

NARST 2012 Annual Conference Presentation Abstracts

NOTES. Any changes made to the actual program after the January 10, 2012 deadline for requested modifications are not reflected in the abstracts. All abstracts are taken directly from the NARST proposal submission system and have not been edited.

Sunday, March 25, 2012

Pre-Conference Workshop—Equity and Ethics Committee Sponsored (Free)

Enacting Equity and Social Justice in Science Education Careers

8:00am – 12:00pm, Room 101

Organizers:

Alicia Trotman, Michigan State University

Regina Wragg, University of South Carolina

Participants:

Julie Bianchini, University of California-Santa Barbara

Heidi Carlone, University of North Carolina-Greensboro

Christopher Emdin, Teachers College, Columbia University

Felicia Moore Mensah, Teachers College, Columbia University

Joi Merritt, Michigan State University

Deb Morrison, University of Colorado at Boulder

Deborah Roberts-Harris, University of New Mexico

Takumi Sato, Michigan State University

Blakely Tsurusaki, University of Washington

Bhaskar Upadhyay, University of Minnesota

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, Room 102

Angela M. Calabrese-Barton, Michigan State University

Joseph S. Krajcik, University of Michigan

Bob Geier, University of Michigan

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 (\$50 Registration Fee)

A Cognitive Model for Implementing Knowledge: Moving Research into Practice

8:00am – 12:00pm, Room 103

Dale R. Baker, Arizona State University

Heather Pacheco, Arizona State University

ABSTRACT: The purpose of this workshop is six-fold: 1) to address the disconnect between educational research and classroom practices, 2) to present a cognitive model to support teacher adoption of research-based practices in their classroom, 3) to present effective strategies for moving educational research into classroom practice, 4) to provide participants with an opportunity to explore the barriers and affordances to moving educational research

Sunday, March 25, 2012

into classroom practice, 5) to help participants develop a plan to help teachers implement research-based practices in their own contexts, and 6) to provide resources to support participants in their endeavors to help teachers implement research-based practices in their classrooms. Participants will leave the workshop with an implementation plan to help teacher move research into classroom practice. Facilitator Power Points, a bibliography, notes and ideas generated by the group during the workshop, and implementation plans of all participants will be shared via email after the workshop.

Pre-Conference Workshop—Research Committee Sponsored (\$25 Registration Fee)

Introduction to Instrument Development and Evaluation in Science Education

8:00am – 12:00pm, Room 104

Irene Neumann, Leibniz-Institute for Science & Mathematics Education (IPN)

Knut Neumann, Leibniz-Institute for Science & Mathematics Education (IPN)

William Boone, Miami University

Ross Nehm, Ohio State University

ABSTRACT: Measurement instruments play a central role in science education research by providing insights into students' and teachers' traits, such as motivation, interest, attitudes, knowledge, and understanding. Many different research designs in science education – ranging from pre-post intervention studies to randomized control trials (RCT) – rely on measurement instruments. The data generated by instruments are only meaningful if they are reliable, and – most importantly – valid. But how can science educators know if the instruments that they use meet these criteria? Using existing instruments and datasets, we will facilitate an interactive exploration of instrument development and evaluation suitable for graduate students and faculty new to this area of research. Specifically, participants will learn (1) procedures for developing high quality instruments, and (2) criteria suitable for evaluating instrument quality. Overall, we hope that the NARST community will leave the workshop with a greater appreciation for the importance of this often neglected area of science education.

Presidential Sponsored Session

The Challenge of 21st Century Science Education to Offer New Insights for a Diverse Global Community: Re-imagining the Use of Participants' Drawings as a Data Collection Strategy

1:00pm – 2:30pm, Room 313

Presenters:

J. Randy McGinnis, NARST president, University of Maryland, jmcginni@umd.edu

Phyllis Katz, University of Maryland

Gili Marbach-Ad, University of Maryland

Wayne Breslyn, University of Maryland

Kelly A. Riedinger, University of North Carolina Wilmington

Nathan Carnes, University of South Carolina

Sue D. Tunnicliffe, Institution of Education, University of London

Michael J. Reiss, Institute of Education, University of London

Chris Astall, University of Canterbury

ABSTRACT: Researching science education in the 21st century takes place in a diverse global community facing mounting challenges. Within this context there is a high expectation that research efforts will offer new insights and approaches. This session examines the ways multiple researchers worldwide are using a visual data source (drawings) as a creative data collection strategy to gain insight into individuals' thinking and beliefs concerning the learning and teaching of science. Issues related to theory, data analysis, interpretation and credibility will be discussed.

Sunday, March 25, 2012

Strand 1: Science Learning, Understanding and Conceptual Change

Related Paper Set - Examining Student Learning of Science through Engineering and Engineering Design

1:00pm – 2:30pm, Room 310

Think-aloud Protocol Analysis as a Measure of Students' Science Learning through Design Assessment

Todd R. Kelley, Purdue University, trkelley@purdue.edu

Brenda M. Capobianco, Purdue University

ABSTRACT: This paper set examines the different dimensions of student learning of science 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 student success. Underpinning each paper is the central theme of student learning of science through engineering and engineering design. Researchers answer one or more of the following questions: How do you define and/or contextualize student success within your research in STEM education? What are examples of measures your research team has generated and/or employed? What are effective ways of measuring students' science conceptual understanding and application when using the engineering design process? In what ways can researchers account for variation in instructional practices related to engineering and its impact on student success? What are applications and/or implications of the measures for student success your research can provide? In this session we engage in a disciplined dialogue on what we value most among the various measures of student learning as we enter a new era of standards and assessments in science education.

Facilitating and Assessing Science Learning Within an Engineering Design-Focused Project-Based Learning Curriculum

Mike Ryan, Georgia Institute of Technology, mike.ryan@ceismc.gatech.edu

Marion Usselman, Georgia Institute of Technology

Elementary Student Knowledge Tests: A Grade-level Specific Pre/Post Assessment of Science, Technology, and Engineering Design Process Concepts

Heidi Diefes-Dux, Purdue University, hdeifes@purdue.edu

Melissa Dyehouse, Purdue University

A Mixed Methods Approach to Measuring Learning through Engineering

Kristen B. Wendell, University of Massachusetts Boston, kbwendell@gmail.com

Merredith Portsmore, Tufts University

Strand 2: Science Learning: Contexts, Characteristics and Interactions

STEM Topics

1:00pm – 2:30pm, Room 302

President: Toni A. Sondergeld, Bowling Green State University

Video Research as a Roadway to Re-imagining the Promise and Potential of Science Education Research

Rowhea M. Elmesky, Washington University in St Louis, relmesky@wustl.edu

ABSTRACT: The analysis of video footage from learning contexts is crucial; particularly within an epistemological paradigm that views students' learning as socially constructed. In fact, one could argue that viewing and re-viewing video provides profound opportunities for better understanding the intersections of social, emotional and cognitive processes during students' engagement/disengagement with school subject matter. Through contextualized examples, this article discusses video analysis as a methodological approach for developing deep understandings of science teaching and learning contexts. Focusing upon a deductive approach for video selection, which is appropriate when the researcher has clear research questions and a strong theoretical orientation (Derry, 2010), the paper will delineate specific methods/micro techniques for studying unconscious and conscious aspects

Sunday, March 25, 2012

of interactions occurring in science education learning environments including approaches to capturing and analyzing fleeting actions, subtle movements, peripheral events, and non-verbal communication (e.g., facial expressions, direction of gaze, hand movements, body position) that are not easily identified in real time viewing.

