii

Gandharva M. Ross, Molokai High School, University Of Hawaii

Steven Mcgee, North Western University

Chiung-Fen Yen, Providence University

Huihui Kanahale-Mossman, Ka Umeke Kaeo, University of Hawaii

Yeong-Choy Kam, Tunghai University, Taiwan

ABSTRACT: Factors contributing to underrepresentation in STEM fields of indigenous and culturally marginalized peoples of the Americas, Hawaii, and Taiwan include poverty, geography, and cultural views about the world that differ from the science taught and assessed in mainstream schools. Unfortunately, high stakes tests do not access place-based ecological knowledge and practices associated with sustainability-oriented cultures. Sociocultural theories enable

researchers to explore the intersection of mainstream science and technology with particular places, cultures, and issues. Recognizing that "activities and advanced technologies that have built and maintained human civilizations clearly have large consequences for the sustainability of these civilizations and the ecosystems with which they interact" (NRC, 2012, p. 195), the Framework for K-12 Science Education (ibid) now addresses sustainability. Researchers from 3 culturally diverse subtropical islands, Puerto Rico, Hawaii, and Taiwan provide a forum for multiple perspectives on ways to connect school and non-formal learning through science and cultural collaborations, culturally grounded sustainability science practices, and application of an Indigenous knowledge framework in 21st century contexts. By framing, teaching, and assessing science learning in more ways than classroom-based tests of disciplinary knowledge, Sustainability STEM (SSTEM) education has the potential to be inclusionary of culturally diverse and underrepresented students (OECD, 2010).

Strand 14: Environmental Education

Reasoning and Creative Methods to Research and Teach in Environmental Education

8:30am-10:00am, Canary Room

Pre-Service Science Teachers' Informal Reasoning in the Context of Nuclear Power Plant Construction

Nilay Ozturk, Middle East Technical University, onilay@metu.edu.tr

Ozgul Yilmaz-Tuzun, Middle East Technical University

ABSTRACT: The purposes of the present study were to investigate the relationships among pre-service science teachers' informal reasoning on SSI, their epistemological beliefs and metacognitive awareness and to investigate the predictors for their informal reasoning on SSI regarding their epistemological beliefs and metacognitive awareness. A total of 674 pre-service science teachers enrolled in the elementary science education department of Education Faculties of 3 public universities located in the Ankara, the capital city of an eastern country participated in the study. The Open-ended Questionnaire developed by Wu and Tsai (2010) for assessing informal reasoning on SSI, Schommer's Epistemological Questionnaire developed by Schommer (1990), and Metacognitive Awareness Inventory developed by Schraw and Dennison (1994) were used. Results of the study revealed that there are correlations among pre-service science teachers' informal reasoning quality and most of their metacognitive awareness subdimensions. Also, there is a negative and significant correlation among pre-service science teachers' certain knowledge and counterargument construction. Metacognitive awareness subdimensions of information management strategies and declarative knowledge were the best predictors for pre-service science teachers' informal reasoning quality.

Environmental Moral Reasoning Patterns of Pre-Service Science Teachers and Correlated Factors

Busra Tuncay, Giresun University, Middle East Technical University, tbusra@metu.edu.tr

Ozgul Yilmaz-Tuzun, Middle East Technical University

Gaye Teksoz, Middle East Technical University

ABSTRACT: The purpose of the present study was to investigate the relationships between environmental moral reasoning patterns and environmental literacy as well as gender and cumulative grade point average (CGPA) scores. Sample of the study was comprised of 153 pre-service science teachers. Four national environmental problems were used to collect data on the participants' environmental moral reasoning patterns (i.e. ecocentric, anthropocentric, non-environmental) and four components of environmental literacy (i.e. knowledge, attitudes, uses, concerns) were measured through a survey questionnaire. Based on canonical correlation results, ecocentric and anthropocentric moral reasoning categories in addition to total frequency of moral considerations were significantly correlated with positive environmental attitudes, higher environmental concerns, knowledge, and CGPA scores. Findings of the study are interpreted as an empirical support for the argument that environmental moral reasoning is a construct that includes both cognitive and affective domains. Moreover, interpretation of the findings led to the conclusion that displaying a human-centered approach should be avoided while considering environmental problems. Implications for environmental education were also discussed.

Reasoning About Climate: The Role of Scientific Reasoning in Climate Education

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Gillian Roehrig, University of Minnesota

Keisha Varma, University of Minnesota

Devarati Bhattacharya, University of Minnesota, Minneapolis

ABSTRACT: The present study investigates teachers' application of scientific reasoning when explaining climate science and how their perceptions about scientific reasoning relate to intended classroom practice. In-service science teachers were recruited to participate in a professional development program which aimed to provide support to enhance understanding and teaching of climate change. Measures such as surveys, daily reflection journal, and photo elicitation interviews were used to assess the nature of teachers' understanding and application of scientific reasoning, as well as their perspectives about implementing scientific reasoning in climate education. Our findings suggest that while teachers held basic understanding about climate change and scientific reasoning, their efforts in embedding scientific reasoning in classroom climate education are relatively limited. Moreover, although multiple reasoning strategies were applied when teachers explained climate issues, critical thinking was the most frequently used and concerned about comparing to other strategies such as deductive and analogical reasoning. This work constitutes our first step to introducing a critical educational and psychological construct, scientific reasoning, to environmental education and professional development. Our findings may provide important implications for educational researchers to inform climate education as well as for future design of professional development programs.

Pre-Service Teachers' Mental Models of the Environment: A Turkish Context

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Christine Moseley, University of Texas at San Antonio

Omer Geban, Middle East Technical University

ABSTRACT: Most research in environmental education has focused on children's environmental attitudes, behaviors, and factual knowledge about environmental issues. This study proposes that research is also essential to identify pre-service teachers' mental models about the environment. The Draw-An-Environment Test used to collect both written and drawn responses of 65 pre-service teachers. The qualitative data were analyzed with the Draw-An-Environment Test Rubric (DAET-R). The results of this study supported the preliminary studies and indicated that the pre-service teachers' models of the environment are incomplete according to the NAAEE Guidelines. The most drawn items in the pre-service teachers' drawing were living organisms (84%) and the least one is humans (37%). Therefore, most of their mental images of the environment do not contain human, although lots of human activities related with the environment. In addition, very few of the drawings evidenced systems interdependence as it relates to the environment. Teacher educators could use these findings while developing curricula to improve mental models of pre-service teachers. A further study on environmental perceptions of not only pre-service teachers from different programs, but also high school students could be conducted. The factors that affect the development of mental models of the environment might also be investigated.

Strand 14: Environmental Education***Related Paper Set - Identity, Situated Practices, and Sociocultural Learning in Environmental Education***

8:30am-10:00am, Río Mar Salon 7

ABSTRACT: With growing interest in addressing cultural difference, and economic and social class in environmental education (EE), this paper session explores situated learning theories and sociocultural approaches to studying the ways youth learn about and identify with environmental issues in EE and STEM curricula. By employing a historically situated approach to learning, authors in this session explore both the theoretical and methodological dimensions of conducting sociocultural research in environmental education. These papers provide examples from diverse populations and contexts in environmental education among formal and informal settings with youth who have been historically excluded from participating in EE or STEM learning. In each study learning is viewed as sets of socio-cognitive practices

that are embodied, situated in time and space, and connected to roles, identities, and larger cultural practices. This historical, context-bound, embodied construction of knowledge affords opportunities for learning that link to one's everyday life and sense of self. For the presenters in this session, the "S" in STEM education denotes not only "science," but also highlights the importance of understanding the "sociocultural."

Time-Space Configurations of Learning and Identity Trajectories: Stories from Projects in Ecology and Gardening

Jrene Rahm, Universite de Montreal, jrene.rahm@umontreal.ca

Positional Identities and Environmental Contexts for Learning in an After School STEM Club

Carol B. Brandt, Temple University, carol.brandt@temple.edu

Frogs Can't Give You Warts, But They Can Make You Brave: Identity Boundary-Work in Field Science

Heidi B. Carlone, University of North Carolina at Greensboro, hbcarlon@uncg.edu

Lacey Huffling, University of North Carolina at Greensboro

Theresa A. Hegedus, University of North Carolina at Greensboro

Terry Tomasek, Elon University

Catherine E. Matthews, University of North Carolina at Greensboro

An Exploration of High School Students' Environmental Identities in a Project-Based Conservation Program

Mele Wheaton, Stanford University, melwheat@gmail.com

My Puget Sound: Students' Positional Identities, Lived Worlds, And Learning In Environmental Education

Blakely Tsurusaki, University Of Washington, btsuru@u.washington.edu

Carrie T. Tzou, University of Washington

Concurrent Session #11**10:15am – 11:45am****Strand 1: Science Learning, Understanding and Conceptual Change*****Examining Strategies, Knowledge Formation and Use, and Self Regulation Processes during Problem-Solving***

10:15am-11:45am, Río Mar Salon 1

Presenter: Cesar Delgado*Do Students' Eye Movements Reveal their Strategies for Solving Physics Problems?*

Elizabeth N. Olson, Union University, besty.olson@my.uu.edu

Bashirah Ibrahim, Kansas State University

Adrian C. Madsen, Kansas State University

Amy S. Rouinfar, Kansas State University

N. Sanjay Rebello, Kansas State University

ABSTRACT: Research has shown that students use different strategies to solve physics problems. We tracked college students' eyes movements as they solved physics problems and compared their allocation of visual attention with the solution strategies that they used. Each problem had two graphs illustrating a situation and students were asked to find a quantitative solution, describing aloud their solution method. We coded each solution strategy as using equations, graphs, or both equations and graphs. These strategies align with the Johnson-Laird cognitive framework that categorizes student's as using propositional representations, mental images and mental models. An area of interest analysis of our eye tracking data compared the percent dwell time in different areas of the graph of students who used the three solution strategies. Our analysis shows no statistically significant differences between the groups, which seems to indicate that students' eye movements do not necessarily reveal their solution strategies.

Comparison of the Knowledge Structures and Problem Solving Ability of Advanced Placement Physics Students in a Traditional Course and a Modeling Instruction Course – An Exploration

Dan Malone, Fox Chapel Area High School, dan_malone@fcsd.edu

Kathy L. Malone, Einstein Fellow at National Science Foundation

ABSTRACT: This exploratory case study tracks the knowledge structures of Advanced Placement Physics students taught using two different pedagogies: traditional and Modeling Instruction. The knowledge structures are determined by using a card sort task. Their knowledge structures are compared to their problem-solving ability and to the structures formed by first year physics students at their respective schools. The study determines that Modeling Instruction students continue on the path towards "expert-like" behavior while the traditional students appear to be arrested throughout the second year AP course.

Influences on the Structure of Scientific Problem Solving Processes

Desiree Heine, University Koblenz-Landau, Institut of science education, heine@uni-landau.de

Alexander Kauertz, University Koblenz-Landau

ABSTRACT: In science education a typical learning goal is to solve problems by using methods of scientific inquiry (Lederman, 2012; Klahr, 2000). In the international research project INTeB an experimental environment is developed to facilitate science learning, which consists of 16 learning tasks to the physical content "flying" (flying of airplanes, balloons and rockets). The aim of the environment is to initiate a self-regulated scientific problem solving process. A precondition for effective learning is the ability of self-regulation (Weinert, 1982). The learning process regarding students planning, controlling and regulating their work is influenced by habitual learning attributes containing motivational and cognitive components. Since a structured process is necessary for learning (Oser & Baeriswyl, 2001), this study investigates the structure of problem solving process of 3rd and 4th grade students using video-categories, tests and questionnaires. Data is used to evaluate the relations between the concepts in a structural equation model. It

could be shown that current motivation, students' knowledge and abilities in physics and scientific interest have an impact on the scientific problem solving process in experimental learning situations.

How do High School Students Approach Ill-Defined Physics Problems?

Jeff Milbourne, North Carolina State University, milbourne@ncssm.edu

Eric N. Wiebe, North Carolina State University

ABSTRACT: The National Research Council's new science education framework suggests that students should engage in authentic, real-world problems as part of their K-12 experience. Such problems, commonly referred to as "ill-defined problems," are quite different from more traditional problem sets, also known as "well-defined problems," found regularly in K-12 classrooms. In order to meet the NRC's framework teachers need pedagogical strategies that will help students learn to deal with the ambiguity associated with ill-defined problems. A first step to realizing such strategies is to understand how students conceptualize and solve ill-defined problems. In this study, ten high school physics students solved a set of ill-defined problems related to waves, while using a talk aloud protocol to narrate their thought process. Analysis of the data focused on identifying the solution pathways that students took when solving problems, as well as the obstacles they encountered during the solution process. The results suggest that these students were capable of creating acceptable solution pathways for ill-defined problems, but faced two significant obstacles in reaching reasonable solutions: knowledge of what constitutes a "reasonable" value, and metacognitive processes that encourage the questioning of assumed/researched values.

Strand 1: Science Learning, Understanding and Conceptual Change

Symposium - Designing for the Teaching and Learning of Evolution in Elementary & Middle School

10:15am-11:45am, El Morro 1 & 2

Presenters:

Kathleen E. Metz, University of California Berkeley, kmetz@berkeley.edu

Richard Lehrer, Vanderbilt University

Brian J. Reiser, Northwestern University

Leona Schauble, Vanderbilt University/Peabody College

Jay Labov, National Academy of Sciences

ABSTRACT: The failure of most people to understand the theory of evolution constitutes a robust finding in the research literature and an enduring challenge to science teachers. This symposium re-considers the teaching and learning of evolution from the perspective of three different research programs, situated in elementary or middle schools, that have each taken a design approach to this challenge. The symposium is organized around five questions, used to analyze and compare these different approaches and their learning outcomes: 1) What does it mean to understand a complex theory such as evolution? 2) What conceptualization of evolution puts foundational ideas within reach of children? 3) How do you approach the scaffolding toward normative reasoning? 4) What have been the affordances of your instructional model for student learning? More specifically, what has tended to be especially challenging to the students and, conversely, what learning has been surprisingly accessible under conditions of your instructional design? 5) What tactics have you tried to address these challenges &/ or how do you think these enduring challenges might be surmounted through alternative pedagogical tactics within the grade-span you have targeted or a subsequent grade-span that builds upon what you have scaffolded?

Strand 2: Science Learning: Contexts, Characteristics and Interactions

Symposium - Climate Change Education: Teaching, Learning, and Assessment

10:15am-11:45am, Caribbean Salon 2

Presenters:

Anita Roychoudhury, Purdue University, aroychou@purdue.edu

Daniel Shepardson, Purdue University

Bruce Patton, The Ohio State University
James R. McGinnis, University of Maryland
Andrew Hirsch, Purdue University
Wayne Breslyn, University of Maryland
Emily Hestenes, University of Maryland
Chris McDonald, University of Maryland
William C. Kyle, Jr., University of Missouri - St. Louis

ABSTRACT: In this interactive symposium we will discuss our models of various facets of climate change education (CCE) derived from empirical data from projects conducted with middle and high school teachers and students. University-based science educators, scientist-educators, and school teachers will present their findings and also make recommendations about future research in CCE. The strands in the presentation will be: (A) researchers' perspective: Overall changes in student understanding of CC and greenhouse effect (GHE); (B) teachers' perspective; (C) professional development of teachers, implementation and accommodation of LP in diverse learning contexts; and (D) assessment in CCE. Our study showed that middle school students made significant knowledge gains in the areas that have traditionally been confusing to others. Teacher adaptations of the curricular materials and related reflections showed the areas of success and challenges in achieving coherent learning goals for their students. The findings and the issues highlighted in this symposium are likely to foster discussion and encourage future researchers to explore these topics.

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

Learning from Graduate Students in Science

10:15am-11:45am, Parrot Room

President: Savannah E. Lodge-Scharff

Authentic Research Practices and Disciplinary Views of Graduate Students in the Physical Sciences

Kristy Chun, University of California, Santa Barbara, kristylauren@gmail.com

ABSTRACT: Graduate students in the physical sciences represent a group of learners who participate in authentic activities of highly specialized disciplines. Studies of post-high school students engaged with authentic research practices have focused mainly on undergraduates and professional scientists. The following study aims to address a) the research practices and disciplinary views of science graduate students and b) the interaction of science, technology, and engineering within the graduate students' research practices and specialized disciplines. This study highlights the different ways experimentalists and theorists engage with skills from other STEM disciplines. Experimentalists identified their practices as interdisciplinary while theorists identified their practices as sub-disciplinary. Implications for this study include providing further insight into how college faculty can prepare coursework to best prepare graduate students to engage with authentic research practices.

Surveying Research University Faculty, Graduate Students and Undergraduates: Reported Beliefs and Practices

Gili Marbach-Ad, University of Maryland, gilim@umd.edu

Kathryn Ziemer, University of Maryland, College Park

Michal Orgler, University of Maryland, College Park

Robert L. Infantino, University of Maryland, College Park

Katerina V. Thompson, University of Maryland, College Park

ABSTRACT: This study explores and compares the perspectives of three populations (faculty members, graduate students, and undergraduates) toward science teaching in the College of Chemical and Life Sciences at a research-intensive university. In particular, we investigate the role of faculty professional development in reforming undergraduate science education. In Spring 2011, we collected data through an online survey of 71 faculty members, 99 graduate teaching assistants, and 288 undergraduates in their senior year. We used mixed mode data analysis to examine the perceived importance of skills for undergraduates as viewed by the three populations and the reported practices used by faculty and experienced by students. We found that across all three groups most of the respondents

placed a high value on active learning and conceptual understanding, which is consistent with national recommendations. However, when comparing reported beliefs with reported practices, we found that faculty members do not always incorporate innovative techniques. In order to bridge this gap, we suggest providing faculty with professional development opportunities, moral support from peers, and instructional support from science education and instructional technology specialists. Our findings support this recommendation, since faculty who were in communities reported using innovative practices more than those not in communities.

Graduate Teaching Assistants and Inquiry-Based Integrated Chemistry-Biology Laboratory Units: The Impact of Extended Professional Development

Jacinta M. Mutambuki, Western Michigan University, jacinta.m.mutambuki@wmich.edu

Renee S. Schwartz, Western Michigan University

ABSTRACT: This study examined the experiences and challenges of five graduate teaching assistants in teaching 5 inquiry-based integrated chemistry-biology introductory laboratory units, following a professional development (PD). Three research questions guided our study: (1) How do science GTAs experience teaching inquiry-based integrated chemistry-biology laboratory units? (2) How do these GTAs integrate biology and chemistry connections when teaching the integrated chemistry-biology units? (3) How does the extended PD training impact the GTAs' views and classroom practices? The participants underwent six weekly PD sessions tailored on the subject-matter knowledge and pedagogical strategies. Data were collected through classroom observations and video recording, reflection questionnaires, and 1 hour end-of-semester open-ended, semi-structured interviews. Data analyses followed qualitative emergent coding and data triangulation. The GTAs expressed unique positive experiences and challenges in teaching the units. Perceived barriers related to their views about student abilities, and perceptions of their role as a teacher. Moreover, we noted a variation in the integration of the chemistry-biology connections between the chemistry and the biology GTAs. Finally, the PD had specific benefits on the GTAs' teaching and classroom practices. Overall, following the PD, the GTAs overcame their initial challenges, and changed their perceptions about students and their perceived role in instruction.