Teacher/Student On-Line Interaction: Role-Playing Scientists to Augment Hands-On Lab. Work in Classrooms

Carol A.B. Rees, Thompson Rivers University, British Columbia, Canada, crees@tru.ca

Annemarie Petrusek, Huron Perth Catholic District School Board, Ontario, Canada

ABSTRACT: Here we report on a study of on-line student/teacher communication using a discourse analysis approach. This student/teacher exchange occurred during a project that the teacher created to help her middle-school students appreciate everyday connections for their work on the topic of heat energy. In this project the teacher role-played multiple expert science professionals (each with their own fictitious identity) with whom students (role-playing junior science professionals) communicated through e-mail and blog to help them achieve the goals of their projects. This report focuses on one example of a conversation wherein teacher and student role-played physicists working together on a protocol for a science demonstration. The conversation occurred over a period of ten days interspersed with time the student spent in the lab. Discourse analysis makes evident how the student adopted a science repertoire as the conversation progressed. This study adds to evidence of the usefulness of discourse analysis for studying student learning in online spaces and directly relates to the conference theme by demonstrating a creative approach to science education made possible through twenty-first century technology.

Development of a Student Self-Evaluation Instrument in Inquiries

Saskia Vanderjagt, Vrije Universiteit, Amsterdam, The Netherlands, s.vanderjagt@ond.vu.nl

Lisette E. Vanrens, Vrije Universiteit, Amsterdam, The Netherlands

Herman H. Schalk, Vrije Universiteit, Amsterdam, The Netherlands

Albert Pilot, University of Utrecht, FIsme

Jos J. Beishuizen, Vrije Universiteit, Amsterdam, The Netherlands

ABSTRACT: This design study aims at developing an instrument that enables students to evaluate the accuracy, reliability and validity in an inquiry, during the time they plan, conduct and handle the data in that inquiry. The design of this self-evaluation instrument was based on thirteen design characteristics. These were converted in a draft of 22 rubrics, based on five levels in the SOLO-taxonomy and the concepts of evidence model. The draft instrument was tested with 16 pre-university secondary science teachers, 23 student-teachers and 2 students, using a student inquiry report. Next, to determine the feasibility of the instrument 24 pre-university students and two science teachers used various rubrics in class in three successive – general science, biology and physics – inquiry modules. Data were obtained from written documents, audiotapes, questionnaires and interviews. It is concluded that the rubrics are feasible to use as an instrument in class. However, the number of rubrics should be reduced and each rubric should contain the same example to show the five intended levels in the SOLO taxonomy within a rubric. Further implications for a student self-evaluation instrument regarding the accuracy, reliability and validity in an inquiry are discussed.

Do We Have a Common STEM Pedagogy? A Comparative Case Study Analysis

Maya Israel, University of Cincinnati, College of Education UC Fusion STEM Education Center, maya.israel@uc.edu

Helen M. Meyer, University of Cincinnati, College of Education UC Fusion STEM Education Center

ABSTRACT: This study involved a cross-case analysis across five K-12 settings that received mini grants to develop innovative instruction in science, technology, engineering, and mathematics (STEM). Two research questions guided this study: (a) What does implementation of STEM look like in STEM innovation funded programs? And (b) What factors enhance or constrain teachers' implementation of innovative STEM instructional practices? Three main themes emerged within the STEM programs. First, all five cases focused on addressing student diversity by providing multiple means of presenting content and allowing students to express their understanding. Second, all five cases relied heavily on teacher collaboration to both secure mini-grant funding and for implementation of the STEM activities. Lastly, all cases placed high emphasis on technologies and 21st Century skills within the STEM

Sunday, March 25, 2012

activities. Factors that enhanced teachers' ability to create and implement engaging STEM experiences included strong administrative support and collaborative environments, teacher commitment, and financial supports to sustain the STEM programs. Factors that created constraints on teaching and learning included teachers' lack of expertise in integrated STEM instruction, lack of funds for either technologies or professional development, difficulties integrating problem-based learning into traditional instructional settings, and difficulties with promoting student collaboration.

Strand 4: Science Teaching--Middle and High School (Grades 5-12): Characteristics and Strategies
Strand Sponsored Session- Climate Change Education: Curriculum, Controversy, Culture, and Critical Review
 1:00pm – 2:30pm, Room 303

Presenters:

Anna R. Lewis, University of South Florida, arlewis@usf.edu
 Susan Buhr, University of Colorado
 Julie Thomas, Oklahoma State University
 Anne L. Kern, University of Idaho
 Ardice Hartry, UC Berkeley

ABSTRACT: As inhabitants of planet Earth each person should understand about the human and natural factors that contribute to climate and climate change, and how changes in climate affect our lives. We need to understand how our energy, land, and natural resources interact with climate, how to prevent the most disruptive effects of climate change, and how to adapt to changes that can't be avoided. These types of issues cut across multiple science domains. To assist students in understanding these types of problems and arrive at possible solutions educators must address a variety of issues, such as; How does climate education fit into the curriculum? How can relevant local issues be linked to global topics? How can conflicting beliefs or media disinformation be addressed when they are at odds with scientific findings? How can climate education be evaluated effectively so as to inform classroom practices and further research? NASA's Innovations in Climate Education (NICE) (formerly called Global Climate Change Education - GCCE) fund projects that address these types of issues. We invite NICE project participants and all NARST members to explore these questions through round-table discussions. We envision this as an opportunity to share expertise, develop greater perspectives, and enrich professional relationships.