Preliminary Lessons Learned from GK-12 Graduate Fellow Scientists in High Schools with Biotechnology Industry Partnerships

Kim C. Sadler, Middle Tennessee State University, kim.sadler@mtsu.edu

Mary B. Farone, Middle Tennessee State University

Anthony Farone, Middle Tennessee State University

Ginger H. Rowell, Middle Tennessee State University

Jennifer Dye, Pope John Paul High School

Todd P. Gary

Patrick Phoebus, Middle Tennessee State University

ABSTRACT: The GK-12 TRIAD (Teaching, Research, and Industry Applications to Deepen Scientific Understanding) program is an innovative, three-fold connection between graduate fellows (GF) from a mid-south university, partner high school teachers (PT), and regional biotechnology/biomedical industry partners (IP). Goals of the program are to provide GFs with opportunities to (1) improve communication skills through teaching and presentations as they share their research and knowledge with PTs, students, and industry leaders; (2) connect their research to applied technologies/products through the design and teaching of a STEM unit; and (3) establish relationships with industry scientists. Each summer, GF-PT pairs spend time in both the research laboratory of the GF and in the facilities of their selected IP. Following this experience, the GF-PT pair develops a standards-based teaching lesson that is focused on a research area related to the interest of the GF and IP. GFs also teach/mentor high school students in research projects. Preliminary findings show an increase in several areas, such as GF perception of ability to develop an IP teaching unit and guide student inquiry on directed projects. The PT reported increases in perception of their high school students' abilities to use resources to provide evidence to generate and support hypotheses.

Strand 7: Pre-service Science Teacher Education***Beginning Teachers' Abilities and Skills***

10:15am-11:45am, Río Mar Salon 9

Exploring Preservice Teachers Development of Awareness of Student Thinking

Vicky Pilitsis, Rutgers University, pilitsiv2@yahoo.com

Ravit G. Duncan, Rutgers University

ABSTRACT: Teachers must engage in noticing which involves attending to student thinking and adjusting lessons to build on student ideas. Experienced teachers' understanding of learners influences their instruction; however, the research on preservice teachers (PTs) reveals mixed results. Since it is difficult to help PTs notice in real time due to the cognitive load of the classroom, we studied a precursor to noticing, developing an awareness of student thinking, which denotes the PTs' ability to: (a) notice evidence of student thinking (in written artifacts); (b) interpret this evidence in terms of how it connects to learning; and (c) decide how to hypothetically respond to their interpretation of students' understanding. Analyzing interview transcripts, we found that PTs are able to attend to student ideas in a variety of ways; however, their perspective of noticing does not change throughout the course of the teacher education program. We also found that PTs seemed to be more evaluative in their interpretation of students' understanding as it related to the inaccuracy of content. However, it seems that PTs still struggle with suggesting appropriate instructional strategies that build on student ideas.

Preservice Teachers' Abilities to Construct Written Scientific Explanations

Nicole J. Glen, Bridgewater State University, nicole.glen@bridgew.edu

ABSTRACT: This design-based research study addressed the issue of how well preservice elementary teachers construct written scientific explanations for science concepts learned in a science methods course. Forty-eight preservice teachers participated, and their science notebooks were analyzed. Science notebook entries were given a numeric score following McNeill's (2011) argument coding scheme: claims could earn 0-1 points, evidence 0-2 points, and reasons 0-2 points. Additional data analysis included the number of students who wrote arguments for each lesson. One set of findings showed that despite modeling and encouraging teachers to write scientific explanations in their science notebooks at the beginning of the semester, the number who actually wrote explanations in their notebooks was much less, particularly during the peer-teaching lessons and at the end of the semester. A second set of findings showed that: a) when the preservice teachers had claims written in their science notebooks, they were usually accurate and appropriate; b) preservice teachers typically recorded only one piece of accurate and appropriate evidence to support claims; and c) preservice teachers struggled to write accurate and appropriate reasons to support their claims. Preservice teachers' abilities to construct written scientific explanations may have implications for when they teach science to elementary students.

Using Critical Experiences to Build Understanding of Science Teacher Educators' Pedagogical Knowledge

Rebecca Cooper, Monash University, rebecca.cooper@monash.edu

ABSTRACT: The research looked to build understanding of science teacher educators' (STE) development of pedagogical knowledge (PK) using critical experiences (CE's) and investigate: • The role of CE's in developing PK for STE's. • Way/s STE's notions of PK develop over their career? • Dispositions to developing an understanding of PK for science teacher education? Eight STEs from six Australian universities identified CE's from their career (all previously secondary school science teachers) during an interview. Interview transcripts were combined with notes from participant's to form cases, which were analysed to identify categories of CE's and theme/s for each participant. The research indicates, • CE's have a personal connection and often challenge or affirm thinking. • CE's may be a mechanism for investigating how a person's thinking and/or teaching practice has shifted with respect to the facets of PK described by Morine-Dershimer and Kent's 1999 model, which was used to help explain any shifts. • Keeping a focus on science plays a role in developing PK as an STE. • Continual reflection and risk taking with teaching practice assists to challenge the notions of PK held as science teacher and shift them to accommodate the complexities of science teacher education.

*The Relationship Between Teacher Practice and Teacher Leadership Skills in Beginning Teachers*Zora Wolfe, Knowles Science Teaching Foundation, zwolfe@kstf.org

ABSTRACT: In many schools, especially schools with high teacher turnover, beginning teachers often find themselves in both formal and informal leadership roles. These teachers are filling leadership roles as they are still working on developing their teaching practice. In this study, I focused on teachers who have completed the Knowles Science Teaching Foundation Teaching Fellowship program and the relationship between these teachers' confidence in the skills that are important for teacher practice and their confidence in the skills important for teacher leadership. Using a mixed methods approach, I surveyed teachers to measure their perception of their development as beginning teachers and teacher leaders, and then conducted interviews of selected teachers to provide a richer description of the relationship between their development as teachers and teacher leaders. Possible examples of the skills that can be advantaged for both teacher leadership and teacher practice include skills related to the development of a collaborative inquiry stance within the support of professional learning communities. I hypothesize that some teacher leadership activities require skills that are similar to and support the skills required for the development of a teacher's classroom practice.

Strand 8: In-service Science Teacher Education***Innovative Models of Professional Development***

10:15am-11:45am, Sea Gull Room

President: Katie Van Horne, University of Washington*Designing Technology-Intensive Science, Technology, Math, and Engineering Professional Development: Insights From NSF's Itest Projects*Carla M. McAuliffe, TERC, Carla_McAuliffe@terc.edu

Caroline Parker, Education Development Center, Inc.

Cathlyn Stylinski, University of Maryland Center for Environmental Science

ABSTRACT: From 2003 to 2008, the National Science Foundation's (NSF's) Innovative Technology Experiences for Students and Teachers (ITEST) program funded 65 projects that provide technology-intensive science, technology, engineering, and math (STEM) professional development (PD) to teachers. We are investigating the design of these projects and the subsequent classroom implementation of participating teachers. In this paper, we report the results from a survey of teachers (N = 264) who participated in ITEST professional development projects, inquiring into their professional background, classroom practices, teaching philosophy, ITEST professional development experience, and resulting classroom implementation. Our survey shows that long-term, technology-intensive, STEM professional development has long-lasting impacts. Years later, the majority of ITEST project survey respondents (86%) are currently implementing some aspect of what they learned during their ITEST professional development experience. This implementation rate indicates the successful design of ITEST projects. The unique features of the ITEST professional development model contribute to this (e.g. authentic contexts, youth institute, collaborative interactions, and a long-term involvement on the part of project staff from initial training through implementation).

*Effecting 'Reform' Through Transformations in District-Wide Science Teacher Learning Networks*Matthew M. Schroyer, University of Illinois, schroye2@illinois.edu

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

Anita M. Martin, University Of Illinois

Caroline Hathornthwaite, University of British Columbia

ABSTRACT: Internal factors in a school district greatly affect how change and innovation are taken up, and social network analysis is a tool that can explain how school districts mobilize resources and exchange ideas to foster reform. As part of a multi-year, large-scale National Science Foundation Math Science Partnership to enhance content knowledge in science teaching and develop entrepreneurial habits, researchers analyzed a partner school district's teaching networks in 2011 and 2012. Analysis of network graphs and metrics show that at a time of turnover and

changes in administration, networks declined, particularly networks exchanging information about classroom management. Yet at the same time, the district encouraged partnerships to reform its science curriculum, and fostered growing network around science teaching and learning.

Virginia Initiative for Science Teaching and Achievement: Developing Effective Elementary Science Teachers, Year Two

Donna R. Sterling, George Mason University, dsterlin@gmu.edu

Elizabeth W. Edmondson, Virginia Commonwealth University

Juanita Jo Matkins, College of William & Mary

Mollianne Logerwell, George Mason University

Anne Mannarino, College of William and Mary

ABSTRACT: This paper discusses results in year two of implementation of the YYY, a U.S. Department of Education (USED) science teaching reform effort. YYY is a partnership among 67 XX public school districts, six universities, and the Virginia Department of Education to build an infrastructure to provide sustained, intensive science teacher professional development to increase student performance. Funded by USED (Investing in Innovation Fund), the goal of YYY is to improve science teaching and student learning throughout Virginia especially in high-need (high-poverty, high minority) schools and for limited English proficient students, rural students, and students with disabilities through a validation study as it is being extended across multiple school districts. YYY has been designed to build leadership and shape state and local practice through four intensive professional development programs for elementary teachers, secondary teachers, school district science coordinators, and university science education faculty. This paper focuses on the elementary teacher component of the professional development programs and its associated preliminary research findings from years one and two of the project. The paper specifically reports the results for elementary teachers' understanding of and confidence in implementing problem-based learning, nature of science, and inquiry instruction.

Integrating Online and Face-to-Face: A Social Networking Approach to Professional Development

Carolyn Staudt, Concord Consortium, carolyn@concord.org

Rachel E. Kay, Concord Consortium

ABSTRACT: Professional development is critical to the amount and quality of technology use in schools. The Innovative Technology for Science Inquiry-Scale Up (ITSI-SU), a portal containing activities that use models or sensors to teacher science, addresses this need through a combination of face-to-face and online professional development. Teachers who participated in the professional development for ITSI-SU were more likely to become active users of ITSI-SU than teachers who had joined the portal, but had not experienced any professional development. Additionally, the teacher participation in the online professional development was more on topic and more collaborative than in an online course that did not contain the social networking features such as message boards, blogs, and "friending" capabilities.

Strand 8: In-service Science Teacher Education

A Focus on Authentic Science Practices

10:15am-11:45am, San Cristobal

Presenter: Steven McGee

Characterization of an Inner-City Elementary School Teacher Practice of Argumentation

Reizelie Barreto, Towson University, rbarreto@towson.edu

ABSTRACT: Inner-city elementary school teachers are often burdened by external factors such as lack of resources and administrative support and low parental involvement. Even when teachers are eager to adopt new pedagogies they often report struggling to engage in these practices by themselves. These issues are amplified when attempting to engage students in argumentation. Professional development opportunities targeting inner-city teachers' adoption of argumentation in elementary school classrooms is limited. Furthermore, there is a gap in the literature characterizing urban elementary school classroom teachers' argumentation practices in highly distressed environments. Hence, the current study aimed at characterizing inner-city teachers' practices when adopting an argumentation pedagogical stance

for the first time. The single-case study reported is a component of a larger study with emphasis on characterizing teachers' practices related to learning and adopting argumentation pedagogies. Data collection took place over a year and was analyzed using StudioCode and HyperResearch software. Findings demonstrated that Susan was able to elicit argumentation-based pedagogies by engaging in cognitive processes of questioning her own practices. She "interpreted" her teaching and engaged in complex thinking and in doing so expanded her teaching repertoire. Finally, Susan was able to develop "images of good practice" that supported argumentation practices.

A Pathway to Inquiry-based Teaching

Franz X. Bogner, University of Bayreuth, franz.bogner@uni-bayreuth.de

Sofolkis Sotiriou, Ellinogermaniki Agogi, Athens

ABSTRACT: The objective of the three-year European project with its 25 partner organisations is to set the pathway toward a standard-based approach to teaching science by inquiry. The project (i) supports the adoption of inquiry teaching by demonstrating ways to reduce the constraints presented by teachers and school organisations, (ii) demonstrates and disseminates methods and exemplary cases of both effective introduction of inquiry to science classrooms and professional development programmes, as well as (iii) delivers a set of guidelines for the educational community to further explore and exploit the unique benefits of the proposed approach in science teaching.

Teaching Science as Inquiry in the Classroom: Experiences from Pakistan

Nelofer Halai, Aga Khan University, nelofer.halai@aku.edu

ABSTRACT: This study examines the journey of three in-service science teachers Arif, Maryam and Rahim who are enrolled in an innovative M.Ed. program offered by a private university in Pakistan and are undertaking an action research to study their practice of teaching through inquiry. The author while supervising the action research examines the process the three teachers follow to undertake inquiry teaching in the science classroom in the context of Pakistan. Three case studies are developed and indicate that for inquiry a flexible goal setting process is required together with continual development of a better understanding of both inquiry method and the science content. Before inquiry teaching could take place an environment conducive for student autonomy and agency had to be nurtured which was made more challenging by the unique religious and cultural context of Pakistan. Inquiry changes the level of students' engagement in the classroom and teachers need to be prepared to not only support but welcome this change. This study also shows that teacher educators themselves need to develop a better understanding of the kind of support teachers require to undertake inquiry in the classroom.

From "Sharing Out" to "Working through Ideas:" Helping Teachers Transition to More Productive Science Talk

Annette Sassi, TERC, annette_sassi@terc.edu

Anushree Bopardikar, Wisconsin Center for Education Research

Amelia Kimball, University of Illinois at Urbana-Champaign

Sarah Michaels, Clark University

ABSTRACT: This paper reports on the research findings from the Talk Science project, an NSF-funded project focused on developing students' science reasoning through discussion. It is a web-based teacher professional development program linked with the Inquiry Project Curriculum. The aim of the project is to cultivate teachers' capacity to orchestrate more academically productive science discussions. Teachers engage in guided independent study, try out ideas in their classroom, and participate in grade level study group meetings. The goals of the research have been to understand more deeply how teachers learn to facilitate more productive science discussions and to see if the program supports this aim. Data was collected in four key areas: 1) actual classroom practice; 2) teachers' attitudes towards and understanding of classroom discourse practices; 3) teachers' use of their study group time; 4) teachers' content knowledge. The paper describes the data collection, analysis, and key findings. It concludes that, while the online resources help teachers begin to shift their science discussions to more productive discussions, more research is needed to understand the relationships among teachers' science knowledge, their understanding of scientific reasoning, their understanding of their role in supporting talk, and their use of productive talk moves.

Strand 8: In-service Science Teacher Education***On the Key Role of Content Knowledge***

10:15am-11:45am, Río Mar Salon 4

Presider: Brian C. Baldwin*Learning from Stories of Youths' Informal Science Learning Experiences*

Daniel Birmingham, Michigan State University, birming2@msu.edu

Angela Calabrese-Barton, Michigan State University

ABSTRACT: Little is known about how teachers can learn from informal science practices to support student engagement in science. Using critical ethnography, we examine how inservice middle school science teachers interpret youth narratives of learning and doing science in informal settings and bring these understandings to their teaching. Our study is based upon professional development experiences where teachers interacted with youth-authored cases regarding how science is meaningful in their lives, how they learn and do science in their communities, and their hopes for school science. The following questions guided our investigation: What sense do teachers make of youths' stories of participation in informal science learning opportunities? Is there evidence that teachers' draw upon interpretations of youths' stories in their classroom practices? Findings indicate teachers initially drew upon institutional narratives when making sense of youth cases but those narratives slowly broke down once teachers began focusing on youths' personal narratives of meaningful science learning juxtaposed against their own experiences participating with science. We also describe the ways in which teachers used their understandings of youth stories to enact change in their science classrooms while struggling to balance proposed changes with existing institutional narratives.

Middle School Teachers' Ideas about the Practice of Developing and Using Models in Science

Carrie A. Bemis, University of Colorado - Boulder, carrie.bemis@colorado.edu

William R. Penuel, University of Colorado Boulder

Hannah Jones, University of Colorado - Boulder

Mary L. Starr, University of Michigan

ABSTRACT: Implementation of the Next Generation Science Standards is likely to present significant challenges to science teachers, because the K-12 Framework for Science Education guiding their development presents ideas about science teaching that are likely to be unfamiliar to many teachers. Key among the unfamiliar ideas is the practice of developing and using models as a means of developing and expressing understanding of core ideas of science. Teachers are likely to view calls for engaging students with models in light of prior conceptions, which in turn will shape their implementation (Spillane, 2004; Spillane, Reiser, & Gomez, 2006). This research focuses on teachers' ideas and beliefs about the practice of developing and using models, with the aim of informing the design of professional development related to the Framework. Preliminary analysis comes from coded pre-assessment data from 53 middle school science teachers in a large urban school district. These data reveal diverse teacher interpretations of models and modeling activities. Teachers most commonly described modeling as a demonstration by the teacher rather than a means for students to develop explanations. Strikingly, only a pair of responses at pre-assessment indicates uses of models consistent with the Framework.

Teachers' Collaborative Inquiry into Scientific Models: Making Sense of Standards

Tamara H. Nelson, Washington State University Vancouver, tnelson1@vancouver.wsu.edu

David Slavit, Washington State University Vancouver

Angie Deuel, Washington State University Vancouver

ABSTRACT: This study shows how one group of experienced, knowledgeable teachers struggled to collectively define learning expectations based on standards about scientific models, improve their instruction in this area, and impact student learning. The findings presented in this paper are based upon this analytic question: What constrains and affords a middle school science PLC's efforts to use a collaborative inquiry process to improve student learning about scientific models? We found that a lack of common understanding about the meaning of model-related standards was a significant constraint on the group's ability to impact student learning. This substantively affected the nature of their

ongoing conversation in the PLC. Other constraints on the teachers' progress included differing epistemological perspectives on the nature of scientific knowledge and varied opinions about the state science exam as a framework for their learning expectations. Given the ongoing emphasis on collaborative teacher inquiry as a form of professional development and on scientific models as a significant element in the Next Generation Science Standards, understanding the challenges teachers encounter in making sense of standards is critical. The findings from this study contribute to understanding teachers' professional development needs in relation to both content and process.

Characterizing Teachers' Incoming Science Content Knowledge In A Professional Development Program

Joyce M. Parker, Michigan State University, parker@cns.msu.edu

Tom J. McConnell, Ball State University

Jan Eberhardt, Michigan State University

ABSTRACT: While research shows that improving science teachers' content knowledge is important in changing teaching practice, offering professional development (PD) that meets the diverse needs of teachers is challenging. Teachers in a PD experience come with different educational backgrounds, licenses, and experience. Just as we expect teachers to pre-assess so they can focus instruction on the needs of students, PD planners should base their instruction on the prior knowledge of participants. The Problem Based Learning Project for Science implemented a pre-assessment strategy that included instruments in seven content strands for K-12 teachers who elected to study a science topic they had identified as an area of need. In this paper, we summarize patterns in teachers' content knowledge. Findings suggest that teachers entered the PD program with no more than the level needed to answer recitation types of questions about science content in their selected strands. Many of the elementary teachers and elementary-certified middle school teachers lacked even foundational science knowledge. Teachers across all levels struggled to connect idea and explain their application to real-world contexts. We discuss the implications of the patterns in the design and delivery of professional development for science teachers.

Strand 10: Curriculum, Evaluation, and Assessment

Science Curriculum Development and Implementation from Global Perspectives

10:15am-11:45am, Pelican Room

Influences of Student and School Characteristics on Scientific Literacy Skills of Turkish Students in PISA

Sevgi Ipekcioglu, Middle East Technical University, isevgi@metu.edu.tr

Özgür Çelebi, Middle East Technical University

Ömer Geban, Middle East Technical University

ABSTRACT: Influences of Student and School Characteristics on Scientific Literacy Skills of Turkish Students in PISA The purpose of this study is to investigate the influence of student and school characteristics on scientific literacy skills of 15-year-old students in Turkey considering hierarchical impacts and interactions, through the use of data from PISA 2006. In the present study, both the datasets from student and school questionnaires that Turkish participants filled in and hierarchical linear modeling techniques to interpret the data were used. Significant associations of students' scientific literacy scores with overall scientific literacy scores of students in that school, academic selectivity of school, the extent of school activities to promote learning of science, adequacy of school's educational resources, and the degree of teacher shortage were found in Turkey. Those variables explained a 51% portion of between-school variance in scientific literacy scores of Turkish students. Student factors positively affecting scientific literacy scores of Turkish students in PISA 2006 were found to be highest occupational status of parents, awareness of environmental issues, general value of science, home educational resources, enjoyment of science, responsibility for sustainable development, self-efficacy in science, and self-confidence in ICT internet. On the other hand, optimism regarding environmental issues, home possessions, hands-on activities in science teaching and learning, self-confidence in ICT high-level tasks, and ICT program/software use were negatively related to Turkish students' scientific literacy scores. These factors accounted for the 31% of variance in Turkish students' scientific literacy scores.