Strand 4: Science Teaching--Middle and High School (Grades 5-12): Characteristics and Strategies
Basic Literacy Skills & Science
 1:00pm – 2:30pm, Room 305

Presider: Saouma B. Boujaoude, American University of Beirut

The Effect of the Science Writing Heuristic on Elementary Students' ITBS Score: A Longitudinal Study

ChingMei Tseng, University of Iowa, chingmei.tseng@gmail.com
 Lori Norton-Meier, University of Louisville
 Brian M. Hand, University of Iowa

ABSTRACT: 158 students and their teachers participated in this longitudinal study while students ITBS scores were collected to examine the effect of Science Writing Heuristic (SWH) approach. After conducting SWH for three years, the experimental group score statistically significantly higher in math and science than students who are not in the control group. One way t-test and ANOVA were performed to examine the difference between experimental and control groups, while Latent Growth Model (LGM) is used to analyze and explore students' growth over times. The mean comparisons were focus on (1) different disciplines: science, math and language, (2) low and high achievement levels and (3) gender difference between experimental and control group. We also used post-test effect size to provide better measurement to detect any differences in student performance. Predictors in the current SEM model, including experimental/control, high/low achievement and gender, are added into the model for investigating and answering questions on which covariates exert important effects on students' growth and

Sunday, March 25, 2012

their causality. Results model show that students have different performance on disciplines: students with high student achievement levels are usually associated with higher initial language scores. This paper provides insights on both learning approach as well as mythology.

The Influence of Non-Traditional Writing Task and Audience on Students' Understanding of Mixture Concept
 Sevgi Kingir, Selcuk University, kingirsevgi@gmail.com
 Murat Gunel, Ahi Evran University

ABSTRACT: This study investigated the effect of non-traditional writing task and audience on 9th grade students' understanding of mixture concepts. A total of 610 students instructed by three chemistry teachers in two public high schools participated in this study. After the completion of the mixture unit, 267 students engaged in traditional writing activities, 122 students wrote letter to younger audience, 91 students wrote letter to their peers, and 130 students wrote letter to their teacher. The Mixture Concept Test was administered as a pre- and post-test to all the groups and semi-structured interviews were conducted with 24 students at the end of the instruction. Pretest analyses revealed that there were significant mean differences between traditional and non-traditional writing groups. Post-test analyses indicated that non-traditional writing group outperformed the traditional writing group and, the groups writing to peers and younger students performed better than those who wrote to the teacher, when the effects of the pre-test scores were controlled. In addition, interview results revealed that non-traditional writing tasks were very helpful in students' understanding of the mixture concepts.

Developing Science Literacy: Investigating Scaffolds that Assist Students in Writing about Science Inquiry Tasks
 Timothy A. Collins, Gresham Barlow School District, collins19@gresham.k12.or.us
 Lawrence B. Flick, Oregon State University

ABSTRACT: Many students struggle with the demands of science inquiry. Part of this challenge may rest in the literacy demands that science inquiry tasks place on students. This study examined the role of metacognitive reflective prompts and the use of sentence stems to scaffold the science inquiry experience in a suburban high school chemistry class. The use of metacognitive reflective prompts had very little effect on the quality of the science inquiry task write-ups that the students produced. Data from the use of sentence stems was mixed. In only one of four instances was the use of sentence stems associated with significantly higher quality student work. This study also tracked changes in student self-efficacy for chemistry content and science inquiry skills. Over the course of the study, student self-efficacy for science inquiry remained unchanged whereas student self-efficacy for chemistry content increased significantly. Implications for classroom instruction and teacher training were addressed.

7th Grade Students' Decisions about Limiting Resources after Writing-to-Learn Instruction
 Meena M. Balgopal, Colorado State University, Meena.Balgopal@colostate.edu
 Lynn Gilbert, Conrad Ball Middle School
 Pam Breitbarth, Conrad Ball Middle School
 Alison M. Wallace, Minnesota State University Moorhead

ABSTRACT: As our world addresses global environmental issues it has become essential that people are equipped to make personal decisions about their behavior using scientific evidence regarding foundational ecological concepts (limiting resources, human population, etc.). We examined the role of writing-to-learn (WTL) activities in both English and Life Science classes with 60 7th grade students. After participating in reading assignments, inquiry activities, class discussions, and a trip to a large urban zoo, students compared and contrasted the issues facing two endangered species (one global and one local) through iterative writing assignments. Students wrote about what they know about endangered species and limiting resources, how this makes them feel, and how they might resolve the problem of declining animal populations. Essays were coded by the team using constant comparison and informed by Wallace (2004). We found that there was a 21% increase in student knowledge of limiting resources, 68% increase in recognition that humans are part of ecosystems and a 15% increase in decisions about personal behavior to resolve perceived problems. We were pleased with these findings and conclude that WTL activities can be successful in improving middle school students' ecological literacy.

Sunday, March 25, 2012

The Comparison of Image-text Relations in High School Biology Textbooks between Australia and Taiwan

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Len Unsworth, University of New England, Australia

Chang-Hung Chung, National Changhua University, Taiwan

Huey-Por Chang, National Changhua University, Taiwan

Kuo-Hua Wang, National Changhua University, Taiwan

ABSTRACT: Visual images in biology textbooks play an important role which influences reading comprehension greatly. Based on modern social semiotics, the relation between signified (meaning) and signifier (form) is not pre-existed in any society or culture. It depends upon author's interest which will influence the selection of images. The purpose of this study is to investigate and compare the image-text relations in high school biology textbooks between Taiwan and Australia. We focus on the chapter of classification in three Taiwanese textbooks and three Australian textbooks as well. The image-text interactions addressed by these textbooks are identified as elaboration and extension. The structures of these images, either narrative or conceptual, can further indicate the ways of representation. A conjunction of image-text relations and structures of images forms new codes for further comparison: elaboration-narrative, elaboration-conceptual, extension-narrative, extension-conceptual. The distribution of these relations is significantly different between these two countries and among textbooks. It implies that information is carried differently by different textbooks. These textbooks tend to use more elaboration-narrative relation in representing concepts. However, some relations are more difficult than the others to comprehend. The implications for science teaching are also discussed.

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

Related Paper Set- Systems Thinking in Introductory Biology

1:00pm – 2:30pm, Room 304

Discussants:

Jennifer L. Momsen, North Dakota State University

Elena Bray Speth, Saint Louis University

Joseph T. Dauer, Michigan State University

ABSTRACT: Contemporary biological research increasingly adopts approaches that cross disciplinary boundaries and asks questions aimed at solving complex societal problems. While biology rapidly advances, much of college-level biology education remains unchanged, with a focus on content recall and little attention to higher-order learning. Our work explores a curricular approach that challenges students to learn relevant biological content, but more importantly, to contextualize content with respect to larger biological systems. To support this approach, we developed a model-based pedagogy that uses student-constructed models as foundational tools for instruction and assessment. Our research with student-generated models sheds light on: (a) how students organize their thinking about diverse systems, (b) how students reason about cause-effect mechanisms in biological systems, and (c) how student thinking about biological systems changes during a course as they practice and learn how to connect concepts across scales. We will introduce how and why models are relevant in biology teaching and learning, and importantly, how student-constructed models can be used to reveal student thinking. Here, we present key findings that have emerged from our work implementing our model-based pedagogy at diverse institutions throughout the Midwest.