Applied Science and Technology: The Implementation of a New Approach to Learning Science in Quebec

Ken H. Elliott, McGill University, kenneth.elliott@mail.mcgill.ca

ABSTRACT: This paper describes the findings of a teachers' online survey – one part of a mixed methods research project studying the implementation of Applied Science and Technology (AST) - a recently-implemented Grade 9 and 10 program in Quebec. AST is part of a comprehensive reform of the K-11 Quebec curriculum. AST teaches science by emphasizing the applications of science and technology in the real world of the students. The program uses the pedagogy of constructivism and integrates engineering technology into the science content. AST teachers responded to an online survey asking them to describe their teaching methodology, curriculum, use of materials, student motivation and support they receive. The survey found that teachers are following the curriculum and beginning to incorporate constructivist pedagogical techniques. They are participating in professional development and sharing resources to enable them to incorporate engineering technology, real world applications and tools into their classroom activities. While students react very positively to this applications-based hands-on approach, teachers face obstacles regarding the lack of congruence of the exams with the program, the need to learn the engineering aspect of AST and the need to produce activities which integrate the applications of science into the curriculum.

Introduction of National Tests in Biology, Physics and Chemistry: Potential Influence on Teachers' Teaching Practices

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Malena Lidar, Uppsala University

Leif Ostman, Uppsala University

Per Sund, Malardalen University

Leif Ostman, Uppsala University

ABSTRACT: This paper reports results from a project that aims at investigating if and in which way the introduction of national tests in science education influence teachers' opinions of what is "good" education in science and how this influence teachers' instruction and assessment of students. National tests in biology, physics and chemistry were introduced in 2009 in year 9 in Swedish compulsory school. Some of the governing arguments for introducing national tests are that they will work exemplary for teachers and create a more equal and fair assessment and grading of students. A survey among Swedish science teachers were performed regarding various aspects of their practice. Selected teachers were then interviewed about their teaching. Analyses of the actual national tests were also carried out. The results showed that different teachers do put emphasis on different goals, contents, and assessment in their classroom practices and that these aspects can be systematically grouped as teaching traditions. Nevertheless, there were no significant differences in how teachers in different teaching traditions responded to national tests. Therefore it is discussed whether the use of national tests is a feasible way to generate a more equal and fair education.

Curricular Developments in South Africa: The Role of Argumentation in Secondary Science Teaching

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Sibel Erduran, University of Bristol

ABSTRACT: This paper presents an analysis of South Africa's policy documents to determine the role of argumentation in the science curriculum. Our interest is in argumentation as part of science learning, particularly in the context of the South African curriculum that seeks an integration of indigenous knowledge (IKS) into science teaching. The study illustrates that South African curricula encourage teachers to be guided by learning objectives and could draw from various content/topics to achieve each outcome. This creates a challenge for teachers to find and adapt materials and resources to achieve all outcomes equally and thus all IKS, NoS and argumentation equally. Our findings suggest that revision of the science curriculum has shifted to a more content-focussed approach and if IKS and argumentation in particular are not explicitly linked to specific content in the curriculum it may not be possible for teachers to address them. The extent to which science teachers are trained to perform this task - which requires a high level of teacher subject matter knowledge and confidence - is questionable. The paper will outline a set of recommendations for how to use the research evidence on argumentation and NOS to raise awareness in the policy context.

Strand 10: Curriculum, Evaluation, and Assessment***Implementation and Evaluation of Science Curriculum***

10:15am-11:45am, Río Mar Salon 2

Presider: Mehmet Aydeniz*Developing a Teaching Strategies of Modeling and Metamodeling in Converging Lenses and its Image Formation*

Koichi Furuya, Hokkaido University of Education, furuya.koichi@a.hokkyodai.ac.jp

ABSTRACT: The acquisition of scientific concepts and Nature of Science through exploration of phenomena and models are at the core of scientific practice. To engage students in developing and using such models is therefore critical in achieving this aim. In addition, the importance of a metaknowledge of modeling—what a model is and why we use it—has emerged from previous research. We have applied these ideas about modeling to the learning of geometrical optics, namely converging lenses and image formation in grade seven classes. Based on earlier studies, we define modeling and metamodeling as the elements of practice and metamodeling. To enhance students' understanding, we developed two new teaching strategies combining these elements of practice and metamodeling and then conducted an experiment to assess the effects of these teaching strategies. The following two points emerged: (1) Learning science through the two new teaching strategies, with the elements of practice and modeling, helped students to understand scientific concepts, especially object and image relationships between phenomena and diagrams functioning as the model. (2) Both new teaching strategies addressing the elements of practice a

Instructional Materials to Support the Next Generation Science Standards: Results of A Proof-of-Concept Study

Eric R. Banilower, Horizon Research, Inc., erb@horizon-research.com

Michele M. Nelson, Horizon Research, Inc.

ABSTRACT: The problem of how to improve elementary student science achievement in the United States is multifaceted. To be effective, interventions must consider challenges associated with teaching, learning, and implementing instructional changes at a large scale. In this paper, we present findings from a study of an educative curriculum materials-based intervention that has three central design principles: 1) the materials are aligned with current knowledge about how people learn; 2) the educative components support teacher content and pedagogical content knowledge, and facilitate instructional implementation; and 3) the instructional activities use low-cost, readily available materials amenable to large-scale implementation. Our findings indicate that student learning gains are greater in classes where teachers implement the intervention than in comparison classes. In addition, the extent of materials implementation and fidelity to the pedagogical approach embodied in the materials are positively associated with student achievement gains. Implications of these findings for supporting implementation of the Next Generation Science Standards are discussed.

Finding Evidence in the Enactment: Elementary Science Teachers' Use of Educative Curriculum Materials

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Amber S. Bismack, Pennsylvania State University

Elizabeth A. Davis, University of Michigan

Annemarie S. Palincsar, University of Michigan

Andrew Shi, University of Michigan

ABSTRACT: New reform documents, including the forthcoming Next Generation Science Standards, underscore the importance of learning both the practices and content of science. These documents set ambitious goals for science teaching. Educative curriculum materials (ECMs)—materials explicitly designed to support teacher and student learning—have been posited as way to support teachers in these ambitious goals, yet little is known about how elementary teachers actually use ECMs in their interactions with students. To fill this gap, this study investigated how two fourth-grade teachers enacted a curriculum unit enhanced with educative features. Evidence of the language and teaching practices promoted by the ECMs was observed in the teachers' enactments. Findings showed differences between the two teachers' use of the various educative features. For example, one teacher made more frequent use of

those enhancements that appeared in multiple locations compared to those found in one or two locations. Implications for curriculum developers and educators are discussed based on the patterns found in the teachers' use of the ECMs.

A Impact Analysis of a 5th Grade Science Curriculum Based on the 5E Model

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Carolyn M. Schroeder, Texas A&M University

Homer Tolson, Texas A&M University

Tse-Yang Huang, National Hsinchu University of Education, Taiwan

Omah M. Williams, Texas A&M University

ABSTRACT: A Tier-1 University, a Regional Education Service Center (ESC) and a diverse school district conducted a study from 2005 – 2009. The state achievement test (called TAKS) scores of 5th graders who were taught using a Grade 5 science textbook designed by the ESC were analyzed in this study. The text emphasized instruction via the 5E Instructional Model; the study determined if sustained training and utilization of the texts by teachers and students changed the participating district's science achievement gaps at Grade 5. The school district provided all 5th grade TAKS scores from 2004 – 2009. Descriptive statistics determined group means, standard deviations, and standard errors. ANOVA tests differentiated TAKS group means by Test Administration Date, Gender and Ethnicity. Analysis of means by ethnicity revealed observable achievement gaps between White, African American, and Hispanic students. Science scale score means by ethnicity increased over the 5-year span. While significant 2 – way interactions were determined between Test Administration Date and Gender, Test Administration Date and Ethnicity, and Gender and Ethnicity, the effect for the interactions were small. The district's African American and Hispanic achievement gaps were greatly reduced, more so than the state achievement gap during the same time period.

Strand 11: Cultural, Social, and Gender Issues

Symposium - Expanding Perspectives and Participation in Research on Teaching and Learning Science with Innovative Methodological Approaches

10:15am-11:45am, Río Mar Salon 7

Presenters:

Stephen M. Ritchie, Queensland University of Technology, s.ritchie@qut.edu.au

Peter Hudson, Queensland University of Technology

Alberto Bellocchi, Queensland University of Technology

Senka Henderson, Queensland University of Technology

Donna King, Queensland University of Technology

Christina Siry, University of Luxembourg

Sonya N. Martin, Seoul National University

Kenneth G. Tobin, The City University of New York

ABSTRACT: This symposium draws on different methodologies for highlighting the complexities of social life. In this interactive symposium session we assert the need for methodologies to emphasize research participants' voices and perspectives in order to reach the ethical demands of democratic, dialogical, and multi-voiced research. The first presentation shares findings from a case study examining the challenges in identifying a teacher's in-the-moment classroom emotions during a stimulated recall interview, and the subsequent development of innovative self-reporting methods for research on the arousal of discrete emotions experienced in science classrooms. The second presentation examines the ways in which participatory practices and methodologies can reveal the complexity of children's science knowledges. The third presentation discusses methods that support researchers and participants in multi-language contexts to engage participants in research that is ethical and transformative. Finally, the fourth presentation will discuss a variety of interventions in multi-level studies of emotion in science education to describe how reflexive inquiry about physiological variables associated with teaching and learning can change the emotional states of teachers and students and enable them to engage in science with more mindfulness and attention to their goals as teachers and learners.

Strand 11: Cultural, Social, and Gender Issues***Cross-cultural Experiences of Students in the Classroom***

10:15am-11:45am, Río Mar Salon 8

Presider: Alice Cottaar*Beyond Passive Broader Crossers: Students as Active Cultural Brokers in Urban Science Classrooms*

Bhaskar Upadhyay, University of Minnesota, bhaskar@umn.edu

Michelle A. Fleming, Wright State University

Kristina Maruyama Tank, University of Minnesota

ABSTRACT: This case study explores how urban elementary students can act as active cultural brokers in science. We used the theoretical framework of cultural border crossing as the central theoretical grounding in this study. We defined culture as a fluid and dynamic construct that is shaped by personal experiences. We explored three 5th grade students over three months when they were engaged in learning about environment and landforms. We collected data through observations, interviews and field notes. We used an iterative process to analyze the data and our findings indicate that students can be influential cultural brokers in science classes. Students not only encourage their peers to connect science to their cultural experiences but they also help transform the classroom dynamics between them and their teachers. The study also showed that students' evolving cultural experiences are as important as their static cultural characteristics gained from their parents.

Discouraging Results: Problematizing Test Questions in Science Education

Margareta Serder, Malmo University, margareta.serder@mah.se

Anders Jakobsson, Malmo University

ABSTRACT: In the wake of a national and global focus on large-scale assessment of students' knowledge and skills, not least in science education, there is a call for research that studies in detail the instruments with which the knowledge is measured: the test-questions. In the presented empirical, qualitative study we make an attempt to problematize the relation between measured knowledge and the activities embodied in the test-situation. We do this by using a methodology in which students, in contrast to the normal test-situation in which knowledge is to be expressed in isolation, collaboratively discuss and answer test questions. In this way, we mean it becomes possible to approach how students actually understand and make meaning of the questions intended to measure their scientific knowledge. The study comprises the recorded and transcribed discussions of 71 students, divided into small groups, working with three units from PISA Science 2006 which are analyzed through a sociocultural semiotic lens. The results reflect a student-test interaction colored by meaning making of scientific, academic language use, and positioning towards science, scientific meanings, scientific identities, and scientific (test-practice-)skill.

Creating Authentic Literacy Experiences for Culturally and Linguistically Diverse (CLD) 5th Graders' Content Understandings

Geeta Verma, University of Colorado Denver, geeta.verma@ucdenver.edu

ABSTRACT: This study explored ways in which elementary-aged culturally and linguistically diverse (CLD) students' literacy experiences and science content understandings were enhanced as a result of modifying and adapting the science curriculum. Research suggests that CLD students have difficulty making meaning in the science classroom due to incongruence between the academic language inherent in the science curriculum and that of students' culture(s) (Lee and Fradd, 1998). In this study, we worked with one science teacher and approx. 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 participating teacher's and students' interactions with literacy experiences and its implications for science content understandings. Data sources included teacher interviews, student group interview, critical content analysis and field notes. Findings indicated 2) teacher's willingness to implement new linguistics and cultural norms for integrated literacy and content experiences; b) teacher's struggle in implementing revised instructional and pedagogical

for increased student success. We will present the ideas of “praxis mediators” in this presentation and expand upon the findings.

Strand 12: Educational Technology

Modeling and Mobile Applications

10:15am-11:45am, Río Mar Salon 3

Presider: Adem Tasdemir, Virginia Commonwealth University

Investigating Student Flow Experience During a Mobile Augmented Reality Science Game

Denise M. Bressler, Lehigh University, dmb309@lehigh.edu

Alec M. Bodzin, Lehigh University

ABSTRACT: Current studies have reported that secondary students are highly engaged while playing mobile augmented reality (AR) learning games. This study investigated factors related to students’ engagement—as characterized by flow theory—during a collaborative AR forensic science mystery game using mobile devices. School Scene Investigators: The Case of the Stolen Score Sheets is a vision-based AR game played inside the school environment with quick response (QR) codes. A mixed methods approach was employed with 68 urban middle school students. Data sources included pre- and post-surveys, field observations, and group interviews. Results showed that neither gender nor interest in science were important predictors of variability in flow experience. Gaming attitude uniquely predicted 23% of the variance in flow experience. Student flow experience features included a flash of intensity, a sense of discovery, and the desire for higher performance. The findings demonstrated a potential for mobile AR science games to increase science interest and help students collaborate on learning tasks. Implications for future research concerning mobile AR games as a scalable design for science learning in schools are discussed.

Using Ipads to Teach Inquiry Science to Students with a Moderate Intellectual Disability

Bridget T. Miller, Purdue University, bmillier6@purdue.edu

Gerald H. Krockover, Purdue University

ABSTRACT: The purpose of this study was to investigate the effect of experimenting with Physical Manipulatives (PM), Virtual Manipulatives (VM), and a blended combination of PM and VM on primary school students’ understanding of concepts in the domain of Electric Circuits. A pre-post comparison study design was used for the purposes of this study that involved 55 participants assigned to three conditions. The first condition consisted of 18 students that used PM, the second condition consisted of 18 students that used VM, and the third condition consisted of 19 students that used the blended combination of PM and VM. In the case of the blended combination, the use of VM or PM are combined according to the framework developed by Olympiou and Zacharia (2012). This framework takes into consideration the PM and VM affordances and specifically targets the content of each lab experiment separately. All conditions used the same inquiry-oriented curriculum materials and procedures. A conceptual test was administered to assess students’ understanding before and after teaching. Results revealed that the use of the blended combinations enhanced students’ conceptual understanding in the domain of Electric Circuits more than the use of PM or VM alone.

Zydeco: A New Mobile Application to Support Claim-Evidence-Reasoning Model

Ibrahim Delen, Michigan State University, delenibrahim@gmail.com

Wan-Tzu Lo, University of Michigan, Ann Arbor

Alex Kuhn, University of Michigan

Chris Quintana, University of Michigan

Joseph S. Krajcik, Michigan State University

Steve McGee, The Learning Partnership

Jennifer L. Witers, The Learning Partnership

ABSTRACT: Michigan science standards expect 4th graders to conduct investigations and develop solutions with reasoning. However, some studies noted that middle school students struggle to create scientific reasoning. Therefore a

number of studies have developed software programs to help students in this hard task. In a similar vein, we have designed a mobile application called Zydeco which helps students bridge informal and formal learning environments. Students can collect data outside the classroom and then bring those data back to the classroom to create scientific explanations by using claim-evidence-reasoning model. A middle school science teacher from Ann Arbor Public Schools participated with four sixth grade classes (n=109). We collected two types of data for measuring students' claim-evidence-reasoning outcomes: (1) students' scientific explanations developed in the iPad version of Zydeco, and (2) paper and pencil assessment that was administered as pretest and posttest. By using Zydeco, students created predictions about water quality (claim), they analyzed the data, and created reasoning for the evidence they collected. Although their ability to complete a scientific explanation was low at pretest, Zydeco successfully scaffolded students to develop scientific explanations. After completing Zydeco, students' posttest performance was significantly higher on the posttest.

Strand 13: History, Philosophy, and Sociology of Science

Curriculum & Creativity

10:15am-11:45am, Heron Room

Presider: Lisa M. Martin-Hansen

Parallel Roles for Nonformal Reasoning in Expert Scientific Model Construction and Classroom Discussions in Science

John J. Clement, University of Massachusetts, clement@educ.umass.edu

Grant Williams, St. Thomas University

ABSTRACT: We describe model construction processes in scientifically trained experts and propose connections to important learning and teaching processes in science class discussions. Our work with science experts has analyzed data from videotaped protocols of experts thinking aloud about unfamiliar explanation problems. These studies document the value of nonformal reasoning processes such as analogies, concept differentiation, Gedanken experiments, and the construction and running of visualizable explanatory models. At a larger time scale, some subjects went through model evolution cycles of model generation, evaluation, and modification that utilized the nonformal reasoning processes above. Parallels to classroom processes are seen via case studies from videotapes of exemplary science teachers leading discussions about electric circuits in high school physics. We found that these teachers encouraged many of the same reasoning processes above seen in experts. There is a need for transparent ways to picture such teaching strategies; we have used diagrams that show cycles of model generation, evaluation, and modification in discussions in order to envision the teacher's process of scaffolding model construction. These analyses of discussions and comparisons to expert reasoning can sharpen our ways of describing important teaching strategies.

Using Films to Engage Graduate Students in NOS and SI

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Catherine M. Koehler, Southern Connecticut State University

Mark Bloom, Dallas Baptist University

ABSTRACT: This study is part of a multiyear project that investigates the portrayal of nature of science (NOS) and scientific inquiry (SI) in popular films and explores how these films impact students' understandings of NOS and SI. In this investigation, we explored the impact of mainstream films on graduate students' understandings of NOS and SI. Thirteen graduate students participated in this study. Over the course of a semester, participants watched four films and completed researcher-developed templates: Twister, Jurassic Park, Gorillas in the Mist, and Contact. Each viewing was followed by small group and whole class discussions. Multiple data sources were collected including pre/post/delayed-post VNOS-D+ and NOS quiz, final papers, film questionnaires, individual and group templates for each film, and video recordings of small group and whole class discussion. Findings revealed that participants' NOS and SI understandings improved and remained consistent five months after participating in the study. Additionally, participants indicated that viewing the films contributed to their improved NOS and SI understandings. Finally, participants successfully recognized how NOS and SI were exemplified in the films.