Building a Rationale for the Integration of Systems Models into College-level Biology Teaching and Learning

Tammy M. Long, Michigan State University, longta@msu.edu

Jennifer L. Momsen, North Dakota State University

Elena Bray Speth, Saint Louis University

Joseph T. Dauer, Michigan State University

Sara A. Wyse, Bethel University

Sunday, March 25, 2012

Change in Correctness and Complexity of Student-constructed Models During a Course

Joseph T. Dauer, Michigan State University, jdauer@msu.edu
Tammy M. Long, Michigan State University
Jennifer L. Momsen, North Dakota State University
Elena Bray Speth, Saint Louis University
Kristen Kostelnik, Michigan State University

From Linear to Complex: How Students Organize Models and Explanations of Causal Relationships in Biological Systems

Elena Bray Speth, Saint Louis University, espeth@slu.edu
Matthew Dirnbeck, Saint Louis University
Jennifer L. Momsen, North Dakota State University
Tammy Long, Michigan State University

Systems Models, Systems Thinking, and Content Knowledge in an Introductory Biology Course

Jennifer L. Momsen, North Dakota State University, Jennifer.Momsen@ndsu.edu
Sara A. Wyse, Bethel University
Elena Bray Speth, Saint Louis University
Kristen Kostelnik, Michigan State University
Joseph T. Dauer, Michigan State University
Tammy Long, Michigan State University

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

Improving Conceptual Understanding

1:00pm – 2:30pm, Room 309

Presider: Huseyin Colak, Northeastern Illinois University

Getting to the CoRe of It! Scaffolding Undergraduates Understanding of Geology Using Content Representation Matrices

Meredith A. Park Rogers, Indiana University, mparkrog@indiana.edu
Heidi L. Wiebke, Indiana University
Adam V. Maltese, Indiana University
Joseph A. Harsh, Indiana University
Ingrid S. Weiland, University of Louisville
Christina Melki, Indiana University

ABSTRACT: Without opportunities for engaging and reflecting on newly acquired science content beyond simple recall, learners, and especially future elementary teachers, may feel their understanding is insufficient for explaining the scientific concepts to others. For future teachers, this may lead to science teaching avoidance. This study explores the use of a pedagogical tool called Content Representations (CoRes) within an undergraduate geology course for the purpose of developing deeper, more relevant understanding of the content. We employed a mixed-method approach comparing CoRe students understanding, as demonstrated on test scores, to a control group who experienced other synthesis types of questions. In addition, we explored the CoRe group's perceptions of the CoRe on their overall learning in the course. Our findings show students in the experimental group (CoRe) made more significant gains in their understanding of the content than the control group. Also, those who identified themselves as education majors in the CoRe group felt the CoRe questions were relevant to their process of learning the content. Almost all students, regardless of their major, stated the CoRe questions helped them learn the content with respect to being a well-informed citizen. Suggestions for how these findings may impact PCK development will be discussed.

Sunday, March 25, 2012

How Do Ideas about Conventional Time and Large Numbers Influence Students' Understanding of Deep (Geologic) Time?

Kim A. Cheek, University of Ciputra, cheek.kim8@gmail.com

ABSTRACT: Geologic processes occur across many orders of magnitude and many require time periods well outside human experience. The ability to use information about rate to judge the duration of a geologic event is one aspect of a concept of deep (geologic) time. This study investigates the relationship between how students' ideas about duration in conventional time and their understanding of large numbers may influence how they understand duration in deep time. Seventeen introductory university geoscience students were individually interviewed for this qualitative study. Results indicate that many students equate spatial size with duration in both conventional and deep time. They are frequently confused about the multiplicative relationships among numbers of various magnitudes. Spatial compression of large temporal periods is common. Specific pedagogical recommendations based upon the study's findings will be discussed.

How Do Biology Undergraduates "Explain" Photosynthesis? Investigating Student Responses to Different Constructed Response Question Stems

Michele M. Weston, Michigan State University, westonmi@msu.edu

Casey Lyons, Michigan State University

John Merrill, Michigan State University

Mark Urban-Lurain, Michigan State University

Kevin Haudek, Michigan State University

ABSTRACT: One goal of assessment is to provide instructors with formative feedback about their students' understanding of class material as well as their misconceptions. Constructed response questions can give a detailed picture of what students know, as long as the question stem is written carefully to elicit the desired information. In previous work with a constructed response question on photosynthesis, we found that many students did not respond to a question about mass gains in plants by explicitly naming a process by which plants gain mass. This study investigated how responses change when the question stem is altered to explicitly ask for the process by which biomass is added to plants. The questions were administered to students in two semesters of the same introductory biology course. We analyzed the responses using SPSS Text Analytics for Surveys software to extract relevant terms and categorize them. Three of the five categories that represent processes showed a significant increase in frequency from the first semester to the second. Our results suggest novices (students) and experts (faculty) have different understandings of what constitutes an "explanation" in a scientific context and that constructed response questions must be worded carefully so that students interpret the questions correctly.

Identification Student Misconceptions of Chemistry Diagrams and the Reinforcement of These Misconceptions by Chemistry Textbooks

Bryna Kumi, University of Maryland, College Park, bclover@umd.edu

Bonnie L. Dixon, University of Maryland, College Park

Felicia Bartlett, University of Maryland, College Park

ABSTRACT: Visuo-spatial representations are found throughout each of the science disciplines, and experts in a field must easily translate between discipline-specific diagrams. The introduction and mastery of such meta-representational competence is a difficult process for novices. We present a two-part, mixed-methods study, in which we have quantitatively investigated Introductory Organic Chemistry students' abilities to translate between discipline-specific diagrams, specifically the dash-wedge and Fischer projections. Through analysis of students' incorrect answers, we have identified holes and false impressions in students' conceptual understanding of diagrammatic convention and the translation between diagrams. A qualitative examination of popular Organic Chemistry textbooks connects textbook illustrations with these student misconceptions. We present evidence which suggests textbook illustrations may reinforce students' difficulties in these translation processes. The implication of such misleading illustrations across scientific disciplines is considered.

Sunday, March 25, 2012

Strand 7: Pre-service Science Teacher Education

Learning Science Teacher Practices

1:00pm – 2:30pm, Room 306

Presider: Sheryl L. Mcglamery, University of Nebraska

Preservice Science Teachers' Use of Inscriptions In Their Peer Teaching Activity

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

Scott P. McDonald, The Pennsylvania State University

ABSTRACT: The current study investigated the preservice science teachers' uses of inscriptions in their peer teaching activities and was guided by the following research questions: 1) what kinds of inscriptions do pre-service teachers use in their peer teaching activity? 2) How and why do pre-service teachers use inscriptions in their peer teaching lessons? This study followed a multi-participant case study approach. Nine science pre-service teachers enrolled in the Secondary Science Teaching course at a large mid-Atlantic University constitute the participants of the study. Seven videos of lessons were analyzed for the inscription use. Data analysis demonstrated that preservice teachers used inscriptions in pedagogical and normative ways and the complexity and type of inscriptions used across different disciplines varies. Preservice teachers used inscriptions 1) to convey final form scientific knowledge, 2) to engage students in scientific practice, 3) to make thinking visible, 4) to connect multiple ideas with multiple inscriptions, and 5) to provide data or example from nature. It is concluded that science topics and the different sequences of the lessons could be conducive these different uses of inscriptions across different lessons. In addition, these complex and integrated uses of inscriptions may impact students' perceptions of how scientists use inscriptions and inscriptional practices.

Peer-to-Peer Mentoring: Examining the Potential for Communities of Practice in Supporting Teacher Learning

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

Angela Calabrese Barton, Michigan State University

Gail Richmond, Michigan State University

ABSTRACT: According to studies, preservice teachers have not been offered many authentic experiences to develop a community of practice with their peers outside their university courses. Fostering this community of practice is essential as an interactive, relational and dialogical space that would offer individuals at different points in their teacher preparation program a legitimate peripheral participation approach to learning to teach. In this paper, we examine preservice teachers' perceptions of the 'peer-to-peer mentoring' experience as part of building a community of practice. Moreover, we investigate how participating in this community helps beginning teachers better reflect on their learning experiences and how it provides a space to further their professional growth.

Using "Approximations of Practice" to Bridge Theory and Practice in an Elementary Science Methods Course

Ashima M. Shah, Harvard University, ashah@mclean.harvard.edu

ABSTRACT: Science methods courses, where prospective teachers (interns) are prepared to teach science, are often criticized for telling interns about teaching instead of preparing them to actually enact teaching. Grossman and colleagues (2009) have proposed the use of "approximations of practice," or simulated experiences that increase in authenticity and complexity to real teaching as one pedagogical approach teacher educators can use to help interns better connect what they learn about teaching to the actions they enact while teaching in actual classrooms. This study examines three types of approximations of practice in an elementary science methods course: targeted rehearsals of teacher talk, peer walk-throughs of lesson plans, and small-group teaching enactments. Video data of how these approximations were used in the methods course to support intern learning as well as written reflection data from the interns about what they gained from the experience will be presented. Findings offer insights for teacher educators looking to improve their methods course activities and teacher preparation directors looking to improve coherence between the often disconnected coursework and fieldwork components of teacher preparation programs.

Sunday, March 25, 2012

Using Specialized Instruction to Develop Scientific Reasoning Abilities in Teacher Candidates

Kathleen M. Koenig, University of Cincinnati, koenigkn@ucmail.uc.edu

Lei Bao, Ohio State University

Melissa Schen, Wright State University

ABSTRACT: The development of a scientifically literate citizenry has become a national focus and highlights the need for K-12 students to develop a solid foundation of scientific reasoning skills along with appropriate content knowledge. This implies that teachers must also be competent in these areas. Although the teacher preparation programs at our public university in a mid-western state place heavy emphasis on science and mathematics, written assessments within the program courses indicated our Middle Childhood Education majors were not developing necessary scientific reasoning abilities. As a result, explicit scientific reasoning training modules were integrated into the program's science foundations course and significant pre- and post-test gains using a paired t-test analysis ($p < 0.05$) were observed. These findings highlight the need and motivation for teacher preparation programs to include coursework that promotes the development of scientific reasoning. In addition, the findings of this study support the research literature which indicates scientific reasoning skills can be better targeted through inquiry-based courses that focus on reasoning training and include substantial and repeated practice within diverse science contexts.

Strand 8: In-service Science Teacher Education

Promoting Language and Literacy in the Science Classroom

1:00pm – 2:30pm, Room 105

Presenter: Andrea R. Milner, Adrian College

We Are All Talking: A Whole-School Approach to Professional Development for Teachers of English Learners

Lauren M. Shea, University of CA - Irvine, lshea@uci.edu

Therese B. Shanahan, University of California - Irvine

ABSTRACT: A number of studies have suggested that integrating language and science content into professional development (PD) will have positive outcomes for teachers and students. However, few studies examine the school-level effects of integrating language and content. This paper investigates a PD model that included two distinct components: (1) grade-level student-talk infused lessons in science and math and (2) school-level learning communities focused on readings and discussions of student-talk research. The investigation reports the PD program's impact on longitudinal school level outcomes, in a high minority, low SES school district. Findings demonstrate greater increases in the math, English language arts, and science state test scores for English language learners in participating schools when compared to non-participating schools. The results suggest that a PD program that integrates language and content and focuses on school-level collaboration is a potential model for successful school improvements.

Elementary Teacher Beliefs about the Role of Language Literacy Instruction in a Science Lesson Sequence

Sandie M. Grinnell, Mount Elden Middle School, sgrinnell@fusd1.org

Barbara A. Austin, Wittenberg University

ABSTRACT: Students benefit from recognizing how to gain information through the reading of informational text and how laboratory findings can be shared through written communication. By sequencing inquiry science lessons in a learning cycle that includes placing exploratory activities prior to explanations of science concepts, teachers provide the necessary foundational knowledge to maximize student learning of science and the development of life-long literacy skills. Unfortunately, many teachers use literacy strategies that are ineffective in science or replace a learning cycle with less effective sequences. This paper provides analysis of qualitative data collected from 110 elementary teachers participating in four Math and Science Partnership programs about their beliefs about the incorporation of the literacy elements of vocabulary instruction and reading and summarizing in a science lesson. The analysis indicates that many elementary teachers believe that vocabulary must be taught prior

Sunday, March 25, 2012

to the lesson in order for students to learn the science concepts and that reading an informational text is not an effective method of building knowledge of science concepts.