Stylized Textbook Graphics of Cell Anatomy and Associated Student Misconceptions

Jennifer Landin, NC State University, jmlandin@ncsu.edu

ABSTRACT: Research into the educational role of textbook figures has repeatedly demonstrated a positive impact on student learning. Recent research, however, has indicated a trend toward more figures overall in general biology texts, with a sharp increase in the number of highly stylized graphics. In this study, I present an analysis of the shift in textbook figures from representational to **ABSTRACT** illustrations, specifically the pictorial representations of cell anatomy. This shift in image-style may negatively influence student conceptions by creating distorted, and persistent, impressions of cellular structures.

"Nature of Scientists" - Students' Views about Scientists and their Activities

Wilfried Wentorf, Leibniz Institute, wentorf@ipn.uni-kiel.de

Tim Höffler, Leibniz Institute

Pay O. Dierks, Leibniz Institute

Heide Peters, Leibniz Institute

Ilka Parchmann, Leibniz Institute

ABSTRACT: This paper discusses a new construct, „Nature of Scientists“, which focuses on students' images about characteristics and occupational activities of scientists. We developed an instrument based on Holland's RIASEC-model to analyze students' views, interests and self-concepts concerning scientists' activities. Additional to the RIASEC dimensions (realistic, investigative, artistic, social, enterprising, and conventional) we found another scale, “cooperative”. Thus, we could identify profiles of students' views about scientists. Focusing on potential scientific talents, the questionnaire was applied to participants of an interdisciplinary science competition (N = 131) and high-school students (N = 305). Overall, students showed high values according to their images about realistic and investigative activities of scientists, whereas they were mostly not aware of creative and enterprising facets. Participants of the competition emphasize scientists' investigative and artistic activities significantly more pronounced than high-school students. Four distinct profiles of students' views about scientists' characteristics were identified by cluster analysis. Our research may be of theoretical and practical value by linking the established concepts of nature of science and scientific inquiry, which allows representing the wide field of modern scientists' activities. This could as well have implications for the evaluation and conceptual design of science education and curricula.

Strand 14: Environmental Education***Research on Teaching and Learning about Short and Long-term Environmental Issues***

10:15am-11:45am, Canary Room

Presider: Ceyhan Cigdemoglu*Building a Learning Progression for the Study of Natural Hazard and Disaster Risk Reduction*

Sheila G. Oyao, University of Tartu, sheila77@ut.ee

Jack Holbrook, University of Tartu

Miia Rannikmae, University of Tartu

Hazura Ab Bakar, SEAMEO-RECSAM

ABSTRACT: Global attention is being drawn towards infusing the study of hazard and disaster risk reduction within the context of Education for Sustainable Development (ESD). This work presents a complete learning progression to provide a snapshot image of what K-12 ESD curriculum in this domain can look like. This progression presents sets of concepts, from multiple disciplines capturing scientific principles, behavioral responses and 21st century skills that are sequentially organized from simple concepts forming the foundation and increasing in sophistication as students move up the grade bands. Four key components are identified in this LP: learning about the earth's natural forces, hazard and disaster impacts and humanitarian response, community's vulnerability and role of technology and engineering to disaster risk reduction, and hazard and disaster preparedness. Big ideas or enduring understandings and instructional guidance are illustrated for each component at the given grade span. Not intended to be exhaustive, this model is seen as a starting

point for ideas and discussions to stimulate the addition of greater perspectives as a way of moving the domain forward. Hypothetical in nature, this LP can be validated through iterative process of instruction and student work analysis.

Using Argumentation about Historical Climate Data to Learn about Climate Change

Barry Golden, University of Tennessee, bwgolden@utk.edu

Martin G. Balinsky, Tallahassee Community College

ABSTRACT: This paper describes a study in which sixth grade students' understandings about climate change were analyzed before, during, and after an argumentation-based unit in which students were asked to analyze historical 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, which was 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 students underwent epistemic scaffolding as a result of their argumentation efforts, i.e., they showed changes in what they valued as evidence; Two, that students did not have an appropriate ontological category for climate change with which to distinguish it from any other environmental problem; and Three, that the conceptual change undergone by these students can best be understood as a contextualized interaction between four factors: epistemic, ontological, analytical, and affective domains. Recommendations are made for developing K-12 climate change curricula and for building models of student comprehension for climate change.

PSTs' Mental Models about Role and Distribution of Ozone Layer and Ozone Layer Depletion

Hilal Yanis, Gazi University, hilalyanis@yahoo.com

Özgül Yılmaz Tüzün, Middle East Technical University

ABSTRACT: Boyes, Chambers, and Stanisstreet (1995) stated that ozone depletion and greenhouse effect are complex and **ABSTRACT** environmental issues. Previous research have shown that pre-service science teachers (PSTs) hold many misconceptions regarding these issues. Also, research regarding misconceptions set up the mental model term in science education (Çepni & Keleş, 2006). This study focuses on mental models of PSTs about role and distribution of ozone layer and its depletion. Research questions that are investigated in this study are as follow: What are PSTs' mental models related to the role and distribution of ozone layer and what are PSTs' mental models related to ozone layer depletion? The study was conducted with twenty four PSTs from Elementary Science Education Program of Education Faculty of one public university located in Central Anatolia in Turkey. Semi structured interview protocol was used. Semi structured interview was translated and adapted by the researcher with an expert from the structured interview used in the study of Leighton and Bisanz (2003). Text and drawings were used as materials for the data analysis. As a result, ten distinct models were formed regarding role and distribution of ozone layer and five distinct models were formed regarding ozone layer depletion.

External Policy and Relations Committee Sponsored Session

Symposium - Blowing up the Silos! What will it take to Change 21st Century Science Education?

10:15am-11:45am, Caribbean Salon 1

Presider: John H. Falk, Oregon State University

Presenters:

Jonathan Osborne, Stanford University

Janet Coffey, Gordon & Betty Moore Foundation

Rudy Crew, Oregon Chief Education Officer

Lynn D. Dierking, Oregon State University

ABSTRACT: Is anarchy going to be necessary to achieve real solutions to the challenges facing 21st century science education? In the increasingly scientific and technological world of the 21st Century, a wide range of issues demand that citizens be interested in, engaged with and persistent in science. At the same time, today's citizens interact within a learning landscape radically different than that of the previous century. New digital technologies and media are rapidly

blurring the boundaries of where, when, and how people learn science across their lives. Meanwhile, most educational institutions continue to operate remarkably similarly to how they operated in the 20th century. Even when educational leaders speak about the tectonic shifts occurring in the learning landscape, their actions often indicate either a lack of understanding, or a lack of will for creating changes in practices equal to the challenges of the new reality. Two symposium speakers will introduce these issues and raise key questions about the current roles and efficacy of formal and informal science education institutions. Reactions by three leading educational thinkers/policy makers will follow the setup. Ample time will be set aside to insure opportunities for questions and discussion by the audience.

Strand 15: Policy***Related Paper Set- Inclusive STEM-focused High Schools: STEM Education Policy and Opportunity Structures***

10:15am-11:45am, Río Mar Salon 10

Discussant: Martin Storksdieck, National Academy of Sciences

James E. Hamos, National Science Foundation

ABSTRACT: This related paper set discusses the theory, conceptual framework, and the current results on two complimentary NSF-funded research projects to explore Inclusive STEM-focused High Schools. Unlike older, highly selective STEM-focused schools that target students already identified as being STEM gifted/talented, the explicit goal of Inclusive STEM-focused High Schools (ISHSs) is to develop new sources of STEM talent among under-represented minority students, and provide them with the means to succeed in school and in STEM jobs, college majors, and careers. The first study, Opportunity Structures for Preparation and Inspiration (OSPri) is an instrumental case study designed to systematically portray some of the promising ISHS models emerging across the US. The OSPri study will examine ISHSs across the dimensions of design, implementation and outcome, and in each school's context, developing 12 rich case studies over 4 years. The second study, iSTEM, in contrast, is a quantitative comparative study that focuses on student outcomes for students who attend ISHSs and compares them with outcomes of students in other types of public schools, while considering the design, implementation and contexts of ISHSs. Together, these two studies can provide a triangulated, and timely, view into inclusive STEM-focused high schools.

Inclusive STEM-Focused High Schools: STEM Education Policy and Opportunity Structures

Sharon J. Lynch, The George Washington University, slynch@gwu.edu

Central High School Case Study

Nancy Spillane, George Washington University, nspillan@gwu.edu

Granite Secondary School Case Study

Erin E. Peters-Burton, George Mason University, epeters1@gmu.edu

Expanding Access To STEM-Focused Education: What Are The Effects?

Ann House, SRI International, ann.house@sri.com

Barbara Means, SRI International

Concurrent Session #12**1:00pm – 2:30pm****External Policy and Relations Committee and Strand 15 Co-Sponsored Session*****Symposium on Climate Change Education: Policies and Implications***

1:00pm-2:30pm, Caribbean Salon 1

President: Sarah J. Carrier, North Carolina State University**Presenters:**

Barry W. Golden, University of Tennessee - Knoxville

Nancy W. Brickhouse, University of Delaware

J. Randy McGinnis, University of Maryland

Elizabeth M. Walsh, San Jose State University

Charles W. Anderson, Michigan State University

Wayne Breslyn, University of Maryland

Chris McDonald, University of Maryland

Emily Hestness, University of Maryland

ABSTRACT: While 63% of Americans may believe climate change is happening, most do not understand why (Leiserowitz et al., 2010). The National Research Council (2010, 2011) has stressed that our society must mobilize now to educate our citizens to understand why the climate system is changing, what the consequences may be, and what choices are before us both for limiting the magnitude of future climate change and adapting to the changing climate. Educational research studies reveal that students and their teachers have misconceptions about global warming and climate change (e.g. Boyes and Stanisstreet, 1997; Christidou et al., 1997; Cordero, 2002; Gowda et al. 1997; Khalid 2003; Michail et al. 2007; Uzzell 2000). It is clear that any effort to address public attitudes about climate change must target key constituencies, stake holders, and policy makers while also focusing on formal and informal education for K-12 and adult audiences. Presenters will discuss research on the inclusion of climate change in states' standards, a description of two states' partnership with attention to ongoing evaluation and research, the collaboration of scientists and educators, and how science education systems can help students develop more scientifically accurate beliefs. Policy implications bind the presentations and audience discussions.

Strand 1: Science Learning, Understanding and Conceptual Change***Constructing and Examining Learning Progressions in Science Education***

1:00pm-2:30pm, Río Mar Salon 1

Students' Progression in Understanding Energy

Knut Neumann, Leibniz Institute for Science Education (IPN) Kiel, neumann@ipn.uni-kiel.de

Gabriel Nagy, Leibniz Institute for Science Education (IPN) Kiel

ABSTRACT: The energy concept is one of the most important scientific concepts for students to be understood. Energy is a core idea in the quest to explain the physical world and a concept cutting across the different science disciplines. Learning Progressions have recently been suggested as a means to guide students in the development of a sound understanding of core scientific concepts such as the energy concept. Learning progressions are supposed to align standards, instruction and assessment based on previous research on students' learning. However, until now, no empirically validated learning progression of energy exists. Little is known about how students learn about energy. The presented paper provides reanalysis of a previously obtained data by means of IRT analyses. It provides evidence that students' progression in understanding the energy concept corresponds to the acquisition of new knowledge elements (knowledge accumulation) and the establishment of new links within the already existing knowledge base (knowledge integration).

Young Children's Understanding of Earth's Features and Changes

Deborah C. Smith, Penn State University, dcs27@psu.edu

ABSTRACT: This study investigated young children's understanding of Earth's features, materials, origins, and changes, in comparison to the Framework for K-12 Science Education's (FSE) recommendations for K-5 core disciplinary concepts in Earth science. Thirty 5 to 10 year olds from a rural school were interviewed, using photographs of local, familiar mountains, streams, valleys, erosion, etc. They also examined samples of Earth materials from the local area. Qualitative methods were used to transcribe videotapes and add gestural components, code, and construct levels of understanding, in comparison to earlier research studies with older children. Findings reveal that children used their local and school science knowledge to describe materials and features, explain their origins, and speculate on possible changes and mechanisms. Children's extensive reasoning and speculative explanations are used to report their uses of FSE scientific practices. Implications for K-12 learning progressions and for teaching and learning Earth science in grades K-4 are proposed.

Learning Progression of Lower Elementary Students' Systemic Reasoning in Ecology

Hayat Hokayem, Texas Christian University, h.hokayem@tcu.edu

Amelia W. Gotwals, Michigan State University

ABSTRACT: In this study, we utilized a learning progression framework to investigate lower elementary students (G1-4) systemic reasoning in ecology. We used semi-structured interviews with 44 students from first through fourth grade. The results revealed that a hypothetical learning progression begins with anthropomorphic reasoning as the lower anchor and ends with complex causal reasoning as the upper anchor for students in this age. However the results showed that many students revealed mixed-level reasoning - meaning that they can reason at different levels in the same context. Those results have implications for defining the learning progression in general, and for practical development of curriculum and instruction. With regard to defining the learning progression, the presence of mixed-level reasoning opens the discussion whether learning progression levels should be strictly pure levels or should include combinations of various levels to identify students' reasoning. With regard to development of curriculum and instruction, the results suggest proper systemic instruction could help students to progress to higher levels even at low grades.

Strand 2: Science Learning: Contexts, Characteristics and Interactions***Science Learning within Physics Domains***

1:00pm-2:30pm, Río Mar Salon 10

Presider: Jonathan F. Osborne

Promoting Self-Determined Learning in Science Classrooms

Anja Göhring, University of Regensburg, anja.goehring@physik.uni-regensburg.de

ABSTRACT: The research project on Self-Determined Learning (SDL) represents an empirically tested educational approach based on the Self-Determination Theory (Deci & Ryan, 1993; Ryan & Deci, 2000a; Ryan & Deci, 2002b) and on specific teaching strategies. According to this theory instruction at school should emphasize the experience of competence (e.g. differentiation of tasks), of autonomy (e.g. free choice of activity) and the feeling of social relatedness (e.g. cooperative learning). With respect to these guidelines teaching units in physics (basic electricity and energy), biology and the German language which aim to improve instruction by enhancing Self-Determined Learning and achievement were developed. The quasi-experimental study follows a treatment-control group design. The students' achievement in physics was measured three times per teaching unit (pre, post and follow-up test). Questionnaires with psychological constructs for both students and teachers were used in addition as well as portfolios, interviews and feedback sheets. Analyses show (Göhring, 2010) that for example the experience of autonomy is significantly higher within the treatment group in contrast to the control group. Concerning achievement, positive effects of Self-

Determined Learning are especially found in low-level secondary school. Findings from different data sets will be presented at the conference.

What Metacognitive Competences Trigger and Support Personal Appropriation of Physics Content Knowledge?

Olivia Levrini, University of Bologna, olivia.levrini2@unibo.it

Paola Fantini, University of Bergamo, Italy

ABSTRACT: The study is framed within a wider research work aimed at analyzing the data collected during the implementation of a teaching proposal on thermodynamics in a class of 17 year-olds students (grade 12) of a scientifically-oriented secondary school in Italy (teacher: P. Fantini). The analysis pointed out that, during the activities, students made evident progress in appropriating physics according to personal approaches. Appropriation includes deep understanding of the content knowledge but it is more than that. It implies explicitly the authenticity of the learning process, i.e. the active role played by a student to take care of and to account for her/his learning. The aim of the specific study that will be presented is to investigate, by means of a fine-grained qualitative analysis, the metacognitive competences which triggered and supported the individual processes of appropriation. The study is methodologically framed within the Design Studies. According to such a framework, the whole study, although empirically-based, is theoretically-oriented: the ambition is to arrive at building a "local theory of appropriation" able to explain not only if appropriation is achieved but also how, when and why it can be encouraged and supported in real classrooms.

The Effect of Lesson Duration (45 vs. 60 minutes) On Quality of Physics Instruction

Rainer Wackermann, Ruhr-University Bochum, wackermann@physik.rub.de

Julia Hater, Ruhr-University Bochum

ABSTRACT: This study concerns the optimal duration of physics/science lessons. It builds on the findings of a previous study, where videotaping of 80 lessons of 18 physics teachers in Germany revealed that less than 1.6% of lesson time was spent on transfer or concept linkage. One hypothesis is that lesson duration (45 minutes) is too short to allow completion of learning processes. Making use of a current transforming situation where some schools have changed to 60 minute lessons, this study follows an experimental pre-post-design. Two teachers from one upper level secondary school were videotaped under both conditions (n=14 videos). Main instrument is a category-based, high-inferent video analysis accompanied by a student and a teacher questionnaire and an expert rating of quality of instruction. Main finding is that the extra time is used in a potentially beneficial way; however the cognitive activation of students remains unchanged. We therefore conclude that professional development might be necessary to make full use of the extra time.

The Pedagogy of Inquiry in Introductory Physics

Daniel Z. Meyer, Illinois Institute of Technology, meyerd@iit.edu

Aracelis J. Scharon, Illinois Institute of Technology

James Kedvesh, Illinois Institute of Technology

Margaretann Connell, Chicago State University/Illinois Institute of Technology

ABSTRACT: Promoting inquiry-based learning has long been, and continued to be, a central focus of science education reform and research. This has included producing a now standard set of impediments to such learning that includes such factors as time, teacher knowledge and assessment pressure. Less well explored are the intrinsic hurdles to conducting inquiry. Similarly, while physics is prominent in both research and curriculum endeavors as a specific content context, less well explored are the unique intricacies of conducting inquiry in physics classes. This study is aimed at exploring the intrinsic hurdles to conducting inquiry in the physics classroom, and structural components and teacher actions that make it possible.

Strand 2: Science Learning: Contexts, Characteristics and Interactions***Related Paper Set - Science Teacher Quality: Factors within School Organizations and Science Leadership Structures***

1:00pm-2:30pm, Caribbean Salon 2

ABSTRACT: We report findings of our study of school organizations and science achievement. We situate “teacher quality” as key to a school’s structure and function. Our intent is to empirically identify factors that can differentiate schools that are more successful with providing equitable success in science achievement when compared to schools where science performance across demographic categories is less consistent. Two sources of data drawn serve as the bases for the findings reported across the four papers in this set. First, a nationally representative pool of 504 K-8 teachers was surveyed. These participants’ responses to eighty items on a 5-point Likert scale were subjected to exploratory factor analysis and the output indicated that we were working with only 9 factors. Second, teachers from a single school system were invited to respond to the same survey with 130 respondents. We also had access to the most recent science scores along with student demographics. Schools were rank-ordered according to their science scores after accounting for the percent of students designated as low-income. We report on the key factors along with comparisons across schools with varying levels of science achievement.

School Organization and Interpersonal Relationships: Teacher-Teacher Trust, Professional Community, and Variations in Schoolwide Science Achievement

Lara Smetana, Loyola University Chicago, lsmetana@luc.edu

Teachers' Knowledge and Perceptions about Community, Families & the Workplace

Malcolm B. Butler, University of Central Florida, Malcolm.Butler@ucf.edu

Teacher Perceptions of Principal Qualities and Leadership Practices

Morgaen Donaldson, University of Connecticut, morgaen.donaldson@uconn.edu

Science Instruction and Educational Equity: Teacher Perceptions about School Leadership

John Settlage, University of Connecticut, john.settlage@uconn.edu

Regina Suriel, University of Connecticut

School Organizations and Science Leadership: A Friendly Yet Focused Critique

Sherry A Southerland, Florida State University, ssoutherland@fsu.edu

Strand 2: Science Learning: Contexts, Characteristics and Interactions***Symposium - Designing for Student Agency in Elementary Science Inquiry Classrooms***

1:00pm-2:30pm, El Morro 1 & 2

Presenters:

Nancy Vye, University of Washington, nancyvye@u.washington.edu

Kari Shutt, University of Washington

Carrie Tzou, University of Washington

Giovanna Scalone, University of Washington

Amy Winstanley, Bellevue School District

Brian J. Reiser, Northwestern University

Andrew Morozov, University of Washington

John Bransford, University of Washington

Andrew W. Shouse, University of Washington

Philip L. Bell, University of Washington

ABSTRACT: The inclusion of science and engineering practices as one of three core dimensions of the NRC Framework for K-12 Science Education (2012) occasions a renewed focus for the field on the nature of science practices and their

praxis in schools. In this symposium the authors address the teaching of science inquiry practices in the context of hands on science kits, a primary curriculum resource in today's elementary science classroom. The symposium discusses efforts to redesign hands on science inquiry to afford greater student agency, engaging students in the formulation, design and control of science investigations and in forging links to their everyday practices and experiences. The symposium discusses theoretical perspectives on agency and its translation to design principles for learning environments and describes research on teacher moves that position/support agency in the context of student lead investigations, the use of self-documentation to promote agency in classrooms and connect everyday settings with formal science practices, and student and teacher perspectives on agency.

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

Symposium - Nanoeducation: Educational Challenges with an Emergent Scientific Field

1:00pm-2:30pm, Pelican Room

Presider: Ron Blonder, The Weizmann Institute of Science

Discussant: Gail M. Jones, North Carolina State University

Presenters:

Grant E. Gardner, East Carolina University

Virginie Albe, École normale supérieure de Cachan

Bénédicte Hingant, Institut Néel, Grenoble

Joel Chevrier, Institut Néel, Grenoble

Stefan Schwarzer, IPN, University of Kiel

Antti Laherto, University of Helsinki

Frederike Tirre, IPN, University of Kiel

Ilka Parchmann, University of Oldenburg

Ron Blonder, The Weizmann Institute of Science

ABSTRACT: Nanoscience is a growing area in research and development in science and technology, involving all different kinds of subjects and expertise. This symposium aims at laying the ground for further discussions and research projects aiming at a more systematic approach of developing investigating and understanding educational perspectives in nanoscience. First we will shortly introduce nanotechnology and current literature in nanoeducation research, then four studies in nanoeducation will be presented, and lastly educational challenges with nanotechnology an emergent scientific area will be discussed.

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

Examining College Science Student Beliefs

1:00pm-2:30pm, Parrot Room

Presider: Sarah A. Haines

Optimism Bias Affecting College Students' Post Predictions of Exam Performance

N. Sanjay Rebello, Kansas State University, srebello@phys.ksu.edu

Carina Rebello, University of Missouri

ABSTRACT: We all want our students to have an optimistic outlook toward life. However, does optimism improve academic performance? Two cohorts of students enrolled in different introductory college physics classes were asked to predict their score on an exam they had just taken. One cohort was enrolled in a calculus-based course for future engineers, with higher prior physics knowledge and was mostly male. The other cohort was enrolled in a conceptually-based course for future elementary teachers, had lower prior physics knowledge, and was mostly female. We define a metric – Post Prediction Error Relative to Mean (PPERM) to characterize students' accuracy of post prediction relative to the mean rather than absolute accuracy. Using this metric, we found that students in both cohorts on average

overestimated their performance on the exam relative to the mean and lower performing students tended to be more optimistic about their performance than higher performing students.

Tinkering and Technical Self-Efficacy of Engineering Students at the Community College

Dale R. Baker, Teachers College, dale.baker@asu.edu

Lorelei Wood, Chandler-Gilbert Community College

James Corkins, Maricopa Community College

Stephen Krause, Ira A. Fulton School of Engineering

ABSTRACT: **ABSTRACT** An instrument to measure tinkering and technical self-efficacy was given to 94 community college engineering students. Items on the instrument measured perception of abilities such as “I can think outside the box” (Tinkering scale), and “I can communicate ideas and concepts to others” (Technical scale). The mean score for the Technical scale was 86.8 and 91.9 for the Tinkering scale out of 120 points. Low self-efficacy on the Tinkering scale was in trouble shooting and generating solution to problems as well as understanding mechanisms and technical drawings. Low self-efficacy on the Technical scale was in mathematical calculations and statistical modeling and several areas of technical knowledge. On the Technical scale, high self-efficacy was reported for written and oral communication skills, logical and practical thinking, and tool use. High self-efficacy on the Tinkering scale was in persistence, curiosity about how things work, thinking outside the box and imagination, working well and building with hands, and a sense of how things work. Self-efficacy in engineering is important because individuals with low self-efficacy have lower levels of achievement and persistence in engineering majors.

Influences to Career Aspirations in Science and Engineering Doctoral Candidates

Deborah Barry, Syracuse University, debarry@syr.edu

John W. Tillotson, Syracuse University

ABSTRACT: This study utilized socialization theory to identify aspects of the doctoral education process influential in predicting the likelihood of certain career aspirations among science and engineering doctoral candidates. These aspects included the type of funding received, relationship with doctoral advisor, research productivity of the doctoral program's faculty, and student support services. Additionally, the role of students' background characteristics including gender, race/ethnicity, marital status, and dependent status were investigated. Data from the National Research Council's Assessment of Research Doctorate Programs (ARDP) were used to develop a ranking system for research doctoral programs in 61 fields at 222 institutions across the United States. The results suggest that doctoral program characteristics and experiences of doctoral students during graduate studies are influential in predicting academic career aspirations. Doctoral candidates' field of study, the research productivity rank of their doctoral program, student support services rank of their doctoral program, the primary type of finding they receive, their level of satisfaction with research experiences, and their sense of belonging in their doctoral program were factors that predicted the likelihood of certain career aspirations. Doctoral candidates' background characteristics that were significant predictors of career aspirations were gender, race, age, and citizenship status.

Strand 6: Science Learning in Informal Contexts

Related Paper Set - Learners in Action: Youth Narratives on Accessing and Transforming Science

1:00pm-2:30pm, Canary Room

ABSTRACT: This session invites researchers and youth learners to virtually present their own narratives around participation in informal science programs to 2013 NARST Annual Conference attendees. The virtual session not only provides scholars a venue for presenting their work from afar, but we feel this opportunity can and should be extended to youth participants that live across the globe. The youth narratives are grounded in scholarly work by youth researchers investigating equity-based issues in science learning and/or as participating members of science programs that empower youth to transform what counts as doing science. In this session, youth presenters will share their work as scientists, authors, videomakers, community science experts, and researchers. The wide range of projects these youth have undertaken directly challenge deficit models and views of youth as incapable novices that continues to exclude

them from fully participating in science endeavors. Furthermore, the youth represent a range of traditionally marginalized groups from different geographic, linguistic, racial/ethnic, gendered and socioeconomic backgrounds.

Youth Researchers Erase-ing Disparities in STEM Opportunities

Takumi Sato, Michigan State University, tsato@msu.edu

Angela Calabrese-Barton, Michigan State University

Viewing School Science through Our Eyes: Middle School Girls' Vision for what School Science Could Be

Tara B. O'Neill, University of Hawaii, toneill@hawaii.edu

Angela Calabrese Barton, Michigan State University

Science Journalism Experiences from a Youth Perspective: Who Or what Transforms?

Joseph L. Polman, University of Colorado Boulder, joseph.polman@colorado.edu

Jennifer M. Hope, McKendree University

Cynthia Graville-Smith, Saint Louis University

"Science is Not Just about Resistors:" Youth Narratives, Newsletters, and Mini-Documentaries as Ways into Science

Audrey Lachaine, Université de Montréal, karma_vi@yahoo.ca

Allison Gonsalves, Université de Montréal

Jrene Rahm, Université de Montréal

"But I Don't Like Anything about Science"

Daniel Birmingham, Michigan State University, birming2@msu.edu

Strand 7: Pre-service Science Teacher Education

Conceptions, Orientations and Beliefs towards Teaching Science

1:00pm-2:30pm, Río Mar Salon 9

Presider: Tonya D. Jeffery

Structure Inherent in Belief Systems

Brian S. Fortney, The University of Texas at Austin, bfortney@austin.utexas.edu

ABSTRACT: Much work has been done on teacher beliefs and General Systems Theory in the past 15 years, yet not together. We offer a framework to make sense of idiosyncratic change in teacher beliefs utilizing Hierarchy Theory as a descriptive language for use of a General Systems Theory lens that utilizes a multidimensional framework.

Relationship Between Pre-Service Elementary Science Teachers' Understandings of Nature of Science and Faith Developments

Gamze Cetinkaya, Middle East Technical University, gamzeczetinkaya@gmail.com

Jale Cakiroglu, Middle East Technical University

ABSTRACT: This study aimed to investigate pre-service science teachers' (PSTs) understanding of nature of science (NOS), their faith/worldview schemas, and whether PSTs with different levels of NOS understanding also differ in faith/worldview schemas or not. Data were collected from 60 PSTs through Views of Nature of Science Questionnaire Version C (VNOS-C) (Lederman, Abd-El-Khalick, Bell, & Schwartz (2002) and Scale of Faith or Worldview Schemas (SFWS) (Ok, 2009). Examination of descriptive statistics revealed that PSTs generally had adequate understanding of NOS and its aspects and they held flexible faiths and respect to other beliefs. The results of Kruskal-Wallis Test showed that there was a statistically significant difference in SFWS scores across three different groups of PSTs with inadequate, adequate and informed views of NOS, $\chi^2(2, n=60)=7.46, p=0.025$. Mann-Whitney U tests were performed as follow-up analyses and revealed a statistically significant difference in faith/worldview scores of informed group ($Md=3.89$) and inadequate

group ($Md=3.22$), $U=60.0$, $z=-2.59$, $p=.010$, $r=.45$. This result indicated that PSTs' with more flexible faith were developed a better understanding of NOS.

Predicting Student Teachers' Conceptions of Teaching Science with their Conceptions of Learning Science, Epistemological Beliefs, and Approaches to Learning Science

Elif Adibelli, University of Nevada, Las Vegas, adibelli@unlv.nevada.edu

Mustafa Sami Topcu, Mugla Sitki Kocman University

Hasan Deniz, University of Nevada

ABSTRACT: Previous studies established a close link between teaching conceptions and approaches to learning, learning conceptions, and epistemological beliefs, separately. Unfortunately, the authors were unable to locate quantitative studies evaluating such relations in a particular study and in the domain of science. Therefore, this study investigated: (1) What are the student teachers' conceptions of teaching science? and (2) What is the relative contribution of dimensions of personal epistemology, learning approaches, and learning conceptions to conceptions of teaching science? The sample included 157 student teachers of elementary science education and class teacher education in a non-Western country. The four instruments of the study were School Physics Teachers' Conceptions of Teaching (Gao & Watkins, 2002), the Epistemic Belief Inventory (Schraw, Bendixen, & Dunkle, 2002), and the Conceptions of Learning Science and the Approaches to Learning Science questionnaires (Lee, Johanson, & Tsai, 2008). Step-wise multiple regressions analyses indicated that most of the student teachers responded positively to all teaching conceptions. Moreover, teacher-centered teaching conceptions were explained by unfruitful learning approaches and naïve epistemological beliefs. On the other hand, student-centered teaching conceptions were mostly explained by constructivist learning conceptions. This study has implications for teacher educators in the design and development of teacher education programs.

Strand 8: In-service Science Teacher Education

Related Paper Set - Virginia Initiative for Science Teaching and Achievement— Second Year Statewide Implementation

1:00pm-2:30pm, Sea Gull Room

ABSTRACT: This paper set discusses the expanded implementation and evaluation of the YYY, a United States Department of Education science teaching reform effort. YYY is a partnership among 67 school districts, six universities, and the XX Department of Education to build an infrastructure to provide sustained, intensive science teacher professional development to increase student performance. Funded by the U.S. Department of Education (Investing in Innovation Fund – i3), the goal of YYY is to improve science teaching and student learning throughout XX especially in high-need (high-poverty, high minority) schools and for limited English proficient students, rural students, and students with disabilities through a validation study of previously targeted efforts as they are being extended across multiple school districts. In conjunction with validating prior program research efforts, the funded project has been designed to build leadership and shape state and local policy and practice through four intensive professional development programs for elementary teachers, secondary teachers, school district science coordinators, and university science education faculty. Four of the five papers each focus on a different component of the professional development and the fifth focuses on the overall preliminary research findings.

Elementary Teacher Professional Development

Anne Mannarino, College of William and Mary, amannarino@wm.edu

Jennifer Mosser, George Mason University

Elizabeth W. Edmondson, Virginia Commonwealth University

Science Methods Courses: Adapting Course One After Year One

Juanita Jo Matkins, College of William & Mary, jjmatk@wm.edu

Jacqueling McDonnough, Virginia Commonwealth University

Mollianne Logerwell, George Mason University

School District Science Coordinator Professional Development

Elizabeth W. Edmondson, Virginia Commonwealth University, ewedmondson@vcu.edu

Victoria Reid, The College of William and Mary

Donna R. Sterling, George Mason University

Anne Mannarino, College of William and Mary

Science Education Faculty Professional Development

Mollianne Logerwell, George Mason University, mlogerwe@gmu.edu

Donna R. Sterling, George Mason University

Juanita Jo Matkins, College of William & Mary

Jacqueline McDonnough, Virginia Commonwealth University

Overall Research Outcomes

Randy L. Bell, Oregon State University, Randy.Bell@oregonstate.edu

Jennifer Maeng, University of Virginia

Strand 8: In-service Science Teacher Education

A Critical Examination of Professional Development Practices

1:00pm-2:30pm, San Cristobal

Presider: Jessica L. Godin

Giving Up Before the Finish Line: Teacher Transformation Resulting in Improved Student Achievement Takes Time

Jeff C. Marshall, Clemson University, marsha9@clemson.edu

ABSTRACT: In our quick-paced, hurry-on-to-the-next-great-thing society, we run a risk of tossing out great initiatives before we even know how well they worked. The work of Supovitz and others have often been cited as the benchmark for what is necessary for successful sustained professional development. However, even though change occurs during the 80+ hours of intervention, teacher transformation that results in increase student achievement may not be reached until after this time. Our professional development goal for this study was to improve the quality of inquiry-based instruction led in the classroom. Research from four years of work shows that even though teachers begin to transform their practice during year one of a sustained intervention (80+ hours) student achievement gains do not consistently follow until the second year. The importance of this study shows how critical it is to follow teachers and their students for a second year to see if transformation takes root and becomes a stable part of the teaching and learning environment thus resulting in increased student achievement.

Building Faculty Capacity to Deliver In-Service PD With Pre & Post Concept Mapping

Chad Huelsman, University of Cincinnati, helen.meyer@uc.edu

Helen M. Meyer, University of Cincinnati

ABSTRACT: In order to improve the impact of professional development programs for pre and in-service teachers, university STEM faculty need to be able to deliver pedagogically sound instruction for teachers. However this is rarely an identified area for research and change. In this presentation we share the results of our mixed-methods study explored how four STEM faculty members reflected on their teaching successes and challenges based on the results of pre and post-concept maps of the 27 pre- and in-service secondary teachers participating in their summer classes. Using the quantitative scoring system detailed by West et al. (2000) and interviews we sought to understand how the faculty understood the learning that took place in their classes represented in the concept maps and the quantitative scores of the maps. The results of the study found the faculty members to be satisfied with the amount of learning of the teachers

in their courses based on the quantitative data from the concept map analysis. The interviews raised questions for the faculty about the challenges of understanding learning gains and knowledge representation

If we Build them... : Can Active Learning Classrooms Promote Changes to Teaching Practice?

Elizabeth S. Charles, Dawson College, echarleswoods@gmail.com

Silvia d'Apollonia, Dawson College

Maria Claudia Orjuela Laverde, McGill University

Chris Whittaker, Dawson College

ABSTRACT: Adoption of educational innovation is not without challenge. Pedagogical approaches grounded in constructivist and social constructivist theories of learning (e.g., active learning) are examples of such. They involve changing age-old practices and developing new ways to promote learning. The last five years has seen a growing interest in expanding the use of such approaches at the post-secondary levels. With this has come a move to include the redesign and construction of new classroom environments that promote social engagement supported by technology (e.g., SCALE-UP, at North Carolina State, and TEAL, at MIT). While such initiatives are grounded in theory there is much to understand about their impact on learning and teaching. In particular, the roles played by pedagogical, content, and technological knowledge, as well as other factors. Using a case study design involving classroom observations, questionnaire data and interviews of teachers and students, this research investigated the impact of an active learning environment on students' efforts in an introductory physics course and on their teachers' practice. Results suggest that students' conceptual gains began to increase even before teachers' explicit practices had changed - (N.B., the project's second year). We propose this is the result of subtle changes to teacher's epistemic beliefs.

Supporting Professional Development that Builds Capacity for Change

Julie C. Brown, University of Florida, brownjc@ufl.edu

Kent J. Crippen, University of Florida

Mary Jo Koroly, University of Florida

Julie R. Bokor, University of Florida

Drew S. Joseph, University of Florida

Houda Darwiche, University of Florida

ABSTRACT: In order to fulfill the vision espoused in the Framework for the Next Generation Science Standards, professional development must be designed to build capacity for sustainable change by empowering teachers to create innovative, inquiry-based instructional materials. However, professional development often focuses on supporting the implementation and adaptation of premade curricula, thus reducing teacher autonomy and ownership. In this paper we present the results of a case study with five science teachers who attended two science-content-focused professional development institutes that provided opportunities for teacher-university scientist collaboration for the purpose of creating innovative, inquiry-based instruction. We focus on the creation of curricula as an outcome because it represents a capacity for change that has the potential to sustain, through the practices of the participating teachers, the positive impact of professional development. Findings from this investigation extends the work in the field of professional development in STEM education regarding curriculum adaptation by redirecting the focus to specific supports aiding teachers in their construction of innovative instructional materials aligned with the Framework for the Next Generation Science Standards. Results shed light on providing appropriate experiences for empowering STEM teachers as curriculum creators, thereby building capacity for sustainable change in science classrooms.

Strand 8: In-service Science Teacher Education***Factors to Consider in the Development of Inservice Education Programs***

1:00pm-2:30pm, Río Mar Salon 4

President: Nasser Mansour, Exeter University, Saudi Arabia*Models of Continuing Professional Development and Practices: Science Teachers' Perspective*

Nasser Mansour, Exeter University, Saudi Arabia, n.mansour@ex.ac.uk

Saeed Alshamrani, King Saud University, Saudi Arabia

Abdulwali Aldahmash, King Saud University, Saudi Arabia

ABSTRACT: The study used a mixed methods approach to study science teachers' experiences of the CPD programmes that they have been offered on the last 5 years. Research methods included closed-ended questionnaire, open-ended questionnaire and in-depth interviews. Sample included science teachers working at primary, intermediate and secondary schools. The findings of the study indicated that teachers have concerns about the CPD offered to them. On one hand, teachers felt that the CPD programmes or activities they participated in did not meet their preferences but also could not meet the challenges and the contexts of the schools that they are working in. On the other hand, teachers reflected on their professional needs, the learning techniques within the training programmes, the contextual factors and the aspects that can lead to effective professional development. Teachers' voices expressed the importance of shifting from a 'top-down' CPD model to one that involves a greater level of participation from the practitioners. This might shed light on why teachers were unable to put some aspects of their CPD training into practice. Using constant comparison data analysis and drawing on all teachers' reflection, this paper offers a conceptual framework for designing effective professional development.

A Comprehensive Professional Development Program for Inservice Middle Science Teachers: Tensions and Early Successes

Rose M. Pringle, University of Florida, rpringle@coe.ufl.edu

Jennifer C. Mesa, University of Florida

Lynda Hayes, University of Florida

ABSTRACT: Our project engages inservice teachers in a comprehensive Science Teacher Leadership Institute (STLI) focusing on improving teachers' science content knowledge, science-specific teaching practices, reform-based science curricula, and leadership skills. To investigate teachers' reactions to the formal courses in the STLI, and the impact of the first two semesters of our STLI graduate program, we used a mixed methodology comprised of analyzing results of an assessment designed to measure pedagogical content knowledge for teaching a force and motion concept and analyzing interviews and course artifacts. Preliminary findings indicate that the job-embedded nature of the STLI, the dual mode of course delivery, and maintaining rigor in university classwork presented unique challenges for our 18 teacher participants. Despite the tension and the anxiety expressed by the teachers, the results of the pre-post-assessment suggests that our participants increased their knowledge for teaching about force and motion from a minimal level to more acceptable level. This study provides insight into inservice teachers' beliefs and reveals how previous educational and other experiences can create tensions between expectations of graduate courses and traditional professional development experiences. This is especially important for alternatively certified teachers lacking rigorous science learning experiences.