Synergistically Aligning Cogenerative Dialogues with Culturally Responsive Teaching and Learning

Wesley Pitts, Lehman College, CUNY, wesley.pitts@lehman.cuny.edu

Gillian U. Bayne, Lehman College CUNY

ABSTRACT: This research uses a sociocultural framework, tenets of culturally responsive teaching, and cogenerative dialogues, within the context of an advanced graduate science education methods course, as a means to learn how to create classroom learning environments that provide increased opportunities for the engagement of urban students in science inquiry. Through participating in a simulated secondary high school science activity, involving the creation of a three dimensional model of a cell, the sharing of reflections and recollections of the activity, and a whole class cogenerative dialogue immediately following the activity, a deepening of understandings inherent to the complexities of urban science classrooms became apparent. We document three salient themes that emerged from the research. These themes pertained to (a) equity issues encountered with material and human resources, (b) the production of social capital, and (c) how science teaching and learning are mediated as a result of inscribing students – from both emic and etic perspectives. Results point to the value of developing both a reflective and reflexive practice, as both were used as springboards to gain new insights into, and develop sensitivity towards, how to effectively address structures that are often overlooked in secondary urban science classrooms.

Teachers' Integration of Science and Language Instruction in Multilingual Classrooms: Implications for In-service Education

Christina Siry, University of Luxembourg, chrissiry@gmail.com

Joëlle Vlassis, The University of Luxembourg

ABSTRACT: In this study, we explore the multiple outcomes of in-service teachers' participation in the implementation of a reform-based curriculum in science education in a multilingual European country. Our in-service teacher education program targets teachers at the 4th through 6th grade level, with a two-fold focus. On the one hand, we focus on the dissemination and implementation of inquiry-based science education. On the other hand, given our national multilingual context, we also focus on the relationship between language and science. It is this second part that is the focus of this presentation, as we elaborate on our research to examine teachers' practices regarding the integration of language and science instruction in multilingual classrooms.

Strand 8: In-service Science Teacher Education

Developing the Pedagogical Knowledge and Practice of Science Teachers

1:00pm – 2:30pm, Room 106

Presider: Andrew W. Shouse, University of Washington

Professional Development of Secondary Biology Teachers held in an Overseas Country

Do-Yong Park, Illinois State University College of Education Normal, IL 61790-5330, dpark@ilstu.edu

Jae Young Han, Chungbuk National University, Chungbuk, The Republic of Korea

ABSTRACT: This session is to report an analysis of design-based professional development of secondary Korean biology science teachers held at a Midwestern University in the U.S. The short-term intensive professional program was offered for one month each year from 2007 to 2009. A total of 68 secondary inservice biology teachers have participated in this study. Data were collected with an open-ended questionnaire followed by a focus group interview and were analyzed with the constant comparative method (Glaser & Strauss, 1967) to find a theme among responses. Trustworthiness of data was obtained through by conducting member checks (Maxwell, 1996). Results are mixed with advantages and barriers that require a careful design so as to meet the needs of participants. This study will contribute to the rationale and methods of professional development of teachers that

Sunday, March 25, 2012

designed to exchange teachers' knowledge and pedagogies on the subject to teach among the countries. Detailed results and implications will be discussed in the session.

An Ethnographic Case Study on Teacher's Involvement in Developing Models of Informal Formative Assessments (IFA) and Understanding the Challenges to Effective Implementations

Asli Sezen, Towson University, asezen@towson.edu

Gregory J. Kelly, Penn State University

ABSTRACT: This study focuses on teachers' use of "Informal Formative Assessments (IFA)" aimed at improving students' learning and teachers' frequent recognition of students' learning process. The study was designed as an ethnographic case study of four middle school teachers and their students at a local charter school. The data of the study collected through the history of teaching questionnaire, video records of the teachers' IFA practices and ethnographic interviews with teachers, and field notes. The analytical tools from sociolinguistics (e.g., transcripts and event maps) were prepared and discourse analysis based in an ethnographic perspective was used to analyze the data. The findings from the analysis of the classroom discourse showed that teachers use three different types of IFA cycles: connected, non-connected, and repeating. The reflection on video-cases of teachers' own practices led to changes in teachers' perspectives and practices of IFA. Teachers also reflected on the challenges for effective implementations of IFA and they emphasized challenges due to the division of labor among the classroom participants and the open nature of scientific knowledge. Through participation in the study, the teachers helped develop an IFA model for middle school science classrooms designed to understand the complex nature of teacher-student interaction.

Utilizing Scientific Habits of Mind as a Framework for Professional Development for Inservice Elementary Teachers

Kim D. Abegglen, Hockinson Middle School, kin.abegglen@hock.k12.wa.us

Amanda M. Gunning, Teachers College

ABSTRACT: This qualitative research study uses various data sources to examine the effect of a professional development for inservice elementary teachers that focused on utilizing scientific habits of mind to approach and teach STEM concepts and skills. One veteran teacher in particular was focused on for this case, set in the context of the other teacher participants. The way this teacher taught science lessons changed as a result of her participation in the professional development and she began to think differently about teaching science and STEM. The participants, in general, found both facility with and interest in using scientific habits of mind, which was evidenced through their personal communications with researchers and researcher observations. Using scientific habits of mind to provide a framework for inservice elementary teachers to both learn science themselves and teach science was found to be a valuable and novel approach that also would be a worthwhile subject for additional research.

Taking on the Challenge of STEM: The Journey of Three Middle School Science Teachers

Tara B. O'Neil, University of Hawaii, toneill@hawaii.edu

Lisa Nishizuka, Waimea Canyon Middle School

Susan Togioka, Waimea Canyon Middle School

Justin Yamagata, Waimea Canyon Middle School

ABSTRACT: This paper presents a case study of three middle school science teachers from a rural school who participated in a two-year professional development (PD) project aimed at supporting science and math teachers in building an understanding of and ability to teach using STEM pedagogy. STEM pedagogy is defined as teaching integrating science, technology, engineering, and mathematics (STEM) via project-based, real world, problem solving curriculum the enables students to use placed-based learning to address issues that effect their families, their community and their world (Flores et al., 2002; Gutstein 2003 & Sanders, 2009). The purpose of the paper is to 1) uncover the challenges these teachers faced in shifting their teaching practice from traditional science instruction to STEM pedagogy; and 2) to examine the components of teacher PD required to support sustained instructional change. Findings are presented in two parts. First, we share the challenges the three case study teachers experienced as they shifted from traditional science teaching practices to employing STEM pedagogy.

Sunday, March 25, 2012

Second, we examine the components of PD that supported sustained instructional change in the classrooms of the three case study teachers.