Cognitive, Affective and Behavioral Changes in K-8 Science Teaching

Martina Nieswandt, University of Massachusetts, Amherst, mnieswan@educ.umass.edu

Kathryn Race, Race & Associates, Ltd.

ABSTRACT: Cognitive, Affective and Behavioral Changes in K-8 Science Teaching This mixed methods, longitudinal study explored (i) how K-8 teachers' attitudes toward teaching physical science inquiry-based developed over the duration of three years, and (ii) whether changes in attitude were reflected in observable teaching practice. Participants (n=17) were enrolled in a 3-year, cohort masters' program focusing on physical science at an urban, private university. Reflecting a complex theoretical construct, our approach to attitudes combines three different components: cognitive, affective and behavioral. These were measured with self-reports, interviews and classroom observations. Classroom observations

focused on the behavioral component of attitudes and surveys and interviews addressed the cognitive and affective components. All instruments were administered three times: beginning of the program (2008), middle of the program (2010), and end of program (2011). Results demonstrate (i) an increase of participants' confidence in teaching science over time (affective component of attitudes) and beliefs in having appropriate science content knowledge to do so (cognitive component), and (ii) a close relationship between participants' intended behavior to teach inquiry-based physical science and their actual teaching practice (behavioral component). In the presentation we will demonstrate how participants negotiate their attitudes resolving possible discrepancies across all three attitudinal components.

Strand 10: Curriculum, Evaluation, and Assessment

Symposium - Genetics Education and the K-12 Science Framework: A Design Approach for Curriculum Development and Implementation

1:00pm-2:30pm, Río Mar Salon 2

President: Michelle Williams, Michigan State University

Discussant: Angela H. DeBarger, SRI International

Presenters:

Joi Merritt, Michigan State University, jmerritt@msu.edu

Dante Cisterna, Michigan State University

Erika D. Tate, bluknowledge LLC

Liliana Ructtinger, SRI International

Yves Beauvineau, Denver Public Schools

Tamara J. Heck, Michigan State University

Michelle Williams, Michigan State University

Angela H. DeBarger, SRI International

ABSTRACT: This symposium provides an overview of our theoretical approach to developing technology-enhanced heredity materials that integrate principles of best practice for curriculum and assessment design. The purpose of this symposium is to describe our design approach, curriculum development, and assessments for helping students (at upper-elementary and at middle school) as well as the design of the implementation research to capture student understanding of heredity-related concepts in the context of experiencing web-based heredity curricula. In addition, we describe our implementation research plan, which includes the design and development of assessment instruments and classroom observation protocols.

Strand 11: Cultural, Social, and Gender Issues

Symposium - Science Education For/Against 'Gated Communities'

1:00pm-2:30pm, Río Mar Salon 7

Presenters:

John L. Bencze, University Of Toronto, larry.bencze@utoronto.ca

Steve Alsop, York University

Lyn Carter, Australian Catholic University

Matthew Weinstein, UW Tacoma Education Program

ABSTRACT: Apparently coinciding with the advent of neoliberalism as a dominant economic force on a worldwide scale has been an increase in the existence of 'gated communities,' specifically, and 'gatedness,' more generally. Largely because of increases between rich and poor and, concurrently, environmental degradation and general senses of fear and mistrust of state services, many people are increasingly living and/or working in security zones. As a major contributor to capitalism, fields of science and technology appear to be implicated in this isolationism and protectionism. Associated with fields of science and technology is, of course, science education; and, therefore, it follows that it, too, may contribute to social injustices and environmental degradation embodied in gatedness. In this paper set, four authors contribute review essays that discuss, in different ways, roles for fields of science and technology

and science education in problematic gatedness. Under consideration are issues associated with multicultural science education, school-community partnerships, the No Child Left Behind act, and societal consumerism. Alternatives, hopefully contributing to increases in social justice and environmental sustainability are offered.

Strand 11: Cultural, Social, and Gender Issues

Sociocultural Perspectives of Scientific Classroom Communities

1:00pm-2:30pm, Río Mar Salon 8

Presider: Anna Jober, Malmoe University

Some Socio-Cultural Factors Impacting Scientific Explanations by Biology Students: A Nigerian Case Study

Peter A. Okebukola, Lagos State University, pokebukola@yahoo.com

Olatunde L. Owolabi, Lagos State University

Sunday O. Banjoko, Lagos State University

Owolabi F. Marinho, Okebukola Science Foundation

ABSTRACT: Science is hollow if unable to explain natural phenomena (Einstein, 1954). The importance of explanation is underlined in science curricula all over the world. The goal of this study was to examine how socio-cultural factors impact on Nigerian students' explanation of biological phenomena. Additionally, it seeks to find out how such factors can be harnessed for improving performance of students on tasks requiring explanations in science. The design was a case study implemented in two schools over a 9-month period involving qualitative and quantitative data-gathering techniques. The topics covered were diversity of organisms, Mendelian genetics, ecology, plant and animal physiology, and biotechnology. During the course of the study, a total of 3,924 scripts containing answers to questions demanding explanation of biological phenomena were graded. A random sample of students was interviewed every two weeks to seek in-depth information on why they offered the explanation to the biological phenomenon in their answers. The teachers noted the socio-cultural attributes colouring each explanation. Follow-up reviews by the research team aggregated five socio-cultural attributes of the explanations namely language, habitat, religious orientation, socio-economic status and gender. The study suggests that science teachers should look beyond traditional variables in the quest to explain students' performance.

Teachers' Sense-Making about Culture in High Enrollment African American Middle School Science Classes

Eileen C. Parsons, University of North Carolina at Chapel Hill, rparsons@email.unc.edu

ABSTRACT: The one-year case study of five middle school science teachers differs from earlier research on culturally responsive science teaching in that it articulates underlying processes of teachers' understanding of culture. Comprehending processes that underlie phenomena can lead to purposeful efforts with greater possibilities of producing the desired outcomes. The presentation features three middle school science teachers as a response to the following question: How did White middle school science teachers make sense of culture within the context of their high-enrollment African American classes? The interpretive and inductive analyses of observation field notes, transcribed interview data, videotaped teaching sessions, and teachers' responses to a questionnaire produced four findings. First, the teachers reflected upon their personal experiences. Second, they used their personal experiences as the evaluative measure in comparing and contrasting their culture to their African American students' culture as way to further articulate their own culture. Third, they identified and used bridges in the structural environment to accommodate African American culture in their science classrooms. One teacher engaged in extending his conception of culture beyond his personal experiences and used the investigative nature of science to embed African American culture into the fabric of his science classes.

Descriptions and Analyses of the Science Classroom with a Social Class Perspective

Anna Jober, Malmoe University, anna.jober@mah.se

ABSTRACT: Earlier research shows that there is a relationship between low achievements in science education and low socioeconomic background. Despite the aim to give all children an equal education, school science contributes to a

reproduction of social. The overall aim of the research is to contribute to a more complex and multi-faced description and analysis of the relation between inequalities in education, focusing on social inequalities in the science classroom. With a characterizing of the science subject and asocial class perspective as a backdrop, the aims of this research will be elaborated on through the theoretical frameworks from foremost Bourdieu and Bernstein. Inspired by an ethnographic approach the data was produced through observations, field notes, interviews and questionnaire in a Swedish compulsory school and students aged fourteen and fifteen, were followed during a five weeks unit on physics (mechanics). The results revealed for example that room to manoeuvre, possibilities, options and success in this science classroom were a collective process. It was shown that science learning and teaching were deeply complex and that social class clearly gets manifested and sometimes created and established in the science classroom with its activities and practices however in collective social processes where many actors interplay.

Creating School Scientific Communities among Urban Refugee ELL Populations

Joseph A. Johnson, Edinboro University of Pennsylvania, jjohnson@edinboro.edu

Randy Yerrick

ABSTRACT: Studies have been conducted from a range of theoretical and disciplinary perspectives, the findings of which have indicated growth in science achievement among ELLs when exposed to science inquiry. Yet studies are still needed to address the needs of specific groups within this large, and growing population. Children who are underserved in schools offering limited ELL support continue to be marginalized, and the gap for their future professional and higher education opportunities continues to grow when compared to their majority peers. Teachers often lack the experience, knowledge, and the institutional support needed to address the complex educational needs of ELLs. The goal of this study was to examine aspects of multimodal science inquiry teaching strategies using technology with a specific group of students learning English as their second language. This intervention study took place in a science classroom located in a large urban school district in the northeastern United States in a classroom identified as one of the lowest performing schools in the district. Participants include several seventh and eighth grade students who have been in the United States for less than a year, coming from Burma by way of refugee camps in Thailand.

Strand 12: Educational Technology

Related Paper Set - Technology to Support Students in Constructing Scientific Understanding Using Real and Model-derived Data

1:00pm-2:30pm, Río Mar Salon 3

Presider: Steven McGee

ABSTRACT: At the heart of science learning is students' work with collecting and analyzing data and subsequently constructing and communicating scientific knowledge through classroom conversation and scientific debate. Technology opens up new possibilities: Students can collect data via digital sensors, interact with computational models of physical phenomena, share data via wireless networks, and analyze data using computer tools. But how do we—researchers and educators—develop environments and curricula that best use these technologies? How do we know that students are constructing scientific knowledge from their interactions with the sensors, models, and tools? How do we design technology to support classroom patterns of use that promote scientific knowledge construction? The papers in this set address these questions and provide results that can be used by teachers, researchers, and curriculum developers to improve science teaching and learning. Research findings from the studies reinforce the idea that innovative technology tools, especially those that enable students to engage with real and model-derived data, can be effective in developing students' abilities to construct and communicate scientific knowledge. This session will help researchers identify lines of research, establish collaborations, and generate design principles for technology that can be used to improve science education.

Supporting Student Understanding of Submicroscopic Interactions Using Technology Infused Materials: A Curriculum Design Study

Dan Damelin, The Concord Consortium, ddamelin@concord.org

Shawn Y. Stevens, University of Michigan

Sung-Youn Choi, Michigan State University

Richard T. Russell, Michigan State University

Evaluating Where Interactive Heat-Transfer Simulations are Most Effective

Rachel E. Kay, Concord Consortium, rkay@concord.org

Amy Pallant, The Concord Consortium

Edmund Hazzard

Promoting Students' Scientific Argumentation with Computational Model-Based Investigations

Amy Pallant, The Concord Consortium, apallant@concord.org

Hee-Sun Lee, University of California, Santa Cruz

Sarah Pryputniewicz, The Concord Consortium

Evaluating the Benefits of Technology-Enabled, Real-Time Feedback in the Science Classroom

Kimberle Koile, The Concord Consortium, kkoile@concord.org

Nathan Kimball, The Concord Consortium

Sarah Pryputniewicz, The Concord Consortium

Joseph S. Krajcik, Michigan State University

Strand 13: History, Philosophy, and Sociology of Science

Related Paper Set - Explicit-Reflective Nature of Science (NOS) Instruction Across Contexts and Learner Outcomes

1:00pm-2:30pm, Heron Room

ABSTRACT: The development of informed views of nature of science (NOS) is considered to be a pivotal goal of modern science education, and research has highlighted the effectiveness of explicit-reflective NOS instructional approaches in improving learners' views of NOS. This paper-set explores the influence of explicit-reflective NOS instructional approaches in differing learning contexts, and the impact of this instruction on learner outcomes. The paper-set will explore learners' NOS views in a diverse range of contexts from elementary school settings, to preservice university settings, and finally inservice professional development programs. Some significant findings emerging from the four papers presented in this paper-set include: the importance of thematic inclusion of NOS in facilitating learners' abilities to transfer NOS views across contexts; evidence that elementary students of varying ability levels will conceptualize NOS ideas to differing degrees; the importance of well-developed PCK for teaching NOS; and the necessity of explicit-reflective NOS instruction in argumentation-based instructional contexts designed to improve inservice teachers' NOS views. Overall, the findings stemming from a consideration of the four papers presented provide further empirical support for the necessity of explicit-reflective NOS instructional approaches to support the development of learners' NOS views across varying contexts.

Impacts of Explicit/Reflective Nature of Science Instruction in the Context of an Undergraduate Biology Course

Renee S. Schwartz, Western Michigan University, r.schwartz@wmich.edu

Third Grade Students' Conceptions of NOS Following One Year of Explicit Reflective NOS Instruction

Valarie L. Akerson, Indiana University, vakerson@indiana.edu

Ingrid Weiland, University of Louisville

Vanashri Nargund-Joshi, SUNY-Buffalo

Kate Pongsanon, Indiana University

The Effect of an Explicit-Reflective Instructional Approach on Inservice Science Teachers' Understandings and Practices Related to Nature of Science

Nader Wahbeh, Qattan Center for Educational Research and Development, nwahbeh@gmail.com
Fouad Abd-El-Khalick, University of Illinois at Urbana-Champaign

Examining Inservice Science Teachers' Views of Nature of Science in an Argumentation Professional Development Program

Christine V. McDonald, Griffith University, c.mcdonald@griffith.edu.au
Deborah Heck, University of the Sunshine Coast

Concurrent Session #13**2:45pm – 4:15pm****Presidential Sponsored Session*****NARST Leadership Team Task Force Response to the NGSS***

2:45pm-4:15pm, Canary Room

Presiders:

Sharon Lynch, George Washington University

Lynn Bryan, Purdue University

Presenters:

Eric Banilower, Horizon Research, Inc.

Janet Carlson, BSCS

Betsy Davis, University of Michigan

Alejandro Gallard, Georgia Southern University

Julie Gess-Newsome, Willamette University

Felicia Moore Mensah, Teachers College, Columbia University

Tamara Moore, University of Minnesota

Maria Ruiz Primo, University of Colorado Denver

Senay Purzer, Purdue University

Sherry Southerland, Florida State University

Mark Windschitl, University of Washington

John Falk, Oregon State University

ABSTRACT: This presentation will focus on the newly formed NARST Leadership Team Task Force to respond to the Next Generation Science Standards (NGSS). The NGSS are currently under review but will likely be out in the spring of 2013. The NARST Leadership Team Task Force will focus primarily on the implementation of the NGSS as they are rolled out in 26 states. Eight writing teams have been formed to create short, research-based position papers that anticipate the needs for coherent implementation of NGSS within and across the states. The topics include curriculum materials, professional development, preservice teacher education, assessment, evaluation, engineering, informal science education and equity issues. The focus of the discussion will be on how an international professional organization such as NARST might provide a cohesive policy response to a major reform effort in science education. A representative from each writing team will discuss the team's progress, thus far, on this new policy-oriented NARST venture.

Strand 1: Science Learning, Understanding and Conceptual Change***Symposium - Thinking with Evidence: Supporting Students' Use of Evidence in Scientific Modeling***

2:45pm-4:15pm, Río Mar Salon 1

President: Ravit G. Duncan, Rutgers University**Presenters:**

Jessica J. Thompson, University of Washington

Christina V. Schwarz, Michigan State University

Lisa Kenyon, Wright State University

Aubree Webb, Penn State University

Richard A. Duschl, Penn State University

Michael Dianovsky, Rutgers University

Hosun Kang, University of Washington

Cynthia Passmore, University of California, Davis

Julia Svoboda, University of California, Davis

ABSTRACT: The recently released Framework for Science Education and the Next Generation Science Standards

emphasize a view of science as knowledge-building endeavour. This knowledge, in the form of scientific theories and models, is developed in the context of a community of practice with shared norms about what counts as valid and reliable scientific knowledge. 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 students struggle to reason with and about evidence. When students engage in developing models and explanations they commonly do not use evidence to support their arguments, and rarely entertain more than one plausible explanation. In this symposium several research groups will present studies describing their efforts in helping students reason with evidence, as well as helping teachers support student engagement with this core scientific practice. Presentations will address the following framing issues for the symposium, regarding the challenges and successes of: (a) helping students reason about evidence in light of multiple plausible explanations/models, (b) helping students provide sufficient justifications for the links between evidence and models, and (c) helping students reason about the quality of evidence (validity, trustworthiness, etc.)

Strand 2: Science Learning: Contexts, Characteristics and Interactions

Assessment-Related Issues and Science Learning

2:45pm-4:15pm, Río Mar Salon 10

Presider: Elaine Klein, University of Washington

AP Science Students Memorize to Study for Tests More than their Peers

Michelle Reicher, University of Michigan, Ann Arbor, reicher@umich.edu

Nancy B. Songer, The University of Michigan

ABSTRACT: This study examined survey data relative to science class enrollment in order to observe similarities and differences in how individuals perceive their own science learning and studying for exams. The participants included 57 high school students in AP Chemistry and Environmental Science, 9th Grade Honors Biology, and an upper level Environmental Science elective from three different schools. Regression models were used to examine predictors of science achievement and studying approaches. Results indicate that AP and Honors students primarily memorize information when studying for science exams. Furthermore, AP and Honors students who prefer to learn through scientific practices have lower grades as compared to students in the science elective. The results indicate that students learning and studying approaches need to be altered to go beyond memorization as addressed by the Next Generation Science Standards (Achieve, May 2012 draft) and the new AP Biology program (The College Board, 2012). Curricular and assessment items need to focus on science knowledge that fuses science content with practices to develop higher order thinking skills and deeper understandings of science topics. One proven learning approach to achieve these goals is learning progression-created resources that purposefully fuse science content and practices (Authors, 2009).

Creative Little Scientists: First Research Results about Enabling Creativity through Science in Early Years Education

Esme B. Glauert, University of London, e.glauert@ioe.ac.uk

Fani Stylianidou, Ellinogermaniki Agogi

Sari Havu-Nuutinen, University of Eastern Finland

ABSTRACT: This paper discusses results from research conducted within the 30 month EU project 'Creative Little Scientists' exploring the common ground that science and mathematics education can share with the development of creativity in early years education (up to the age of 8). This phase of research was designed to map and compare existing approaches to science and mathematics education in nine sample countries, highlighting instances and absences of, practices marrying science and mathematics learning, teaching and assessment with creativity. Our analysis draws on questionnaires designed to interrogate key policy documents in each partner country and to map teachers' conceptualisations in relation to classroom practices in early years science education. Findings from the policy survey reveal a common emphasis on the development of science ideas and process skills associated with inquiry. More varied attention is afforded to affective and social aspects of learning and to the development of procedural understanding. Explicit references to creativity were limited but implicit links were evident in the attention given to creative learning dispositions and teaching approaches. Policy in relation to assessment showed the widest variation with very limited indications of a role for creativity either in the priorities or methods advocated. 0 0 1 197 1154 ioe 17 1 1350 14.0

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Improving Physics Learning by Using Multiple-Choice Tasks for Feedback Purposes

Henning Rode, Institute for Mathematics and Physics Education, rode@idmp.uni-hannover.de

Gunnar Friege, Institute for Mathematics and Physics Education

ABSTRACT: The benefit of tasks - containing different types of exercises and assignments, used for training and learning purposes - in school physics education is often discussed (e.g. BLK 1998; Leisen 2006). Their enrichment to science classes cannot be denied. Nevertheless the use of tasks at least in German physics classes is often marginal: Tasks are located at the end of a lesson or moved to homework, their content is often limited in complexity. Improvement could be achieved by developing another attitude towards tasks in physics classes and their associated scripts (e.g. BLK 1998). Mie (2002) sketches different situations in which multiple-choice tasks could be beneficial for learning physics but empirical research is outstanding. In this empirical study (n>200) multiple-choice tasks are used for formative assessment, focusing on feedback purposes. Identical teaching units for 8th grade varying only in the use of multiple-choice tasks were developed. Applying a parallel-crossover design every teacher taught two classes on identical content, documenting contents shortly. The pupils' perspective is measured using questionnaires concerning attitudes and pre-post-tests for the gain of content knowledge. Interviews and questionnaires are used to get insight in the teacher's perspective on the unusual use of tasks for feedback purposes.

The Influence of Student Positioning on Formative Assessment Interactions in a Middle School Classroom

Amy Trauth-Nare, Towson University, atrauthnare@towson.edu

Gayle A. Buck, Indiana University

ABSTRACT: Formative assessment is the process of eliciting students' understanding during instruction in order to make sensitive instructional decisions and provide feedback to enhance students' learning. Research indicates that when used properly, formative assessment can lead to significant learning gains and enhance students' self-efficacy. Using discourse analysis, we examined the positions claimed, assigned and negotiated by middle school science students during formative assessment interactions. Findings indicate that students had the capacity to influence the direction and focus of formative assessment interactions by positioning themselves in ways that not only allowed them to assert their understanding of content, but also to re-direct topical focus of interactions in order to gain additional cognitive support. This study illustrates that formative assessment is not simply an instrumental act carried out by teachers, but rather is a relational process that necessarily involves students. As a result, formative assessment should balance authoritative and dialogic discourse as a means for supporting and engaging students as they develop rich conceptions of science while connecting those conceptions to their own experiences.

Strand 2: Science Learning: Contexts, Characteristics and Interactions

Computer and Gaming-Related Projects and Science Learning

2:45pm-4:15pm, Caribbean Salon 2

Presider: Rowhea M. Elmesky

Earthquake: An Educational Innovation Engaging Students in the STEM Domains of Earthquake Engineering

Abigail C. Perkins, Texas A&M University, acperkins@neo.tamu.edu

Carol L. Stuessy, Texas A&M University

ABSTRACT: This study chronicles the research and development (R&D) of a cooperative educational board game about earthquake engineering, Earthquake, in which players build an inhabitable and earthquake-resilient city. Learning objectives are to provide opportunities for metacognitive development and collaboration while addressing the

interconnectivity of main urban infrastructure components: water, transportation, communication, and power. Situated within a socio-cognitive framework, Earthquake is designed to foster social learning. Few games have undergone an R&D process based on constructivist learning theory. With the objective to create such a game for middle and high school STEM classrooms, this study focuses on four of five phases of an R&D process: analysis, development, design, and implementation. The evaluative fifth phase will ensue after this study. Focus groups guided game development, aiming to draft an educational and engaging product that would hook students, allow them to become immersed in the game, and to learn by doing. This study reports results of beta-testing the game with STEM teachers. Groups participated in open-ended interviews relating to logistics and educational value. Analyzed by constant comparison methods, transcribed interviews were organized into categories most appropriately serving game modification. Study results include a revised game which will be demonstrated during this presentation.

Beyond Computational Thinking: Resources for Development of Collaborative Perspectival Computer Programming and Modeling

Pratim Sengupta, Vanderbilt University, pratim.sengupta@vanderbilt.edu

Amy V. Farris, Vanderbilt University

Amanda C. Dickes, Vanderbilt University

Gokul Krishnan, Vanderbilt University

Kara Krinks, Vanderbilt University

ABSTRACT: This paper investigates the process of co-development of computational thinking and physics understanding through the collaborative agent-based programming and modeling activity of a dyad of two elementary students. We present an interaction analysis (Jordan & Henderson, 1995) of the students' discourse and computational modeling, and identify three key mechanisms through which their conceptual understandings emerged: (1) the interconnected nature of their talk, the programming language, and the scientific domain, (2) gestural and computational enactments of embodied knowledge as productive modes of communicating with each other about the goals of their models, and (3) the establishment of perspectival understanding through a process of "constructive listening" (Greeno and van de Sande, 2007).

Are Teachers able to Foster Experimental Skills with Hands-on and Computer-based Learning Environments?

Silke Schiffhauer, Ruhr University Bochum, silke.schiffhauer@uni-due.de

Joachim Wirth, Ruhr University Bochum

Detlev Leutner, University of Duisburg-Essen

ABSTRACT: The importance of experimentation in science teaching and learning is stated by the National Research Council (2000). Recent studies focused on methods to increase experimental skills of students. Most studies are designed to support only specific rather than all relevant experimental skills (Chen & Klahr, 1999). The overall aim of our study was to investigate whether learners achieve higher learning outcomes while learning with a combination of computer-based and hands-on learning environments (combined program) because the advantages of the one learning environment offset the disadvantages of the other so it is possible to foster all relevant experimental skills. The second aim was to validate, if results which were gathered under laboratory conditions are suitable to inform the design of 'real' science lessons. We conducted an in-service-teacher-training where the combined program and scientific methods (like experimental skills, science education standards, modes of scientific inquiry and scientific modi operandi) were taught. Participants were 24 physics teachers with two parallel (control- and treatment-group) classes (in total: 1.249 eighth graders). Our results, gathered in a pre-post-design and analyzed with multilevel models, revealed that the treatment-group-students from teachers who really implemented the combined program significantly outperformed the other students-groups on all used tests.

Strand 4: Science Teaching--Middle and High School (Grades 5-12): Characteristics and Strategies
Symposium - Energy as a Crosscutting Concept: Research and Impact on Teaching and Learning of Science

2:45pm-4:15pm, Pelican Room

Presenters:

Arthur Eisenkraft, University of Massachusetts Boston, arthur.eisenkraft@umb.edu

David L. Fortus, Weizmann Institute of Science

Joseph S. Krajcik, Michigan State University

Knut Neumann, Leibniz Institute (IPN) Kiel

Jeffrey Nordine, Trinity University

Robert F. Chen, University of Massachusetts Boston

ABSTRACT: Energy is perhaps the single most important concept in all of science, and it plays a central role in our everyday lives as well. Its significance is underscored by its inclusion as both a core disciplinary idea and a crosscutting concept in the Frameworks for K-12 Science Education. Yet, the energy concept has proven difficult to understand and there is by no means consensus on what students should know about energy, when they should know it, or how to promote student understanding over time. Thus, it is critical to initiate conversations about how energy is applied across scientific disciplines and how the existing literature base can be leveraged to generate recommendations and strategies for use in real classrooms. In this symposium, we share outcomes from recent summit convened between scientists, science education researchers, and teachers to discuss what is known about energy as a scientific concept, what is known about how students understand energy, and implications for instruction and future research. We will welcome feedback from session participants regarding the reported outcomes and the implications for a second teacher-focused summit that will occur in late spring of 2013.

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

2:45pm-4:15pm, Parrot Room

Presiders:

Emily M. Walter, University of Missouri

Stephen B. Witzig, University of Massachusetts

Influence of PCK for Teaching Evolution on Student Outcomes in a Non-Majors' College Course

Emily M. Walter, University of Missouri, emw2n4@mail.missouri.edu

Patricia J. Friedrichsen, University of Missouri-Columbia

ABSTRACT: This study investigates the influence of pedagogical content knowledge (PCK) for teaching evolution on knowledge of macroevolution and evolution acceptance in undergraduate non-science majors. This research answers the call of Abell (2008) to investigate the influence of PCK on student learning, addresses a gap in the literature on college instructor PCK, and describes the unknown relationship between knowledge of macroevolution and evolution acceptance for non-science majors. PCK of the instructor was examined by pre-instruction and stimulated recall interviews, a reflective lesson planning document (CoRe; Loughran, Berry, & Mulhall, 2006), and by classroom observation. Data were then coded using the Magnusson et al. (1999) PCK model. Student learning was examined through the lens of how people learn (Bransford, Brown, & Cocking, 2000), considering the preconceptions, development of a conceptual framework, and the personal reflections of students to understand their perspectives. Three data sources describe student learning: (1) the Measure of Understanding of Macroevolution (MuM, Nadelson & Southerland, 2010a) (2) the Measure of Acceptance of the Theory of Evolution (MATE, Rutledge & Warden, 1999) and (3) semi-structured interviews. Using student outcome data, the relationship between knowledge of macroevolution and acceptance of evolution for non-science majors are also explored.

Investigating Experiences that Inform University Instructors' Specialized Knowledge for Teaching Protein Synthesis

Stephen B. Witzig, University of Massachusetts, sbwitzig@umassd.edu

Mark J. Volkmann, University of Missouri

ABSTRACT: The purpose of this study was to investigate the experiences that informed three university instructors' specialized knowledge for teaching protein synthesis. We investigated the differences in the experiences and developed in-depth case profiles for each instructor. The primary sources of data for the study were stimulated recall interviews following observations of an entire unit on protein synthesis. These data sources were supported by background interviews to determine their academic and PD history as well as interviews focused on their lesson plans and orientations towards teaching. The results of the analysis revealed three assertions that emerged from all three case profiles. The assertions are: (1) University science faculty change their instruction in their classes based on the specificity of their view of student difficulty, (2) University science faculty members learn science content through coursework and learn how to teach the science content through interactions with other teachers, and (3) How university science faculty members learn through their experience influences the integration of specialized teacher knowledge. The findings of this study led to the development of a model to explain how learning through experience transforms specialized teacher knowledge. These findings have implications for graduate student training and faculty PD.

Use of a Concept Inventory to Probe Student Learning and to Inform Faculty Development

Ann C. Smith, University of Maryland, asmith@umd.edu

Gili Marbach-Ad, University Of Maryland

Katerina Thompson, University of Maryland

Kenneth Frauwirth, University of Maryland

Daniel C. Stein, University of Maryland

ABSTRACT: As research faculty with expertise in host–pathogen interactions (HPI), we have worked collaboratively since 2004 to engage students in meaningful learning of HPI concepts. To this end, we developed a concept inventory assessment tool, which is used to probe the learning progression of undergraduate microbiology students. The CI was administered prior to and following each course in the undergraduate microbiology curriculum. It is comprised of 18 multiple choice questions, with a request for students to provide an explanation for the option they chose. Here we present our model for deep qualitative analysis of the open-ended explanations to identify misconception themes beyond those on which the CI was built. We also show how we code the misconception themes according to origin. We reviewed 694 open-ended responses generated from the HPI-CI pretest for students enrolled in a general microbiology course over three semesters at two large research universities. Through the analysis of student explanations, we found that many undergraduates in microbiology courses hold misconceptions that are consistent with those identified previously in middle school and high school students. This project will contribute to scientific teaching by providing insight into student learning and providing a model for enhancing faculty development in teaching.

Strand 7: Pre-service Science Teacher Education

Methods for Improving Preservice Teacher Education

2:45pm-4:15pm, Río Mar Salon 9

Presider: Jacqueline T. McDonnough, Virginia Commonwealth University

Hands-On Science: Hands-On, Integrated Natural Science For Pre-Service Elementary School Teachers

Antonia Chimonidou, University of Texas at Austin, antonia@physics.utexas.edu

Randi Ludwig, University of Texas at Austin

ABSTRACT: The process of scientific discovery is an exciting and engaging one. How do we teach science to future elementary teachers, while simultaneously giving them the tools they need to engage their own students? The Hands-on Science (HoS) program at UT Austin was designed to train future elementary teachers through the process of guided inquiry, while emphasizing evidence-based reasoning. Students experience phenomena through observation and experiment, and learn to explain or articulate their ideas based on the collected experimental data. The program is a four-semester integrated course that develops core concept knowledge across the Natural Sciences: physics, chemistry, geology, biology, astronomy, and Earth climate. Our courses are modeled after the groundbreaking work by Fred

Goldberg et al. (PET), who were the first to apply it to other disciplines. We extend this model further, adding geology, astronomy, and Earth science to the subjects addressed. Additionally, Hands-on Science has been built on the experience gained in UT Austin's UTeach program for secondary teacher preparation in the sciences. In this talk, we will present the framework on which a typical lesson is based and present assessment results on both content and attitudes of students registered in the HoS program and appropriate comparison groups .

Teacher Learning Supports in Japanese Elementary Science Curriculum Materials: Are they Educative Curriculum Materials?

Etsuji Yamaguchi, Kobe University, etuji@opal.kobe-u.ac.jp

Shota Komeda, Kobe University

ABSTRACT: Educative curriculum materials include supports that are intended to promote both student and teacher learning. However, almost no examination has been conducted on whether existing curriculum materials can support teacher learning. Beyer et al. (2009) analyzed curriculum materials of high school biology in U.S.A.. If Beyer et al.'s work is followed by analysing curriculum materials of other countries and grades, then educative curriculum materials can be discovered among those materials already in existence throughout the world. The purpose of study is to clarify some of the features of the Japanese standardized national curriculum materials for elementary science. The curriculum materials for teachers evaluated were from six companies that used in almost all Japanese elementary schools. The science topic is the "moon and sun" for 11-12 year olds. The evaluation criteria used in this study are those developed by Beyer et al. It is clarified that Japanese materials supports relatively frequently PCK for scientific inquiry and Implementation guidance. Finally, we discuss strength of the Japanese curriculum materials and suggestions for the Curriculum Materials of U.S.A. and Japan.

Simulated Interactions as a Pedagogy for Preservice Science Teachers

Jeffrey J. Rozelle, Syracuse University, jrozelle@syr.edu

Sharon Dotger, Syracuse University

Bejamin Dotger, Syracuse University

Joanna Masingila, Syracuse University

Mary Bearkland, Syracuse University

ABSTRACT: Utilizing a pedagogy common to medical education contexts, we have designed a series of simulated interactions, where preservice science teachers engage in live, one-to-one simulations with standardized individuals to address content-specific problems of practice. This research paper reports findings from the first year of the Science and Mathematics Simulated Interaction Model (SIM), describing the concept of content-specific teacher education simulations, their developmental and iterative design constructs, the data in support of four science simulations, and the resulting products (i.e., the simulations themselves). We conducted 25 semi-structured interviews with experienced teachers in which they reflected upon challenging components of the curriculum, common content challenges for their students, and examples of challenging situations for novice teachers. While we were conducting and reading these interviews, we were also reviewing literature that allowed us to identify particular learning difficulties that students might have as potential sources for simulations. Our selection and design of simulations is informed by design tenets used to design similar medical education simulations –prevalence, clinical/ social impact, and instructional importance (Barrows, 1987, 2000). We report here on four designed simulations related to iconic misinterpretation, density and buoyancy, plant growth and graph interpretation, and natural selection

Strand 8: In-service Science Teacher Education

Related Paper Set - Scale-up Study of a Videocase-based Science Professional Development Program: Teacher and Student Learning

2:45pm-4:15pm, Sea Gull Room

Presider: Sarah Michaels, Clark University, smichaels.iclub@gmail.com

ABSTRACT: This paper set reports on four dimensions of an ongoing study of STeLLA – an analysis-of-practice based

professional development program. By engaging elementary teachers in analyses of videocases through the application of Student Thinking and Science Content Storyline Lenses, STeLLA is designed to deepen teachers' science content and pedagogical content knowledge, improve their teaching practice, and increase student achievement in science. In this paper set we explore four facets of this program, applying both quantitative and qualitative methodologies. In the first paper, we present promising findings about teacher and student science content learning from the first cohort of a cluster randomized trial. The second paper examines STeLLA assessment data to reveal important methodological insights about instructionally sensitive instruments and discusses the implications of these findings for the field. Paper 3 presents rich data about young students' thinking and learning about earth science that will provide an important anchor point for learning progressions research in this content area. The final paper reports on our study of the STeLLA PD leaders, presenting an analysis of the kinds of knowledge and abilities needed to effectively lead this kind of PD and introducing a new construct to the field – PCK for PD leaders.

Scale-Up Study of a Videocase-Based Lesson Analysis PD Program: Teacher and Student Science Content Learning

Kathleen J. Roth, BSCS, kroth@bscs.org

Christopher Wilson, BSCS

Joseph A. Taylor, BSCS

Demonstrating the Impacts of Lesson Analysis PD: Meeting the Challenge of Developing Instructionally Sensitive Instruments

Christopher Wilson, BSCS, cwilson@bscs.org

Joseph A. Taylor, BSCS

Kathleen J. Roth, BSCS

Stella Focus on Student Learning: Elementary Students' Ideas about Earth's Changing Surface

Connie Hvidsten, BSCS, chvidsten@bscs.org

Elaine V. Howes, BSCS

Pedagogical Content Knowledge for Science Professional Development Leaders

Nancy Landes, Senior Science Educator, nlandes@bscs.org

Kathleen J. Roth, BSCS

Strand 8: In-service Science Teacher Education

Impact of Authentic Research Experiences on Professional Development

2:45pm-4:15pm, San Cristobal

At the Elbows of Scientists: Shaping Science Teachers' Thinking about Inquiry Teaching

Cheryl A. McLaughlin, University of Florida, chermac72@ufl.edu

Rose M. Pringle, University of Florida

Bruce J. MacFadden, University of Florida

ABSTRACT: The New Framework for K-12 Science Education alludes to the importance of professional development support for science teachers to ensure successful implementation of new standards and curricula. In order to teach science as inquiry, teachers should be provided with opportunities to develop a deeper understanding and appreciation for the way scientists collaborate to construct new theories. One promising opportunity for professional development lies in the formation of partnerships between classroom teachers and practicing scientists. Experiences involving scientists and science teachers have the potential of promoting an instructional model that parallels the way scientists solve problems in the real world. Additionally, collaborative partnerships with practicing scientists provide science teachers with the opportunity to integrate their research experiences into classroom activities. Our study focuses on the use of this research experience as part of a professional development activity for high school science teachers and

examines the ways in which the research experience with scientists shaped science teachers' thinking about inquiry teaching. Our findings support calls within the science teacher education community to expose science teachers to authentic research experiences that will allow them to see science as a process rather than merely a body of knowledge.

Examining the Influence of RET's: Tracing Changes in Science Teachers' Beliefs and Affect

Michael Dentzau, Florida State University, mwd09c@my.fsu.edu

Patrick J. Enderle, Florida State University

Katrina Roseler, Florida State University

Sherry A. Southerland, Florida State University

ABSTRACT: Student participation in classroom inquiry is considered one of the most direct ways to foster proficiency in science. To replace teacher-centered direct instruction in science classrooms with learner-centered, inquiry-based science experiences, teachers need to actively engage in scientific inquiry themselves. This research examines the impact of two distinct RET experiences on teachers – the SciRes program connects teachers with authentic ongoing laboratory research, while the SciPed involves teachers in inquiry from the “ground up” to answer a question they initiate. This research looks at the characteristics of self-efficacy, pedagogical discontentment, and beliefs about science teaching to understand how practicing teachers’ engage with messages of reform. Data were collected from 5 cohorts of teachers - 54 from the SciRes and 52 from the SciPed programs. Instrument “X” (discontentment) and the Beliefs about Reformed Science Teaching and Learning instruments demonstrated significant pre-post change in mean scores in both RET programs. The Science Teaching Efficacy Belief Instrument demonstrated significant change in the SciRes program, while the Teacher Belief Inventory and Teaching Science as Inquiry instruments showed significant change only in the SciPed Program. Explanations for the differences and the implications of these results for professional development on inquiry are discussed.