Strand 9: Reflective Practice

Reflective Practice in Professional Development and Teacher Education

1:00pm – 2:30pm, Room 301

Presider: Tom J. McConnell, Ball State University

Teacher Professional Development Delivery and its Impact on Higher Education Faculty and their Institutions

Dominike Merle-Johnson, University of Missouri - Columbia, dmk99@mizzou.edu

Ya-Wen Cheng, University of Missouri

Rose M. Marra, University of Missouri

Anna M. Waldron, University of Missouri

ABSTRACT: Numerous research studies have reported the impact professional development (PD) has on the participants, the students of those participants and in their schools, but there is a lack of focus on the impact PD has on faculty developers and their institutions. The purpose of this study is to identify the impact teacher PD projects had on the higher education faculty who created and/or delivered those PD projects, as well as the impact on their institutions. Five years of data collected from thirteen faculty members at six higher education institutions were analyzed for this study. Results indicate that the impacts included: creation and/or changes to existing courses for college students, changes in teaching practices as a result of collaboration with education faculty members, helping other faculty not involved in the PD delivery to learn best teaching practices, implementing activities that promote learning, and establishing strong partnerships with K-12 schools. Faculty, higher education institutions, pre-service and in-service teachers, as well as undergraduate students benefited from these impacts. PD projects can contribute to improved teaching practices, changed beliefs about how people learn, as well as contribute to understanding the bridge between K-12 and higher education settings.

The Nature of Elementary Science Teachers Reflections When Working with English Language Learners

Cynthia C. Deaton, Clemson University, cdeaton@clemson.edu

ABSTRACT: This qualitative study examined the focus of elementary teachers explanations on their science teaching practice. The six participants in this study developed explanations of their science teaching with English Language Learners as they engaged in reflective practice. Open coding was used to analyze the data and cross-case comparison was used to identify similarities and differences among the participants' cases. Explanations developed by participants focused on themes, such as navigating the school world, managing the technical classroom, negotiating barriers, nurturing all students, and understanding learning. An examination of participants' reflections indicated that participants' knowledge of their students' culture and background influenced their teaching practice. Findings illustrate that teachers need to reflect on their science teaching practice to develop an understanding of their teaching practice, learning environment and how they influence student learning.

Working Collaboratively with Teacher-researchers to Investigate What Young Children Know and Can Do in Science

Mary E. Hobbs, University of Texas at Austin, maryhobbs@mail.utexas.edu

Robert A. Williams, University of Texas at Austin

James P. Barufaldi, University of Texas at Austin

ABSTRACT: Researchers will describe the methodology and preliminary results from a four-year NSF funded study that integrates research and applied education to look inside prekindergarten classrooms, assess young learners' knowledge and skills, and test strategies for teaching core science concepts. The overall research program includes extensive classroom observation by teachers and researchers of children's ability to learn science processes and content; intensive professional development and mentoring support for teachers to learn science; and multiple qualitative, as well as quantitative, assessment strategies. Currently in its fourth and final year, and the third year of data collection, the project involves 48 pre-kindergarten teachers from multiple backgrounds and in a variety of

Sunday, March 25, 2012

settings, with an emphasis on including classrooms where students are culturally and economically diverse. Twenty-four of these teachers are actively involved as teacher-researchers. The mixed methods research includes data collection via case studies and technology-based assessment techniques, probing for answers to the question—What do four year olds know, and what can they do in science? Researchers intend that information, models and other outcomes of the project will generate additional research and provide a basis for future curriculum and professional development delivery planning, assessment, and revisions of standards (guidelines) for prekindergarten science.

Assessing the Reflective Practice of Prospective Teachers Through Written Reflections

Geraldine L. Cochran, Florida International University, gcoch001@fiu.edu

Eric Brewe, Florida International University

Laird H. Kramer, Florida International University

David Brookes, Florida International University

ABSTRACT: At our university we have been engaged in efforts to assess the reflective practice of our Learning Assistants (LAs) who are prospective teachers. This is a part of a broader goal to help prospective teachers to develop as reflective practitioners. As a part of the LA experience, LAs participate in a variety of teaching experiences. In a weekly seminar course on science education and theory LAs were asked to submit written reflections on their teaching experiences each week. We examined their reflections in weeks, 3, 6, 9, and 12 for evidence of 1) reflection, 2) changing levels of reflection across the weeks, and 3) reflective teaching practice. Results showed that LAs are engaging in reflection at all levels, even critical reflection. We also observed evidence of reflective teaching practice in their written assignments. However, we were not able to detect a difference in level of reflection over the course of the semester. We conclude that our efforts in the seminar course are promoting meaningful reflection in our prospective teachers and that we may need to be more systematic in our instructions on reflective writing assignments to help our students engage in and write about higher levels of reflection.

Strand 10: Curriculum, Evaluation, and Assessment

Related Paper Set - Using Curriculum to Change How Teachers Teach Science and Students Learn Science

1:00pm – 2:30pm, Room 308

ABSTRACT: We were funded through an IES Goal 2 Development and Innovation grant to develop and study the feasibility and usability of a year-long, multidisciplinary science program for middle school students and teachers. To develop a research-based curriculum, we relied on a process that is iterative, multifaceted, and carefully integrates development with research findings. Our goal was to develop materials using the 5E Instructional Model that were coherent, rigorous, and focused and that fully integrated metacognitive strategies, literacy strategies, collaborative learning, comprehensive and embedded assessments, and curriculum-specific professional development resources for teachers. All of the materials were evaluated by external experts for each of the key features of the materials we tested. In addition to testing the usability and feasibility of the materials, we collected data on student learning, student attitudes, and teacher practice. We held two nationwide field tests in a range of settings, each of which informed revisions to the materials. We found that use of the curricula is consistent with and associated with reform-based teaching practices. Furthermore, use of the curricula is associated with student progress in attaining the four key science proficiencies as described by the National Research Council (2007).