Changes in Teachers' Beliefs and Classroom Practices Concerning Inquiry-Based Instruction Following a Year-Long Ret Program

Rommel J. Miranda, Towson University, Rmiranda@towson.edu

Julie B. Damico, Towson University

ABSTRACT: This study investigates the extent to which teachers’ beliefs and classroom practices concerning inquiry-based instruction change following participation in a year-long RET professional development program. It specifically examines how having science teachers experience an authentic research learning environment and participate in professional learning community meetings might facilitate changes in their beliefs. Mixed-methods were used to explore this study’s research questions. Supported with NASA funding, twenty high school teachers participated in a large mid-Atlantic university’s RET professional development program and in this study. Findings suggest that RET programs that incorporate a professional learning community component can help to transform teachers’ initial beliefs and classroom practices regarding inquiry-based instruction and help to increase the level of inquiry in their science lessons. However, professional development models need to be developed to help teachers effectively plan more time for students to conduct inquiry-based activities, to communicate findings based on evidence, and to develop questions to investigate themselves. Additionally, professional development models need to be developed to help teachers of math-laden, higher-level, or physical science type courses to incorporate more student-centered leaning experiences that can promote student engagement with science. Moreover, RET professional development models which focus on increasing teachers’ propositional knowledge warrants further investigation.

Mapping the Influence of Research Experiences for Teachers: Essential Features for Shaping Classroom Inquiry

Sherry A. Southerland, Florida State University, ssoutherland@fsu.edu

Ellen M. Granger, Florida State University

Pat J. Dixon, Florida State University

Patrick J. Enderle, Florida State University

Barry Golden, University of Tennessee, Knoxville

Katrina Roseler, Florida State University

Roxanne M. Hughes, Florida State University
Yavuz Saka, Florida State University

ABSTRACT: Reform in science education calls for a very different portrait of science teaching than many teachers experienced as learners, thus professional development becomes essential to change science instruction. The National Science Foundation has funded many projects that focus on providing teachers with scientific experiences in the form of Research Experiences for Teachers (RET's). The proximal goal of this research was to map the influence two different types of RET experiences have on teachers' thinking and practice. Data about teacher beliefs and classroom practices were collected from 104 teachers before and after their participation two different RET programs: scientific research (SciRes) and scientific research and pedagogy (SciPed). Data collection instruments include Teacher Belief Inventory (TBI), Context Beliefs about Teaching Science (CBATS), and Reform Teaching Observation Protocol (RTOP). Multiple linear regressions were conducted with different predictors as constants and using post RTOP scores as the dependent variable. The program selected influences teachers' use of reform based teaching practices, with teachers from the SciPed program showing higher RTOP scores. Teachers' beliefs about their teaching (TBI) and teaching contexts (CBATS) were highly predictive of their use of reform-based teaching practices, and the SciPed program was more successful in shaping these beliefs.

Strand 10: Curriculum, Evaluation, and Assessment

Symposium - Impact of an Embedded Assessment System on Elementary Science Teaching and Learning: Power and Promise

2:45pm-4:15pm, Río Mar Salon 2

Presider: Steve Schneider, WestEd

Presenters:

Kathy Long, University of California, Berkeley, klong@berkeley.edu

Yunyun Dai, University of California, Los Angeles

Ellen Osmundson, University of California, Los Angeles

Joan L. Herman, University of California, Los Angeles

Cathy Ringstaff, WestEd

Yourim Chai, University of California, Los Angeles

Michelle Tiu, WestEd

Mike Timms, Australian Council for Educational Research

Steve Schneider, WestEd

Jim Pellegrino, University of Illinois at Chicago

ABSTRACT: Formative assessment is a powerful classroom process that can significantly increase learning, particularly for low achieving students. The objective of the symposium to provide results from a large-scale, randomized, controlled study of an embedded assessment system in a hands-on, investigative elementary science curriculum. Researchers from the Lawrence Hall of Science, CRESST/UCLA and WestEd will present this work. The conceptual framework that informed design of the embedded assessment system, methodological considerations, and project impact on science teaching and learning will be discussed. Study findings and conclusions contribute to our knowledge and understanding of how formative assessment use can enhance science teaching and learning.

Strand 11: Cultural, Social, and Gender Issues

Related Paper Set - Culturally-congruent Approaches to Science Education in Native Communities

2:45pm-4:15pm, Río Mar Salon 7

ABSTRACT: In spite of the prominent role of STEM in K-12 education and the investment of millions of dollars in various STEM initiatives, there remain sizable inequities in science and mathematics achievement of K-12 students that disadvantage students' career choices and economic futures. Students in Native communities are among those who are most underserved and underrepresented by traditional curriculum materials and instructional approaches. American

Indian students experience higher percentages of high school dropout and special education placements than any other minority group and are the most underrepresented group in higher education. As educators, we need to do more to address the education of American Indian students through promoting respect for Native ways of knowing and exploring educational models that better align with Native culture. In this paper set, we share approaches to culturally-congruent science education and research from five unique projects in three states that have worked collaboratively with Native communities for many years.

A Culturally Congruent Participatory Process for Developing a Research Instrument in a Tribal Context

Regina Sievert, Salish Kootenai College, regina_sievert@skc.edu

Teacher and Community Collaboration: A Need for a Culturally Congruent STEM Curriculum

Melinda A. Howard, University of Idaho-Coeur d'Alene, howa4758@vandals.uidaho.edu

Marcie Galbreath, University of Idaho, Coeur d'Alene

Aimee S. Navickis-Brasch, University of Idaho-Coeur d'Alene

Anne Kern, University of Idaho, Coeur d'Alene

Identification of Points of Intersection for Cultural Relevant STEM Instruction

Irene Grimberg, Montana State University, grimberg@montana.edu

Gail Whiteman Runs Him, Little Big Horn College, Crow Agency, MT

Reach for the Sky: Improving Science Agency for American Indian Students

Gillian Roehrig, University of Minnesota

Stephen Carlson, University of Minnesota

Brant Miller, University of Idaho

Native Teachers' Ideas for Restructuring Online Learning about Science Education

Elisabeth Swanson, Montana State University, Bozeman, elsswa@gmail.com

Lee Cook, Montana State University, Bozeman

Dora Hugs, St. Charles School, Pryor, MT

Lisa Stevens, Crow Agency School, Crow Agency, MT

Gail Whiteman Runs Him, Little Big Horn College, Crow Agency, MT

Strand 11: Cultural, Social, and Gender Issues

Classroom Climate and Student Relationships Impact Discourse in STEM Classrooms

2:45pm-4:15pm, Río Mar Salon 8

Presider: Regina Surriel

Examining Relationships among Lebanese Students' Conceptions of and Attitudes toward Science, Career Choices, Religious Affiliations and Gender

Rola Khishfe, American University of Beirut, rk19@aub.edu.lb

Saouma B. Boujaoude, American University of Beirut

Sahar K. Alameh, American University of Beirut

ABSTRACT: Students' attitudes and conceptions seem to be influenced by social/cultural contexts and interactions with other students from diverse backgrounds. Therefore, educators need to study attitudes, conceptions, and career choices in relation to diversity indicators. Such is one focus of Science Education for Diversity project, which involves collaboration among UK, Netherlands, Turkey, Lebanon, India and Malaysia. The purpose of this component of the project was to investigate Lebanese students' attitudes, conceptions, and career choices in relation to gender and religion. The 1260 Grade 4 to 8 participants, who came from private and public schools that were purposefully selected

to include different religions, filled out a questionnaire designed specifically for the Project. Results showed that students generally had positive attitudes towards science. They seemed to identify only things they study about in school as “science” with some gender differences. Students seemed to be worried about environmental socioscientific issues. About 40% of students believe that God created all life and that their families believe that too, with significant differences by gender and religion. Finally, the greater majority stated that they would like a job that ensures recognition and respect. Implications related to maintaining students’ interest in science and science-related careers were discussed.

Cultural Practices' Impact on Muslim Elementary School Pupils' Conceptions of Nationally-Set Astronomy Concepts

Walid M. Shihabi, University of Oklahoma and Tulsa community college, shihabi@ou.edu

Edmund A. Marek, University of Oklahoma

ABSTRACT: Science education standards mandate that children in early elementary school learn about the observable phases of the moon and the apparent celestial motion of the sun. This study explored the cultural congruence of American Muslim students’ antecedent knowledge constructed from their religious practices and their ability to learn these concepts. Understanding any congruence between national education standards and Muslim cultural knowledge could aid in designing culturally responsive and contextually relevant instruction related to science. The study included interviews with 16 children as they exited fourth grade. It was apparent that observing daily prayers and celebrating holy months had impacted their conceptions of the apparent patterns of the sun’s motion and moon’s phases prescribed by the science education standards. The results of the study revealed that cultural practices created pre-conceptions that the students bring to the school and thus have a direct effect on their understanding related to the pertinent standards. In this paper, we discuss these pre-conceptions within the context of cultural influences on antecedent knowledge in the science classroom.

Promises and Challenges of Using Hybrid Discourses in Science Classrooms with Diverse Students

Minjung Ryu, University of Maryland, mryu@umd.edu

ABSTRACT: Hybridity and hybrid practices have been highlighted as ways to help students engage in science learning activities and learn science. In this framework, teachers identify students’ cultural practices (e.g., language use, knowledge, and ways of reasoning), bridge those practices and the practices of science, and engage in hybrid practices in their instruction through which students’ practices are valued as resources to learn science. In the present study, I examine how this hybridity unfolds in a science classroom of students of multiple racial, ethnic, and linguistic backgrounds and in which students from those diverse students possess radically different knowledge. An analysis of ethnographic data from two high school biology classes that contain a significant number of immigrant students shows how the hybrid practices, which engage some students’ resources (e.g., knowledge, language use, sense of humor), fail to acknowledge other students’ resources. Implications of the findings are discussed in terms of science education in classrooms with diverse students, especially in the national and international contexts in which international migration is common.

Strand 12: Educational Technology

Motivation, Attention and Metacognition

2:45pm-4:15pm, Río Mar Salon 3

Presider: Steven McGee

Identifying a Gap Between Attitudes and Perceptions about ICT among Pre-Service STEM Teachers

Miri Barak, Technion, Israel Institute of Technology, bmiriam@technion.ac.il

ABSTRACT: Despite the fact that educational technology and web-based systems have become a common component of K-12 STEM education, there is still a concern regarding pre-service teachers' readiness for embracing new learning environments and methods. Our study examined pre-service teachers (N=126) views and perceptions about the 'ideal' learning environment and the use of advanced technologies for STEM education. The study was conducted in two

iterations, during the years 2008 (N=71) and 2012 (N=55). The mixed method model was used in the interpretation of data, collected by three tools: reflective drawings, questionnaires, and think-aloud interviews. In the first iteration, findings indicated that most pre-service teachers were in conflict between their declared attitudes and their actual perceptions. On one hand, they depicted educational gains, such as: the ability to simulate **ABSTRACT** concepts and apply web-based inquiry; on the other hand, they presented situations in which the use of technology can cause the 'robotization' of education and disrupt the learning process. In the second iteration, findings indicated less conflict in attitudes and perceptions, suggesting that nowadays pre-service teachers are more open to changes and to the adoption of innovative learning environments.

Shifts in Student Motivation during Usage of a Multi-User Virtual Environment for Ecosystem Science

Shari J. Metcalf, Harvard University, shari_metcalf@harvard.edu

Jason A. Chen, The College of William and Mary

Amy M. Kamarainen, New York Hall of Science

Tina Grotzer, Harvard University

Chris Dede, Harvard University

ABSTRACT: In incorporating technology in science education, some have expressed concern that the value added by technology is primarily due to the novelty or excitement about using the devices, resulting in no lasting effect on student motivation or learning in science. This research evaluates student motivation during a two-week, multi-user virtual environment (MUVE)-based curriculum for middle school ecosystems science. Analysis of multiple surveys at the beginning, middle, and end of the curriculum found that students continued to find the activity engaging from beginning to end, while student value of its utility in helping them learn science increased significantly. Furthermore, while initial student engagement resided primarily at the technology interface level, with time and experience students became increasingly engaged in the student-led, collaborative inquiry experiences afforded by the embedded scientific investigation.

Students' Visual Attention while Using an Online Physics Tutoring System

Amy S. Rouinfar, Kansas State University, rouinfar@phys.ksu.edu

Christopher Nakamura, Saginaw Valley State University

Dean A. Zollman, Kansas State University

N. Sanjay Rebello, Kansas State University

ABSTRACT: Extracting meaningful learning from a multimedia environment is a key goal in science education. In this study we investigate student usage a synthetic online tutoring system which uses interactive and multimedia technologies to help students learn physics. The system includes several visual elements which could cause students to split their attention between videos and increase cognitive load. To investigate this, students' eye movements were recorded as they complete a set of activities focusing on Newton's 3rd Law. We report where students visually attend to while they use the system as well as where they look while the tutor and supporting videos are playing. We find evidence of the split attention effect while students use the system, however we find that this does not influence their ability to recall and explain the physics in the supporting media.

Contribution of Metacognitive Instruction Embedded within an Open Inquiry-Based Learning to Metacognitive Online Discourse

Idit Adler, Bar-Ilan University, Israel, dan-idit@bezeqint.net

Michal Zion, Bar - Ilan University

Zemira Mevarech, Bar - Ilan University

ABSTRACT: The present study investigates the contribution of overt and explicit metacognitive instruction embedded within an open, hands on, long term inquiry-based learning, to the development of a metacognitive discourse among students in an online community of inquiry. It focused on the expression of the two major components of metacognitive awareness, knowledge of cognition and regulation of cognition, and the expression of the subprocesses of regulation of cognition: planning, information management strategies, comprehension monitoring, debugging strategies, and

evaluation. Students from the test group (Meta) received metacognitive embedded within general guidance whereas the students from the control group (Cont) received general guidance only. Students' messages were analyzed using content analysis methods and descriptive statistics methods such as frequency counts followed by t-test analysis. Significant differences were found between the two groups in the expression of the regulation of cognition component, and the evaluation subprocess, which were predominant in the Meta group. However, students from the Cont group expressed the planning subprocess significantly more than their counterparts in the Meta group. Our results indicate that metacognitive instruction promotes a metacognitive discourse in an online community of inquiry, and provide further evidence that students' metacognitive behaviors are observable and measurable in online discussions.

Strand 13: History, Philosophy, and Sociology of Science

Teaching Strategies & Assessment

2:45pm-4:15pm, Heron Room

Presider: Jonathan F. Osborne

Linking Experiential Aspects of a Research Apprenticeship Program to Gains in NOS Understandings for High School Student Participants Experiencing Different Approaches to NOS Teaching and Learning

Stephen R. Burgin, Old Dominion University, sburgin@odu.edu

Troy D. Sadler, University of Missouri

ABSTRACT: The merits of three different approaches to NOS teaching and learning (implicit, reflective, explicit/reflective) were investigated in the context of a research apprenticeship program designed for high school students. Participants experiencing each of the three approaches responded to an open ended NOS questionnaire at the beginning and again at the end of the experience. Categorical data analysis revealed whole group significant changes in NOS understandings only for the participants who experienced the explicit/reflective approach. That being said, individual students experiencing either of the other two approaches did exhibit growth in their understandings of a number of NOS aspects (e.g. creativity, subjectivity, myth of the scientific method). Analysis of interviews and observations conducted with both participants and their mentor scientists were used to investigate factors of the research apprenticeship apart from the explicit/reflective approach that may have accounted for growth in NOS understandings. Results indicated a complex interaction between participant attributes (including their personal science identity or feelings of being a scientist), the ways in which participants were treated by their mentors, the authentic action in which participants were allowed to engage and gains in NOS understandings. Implications for NOS teaching and learning in both traditional and nonformal settings are discussed.

Meaningful Assessment of Learners' Understandings of Scientific Inquiry – Views About Scientific Inquiry (VASI) Questionnaire

Norman G. Lederman, Illinois Institute of Technology, ledermann@iit.edu

Judith S. Lederman, Illinois Institute of Technology

Stephen Bartos, Illinois Institute Of Technology

Selina Bartels, Illinois Institute Of Technology

Allison Antink Meyer, Illinois Institute of Technology

Renee S. Schwartz, Western Michigan University

ABSTRACT: Helping develop informed views of scientific inquiry (SI) has been and continues to be a goal of K – 12 science education, as evidenced in various reform documents. Nevertheless, research focusing on understandings of SI has taken a perceptible backseat to that which focuses on the “doing” of inquiry, due in part to the typical conflation of scientific inquiry with nature of science (NOS), and also attributable to the lack of a readily accessible instrument to meaningfully assess learners' views of SI. This paper intends to describe the development of the Views About Scientific Inquiry questionnaire (VASI), and outline the framework of scientific inquiry that undergirds the VASI. The utility of the resulting rich-descriptive views of SI that the VASI provides for informing further research efforts will also be explicated. The trend in recent reform documents, unfortunately, ignores much of the research on NOS and SI and presumes that

the “doing of” inquiry is sufficient for developing understandings of both. We feel the VASI will provide an essential tool in further discrediting this contention, and providing both the classroom teacher and the researcher a more powerful means for assessing learners’ conceptions about essential aspects of scientific inquiry.

Teaching with and about Nature of Science: Coupling Inquiry and Nature of Science Teaching and Learning Goals

Fouad Abd-El-Khalick, University of Illinois at Urbana-Champaign, fouad@illinois.edu

ABSTRACT: The ubiquitous goals of helping K-12 students develop informed conceptions of nature of science (NOS) and experience authentic inquiry learning environments have been long-standing and central aims of science education reform efforts. However, realizing these goals continues to elude the science education community partly because of a persistent, albeit not empirically supported, coupling of the two goals in the form of ‘teaching about NOS with inquiry’. This position paper aims, first, to introduce the notions of, and articulate the distinction between, teaching with and about NOS, which will allow for the meaningful coupling of the two desired goals. Second, the paper aims to explicate science teachers’ knowledge domains requisite for effective teaching with and about NOS. I argue that research and development efforts dedicated to helping teachers develop robust and integrated NOS understandings would have the dual benefits of not only enabling teachers to convey to students images of science and scientific practice that are commensurate with historical, philosophical, sociological, and psychological scholarship (teaching about NOS), but also to structure robust inquiry learning environments that approximate authentic scientific practice, and implement effective pedagogical approaches that share a lot of the characteristics of best science teaching practices (teaching with NOS).

NOS Views of Science and Non-Science Majors at the Onset of their Specialization

Ora Kahana, Technion – Israel Institute of Technology, oraka@technion.ac.il

Tali Tal, Technion – Israel Institute of Technology

ABSTRACT: This study examined whether science and non-science majors, at the onset of their majoring studies in high school, have different views about nature of science (NOS). A socio-scientific issue based instrument developed by the authors was used to assess differences in students’ NOS views of various aspects: the empiric nature of scientific knowledge, its subjective, tentative and limited nature, and the influence of society and culture. A total of 643 science and 336 non-science majors from 19 Israeli high schools participated in the study. Students’ responses were content analyzed and compared. Results indicated that naïve views in all aspects were more common among non-science majors, and the difference is significant in three of them: the empirical nature, limitations, and cultural-dependent aspects of science. Non-science major students describe science as objective and depersonalized. They do not perceive that scientific practice is a human endeavor influenced by the sociocultural context in which it is situated. The perceived depersonalized and objective image of science and scientists does not match their aspirations of self-efficacy and self-realization. More informed views of NOS may contribute to the interest of students in science as a future career.

Strand 14: Environmental Education

Symposium - The Policy, Practice, and Research Nexus of Climate Change Education

2:45pm-4:15pm, El Morro 1 & 2

Presenters:

J. Randy McGinnis, University of Maryland, jmcginni@umd.edu

Nancy Brickhouse, University of Delaware

Wayne Breslyn, University of Maryland

Chris McDonald, University of Maryland

Emily E. Hestness, University of Maryland

Anita Roychoudhury, Purdue University

Daniel P. Shepardson, Purdue University

Bruce R. Patton, The Ohio State University

Andrew Hirsch, Purdue University

Joel D. Wilson, Rossville Middle School

Carolyn Parker, Johns Hopkins University

ABSTRACT: In this session, the focus will be on exploring the nexus among (educational) policy, (science teacher educator and science teacher) practice, and research in climate change education. Theoretical positions will be presented and empirical studies referenced.