Developing Research-Based Science Curricula: An Iterative Research and Design Process

Pamela Van Scotter, BSCS, pvan Scotter@bscs.org

Janet Carlson, BSCS

Susan M. Kowalski, BSCS

Paul M. Beardsley, BSCS

Brooke N. Bourdelat-Parks, BSCS

Stephen R. Getty, BSCS

Sunday, March 25, 2012

Betty Stennett, BSCS

Key Features of Research-Based Science Curricula: Theory and Application

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Using Research-Based Curricula to Change how Teachers Teach Science

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Using Research-Based Curricula to Change how Students Learn Science

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Strand 11: Cultural, Social, and Gender Issues

Girls Aspirations in Science: Bridging the Gap between Students and Science

1:00pm – 2:30pm, Room 107

Presider: Maria S. Rivera Maulucci, Barnard College

Girls' Gateways to Science and Mathematics Education in Cameroon

Anne E. Emerson, University of California at Santa Barbara, aemerson@education.ucsb.edu

Danielle Boyd Harlow, University of California at Santa Barbara

ABSTRACT: Mathematics is a gateway for learning science and thus limits the number of students choosing science as a discipline of study. In Cameroon, this limitation is exacerbated by the introduction of algebra and early math and science tracking in secondary school. Observations in Cameroon show that, in primary school, boys and girls are equally interested in math and science and participate in class at similar levels; however, there are significant gender differences in math performance and attitudes after algebra is introduced. Interviews and surveys with girls in these classes suggest that most difficulties in math have to do with learning abstract concepts. This research indicates that algebra may be a significant gatekeeper for pursuing math and science in Cameroon. For this reason, I use textual analysis supported by ethnographic fieldnotes to examine the intended and observed structure of algebra classes. This research provides insight into how a textbook informs instruction in an effort to better understand its role in supporting or constraining access to the fields of math and science.

Sunday, March 25, 2012

The Importance of Individual Interpretations of Cultural Understandings of Gender by Female Undergraduate Science Majors in Explaining Trends of Underrepresentation

Rachel E. Wilson, Appalachian State University, wilsonre3@appstate.edu

Julie M. Kittleson, University of Georgia

ABSTRACT: In exploring the persistence of historically underrepresented students in their science-related career aspirations, we focused on how female science majors made meaning of their experiences at a research university. Using cultural production theory as a framework, we sought to understand the influence of cultural understandings of gender on the experiences of ten upwardly mobile females by focusing on their narratives of their experiences in in-depth interviews. Participants' interviews were analyzed to identify the cultural understandings they used in narrating and thus explaining their experiences. Some participants found their gender salient because of explicit past positioning events where cultural understandings of these factors were used to evaluate them. A possible explanation for why some students did not find these factors salient is the presence of a gender-neutral discourse at the university that masked the influence of this factor in participants' interactions. This study supports the need to look beyond trends in participation of underrepresented groups in science and stresses the importance of individual narratives of experience to explore explanations for why underrepresentation may continue to be an issue (i.e. cultural understandings of gender and/or race/ethnicity).

"It's about Relationships": Girls Imaginings of Science and Self in an Afterschool Program

Allison J. Gonsalves, Universite de Montreal, allison.gonsalves@umontreal.ca

Alice Carvalho, Universite de Montreal

Jrene Rahm, Universite de Montreal

ABSTRACT: This paper draws upon a study of a girls-group in an after-school program directed towards building girls' self-esteem, exploring issues related to adolescence, and supporting girls in their academic and personal struggles. Building upon their interest in both science and digital technologies, we together pursued the creation of a digital story (as an exploration of self-in-the-world) and a video documentary on science. In this paper, we report on the girls' positioning work in and around science, in the context of their work on individual collages about "what science means to me", an activity that preceded the video documentary work. We explore the manner in which identity work was mediated and afforded through that activity and the figured worlds of the girls' group.

Factors Influencing Female Students' Participation in a Pre-engineering and Engineering Program

Mary Kasarda, Associate Professor in Mechanical Engineering, bbrand@vt.edu

ABSTRACT: Two alternative programs designed to enhance students' efficacy in engineering were the focus of this study. The two programs are: a multiyear high school pre-engineering course and an all-women undergraduate engineering program. The design of both programs acknowledge the significance of students' beliefs about their abilities to learning, particularly for disciplines like engineering which is associated with high levels of anxiety. Programmatic factors influencing the successful retention of female students were investigated using the four sources of self-efficacy identified by Albert Bandura (1994). Findings are presented in this report. The participants for this study included males and females from the high school, and females from the university. Analysis of data indicated that students from all groups, male and female were motivated by achieving mastery of the technical applications. However, the female students placed considerably higher emphasis on the environmental structures that facilitated their mastery. They articulated the value of the collaborative and supportive atmosphere more than the male students. This data is significant in that the students' discussions of factors influencing their learning were a reflection of their needs as students. The researchers believe these findings to be significant to improving the attrition rates of female students in engineering disciplines.

Sunday, March 25, 2012

Strand 12: Educational Technology

Strand Sponsored Session - Serious Educational Games: Research Experiences from National Science Foundation Funded Projects

1:00pm – 2:30pm, Room 101

Presider: James Minogue, North Carolina State University

Presenters:

Leonard A. Annetta, George Mason University, lannetta@gmu.edu

Douglas B. Clark, Vanderbilt University

Diane J. Ketelhut, University of Maryland

Troy D. Sadler, University of Missouri

James Minogue, North Carolina State University

ABSTRACT: This symposium is comprised of National Science Foundation funded Principal Investigators whose projects revolve around game-based learning projects in science. Research from these projects will be presented from varying periods of assessment within the respective grant projects. Research findings that will be presented include, science interest, science and technology efficacy, mental rotation and scientific visualization abilities, curriculum design, teacher professional, contextualized, and authentic assessment of middle school children's understanding of both science content and process. Further, these projects focus on science topics ranging from fundamental biological principles and biotechnology, renewable/reusable energy, and Newtonian mechanics.

Strand 13: History, Philosophy, and Sociology of Science

Teacher Education in HOS, POS & SOS

1:00pm – 2:30pm, Room 102

Presider: Catherine E. Milne, New York University

Experiencing Research for Teaching Science [ExpeRTS]: Tracking Changes in Future Secondary Science Teachers' Conceptions of Nature of Science, Scientific Inquiry, and Inquiry Science Teaching

Renee S. Schwartz, Western Michigan University, r.schwartz@wmich.edu

Cathy K. Northcutt, Western Michigan University

Susan Stapleton, Western Michigan University

ABSTRACT: "Experiencing Research for Teaching Science" [ExpeRTS] is based on research-recommended "best practices" of extended science research internships and teacher professional development to enhance future science teachers' knowledge about nature of science [NOS], nature of scientific inquiry [NOSI], and inquiry teaching abilities. ExpeRTS targets secondary education majors in biology, physics, chemistry, and geosciences. The program involves (a) a full-immersion 10-week research internship; (b) guidance for NOS, NOSI, and inquiry teaching through seminars, group sessions, and reflective writings; and (c) a course and science teaching practicum. This paper reports impacts from the research internship portion. Pre/post data demonstrate the 13 Fellows were fully immersed in their research experience, taking ownership and pride in their projects. We identify positive shifts in views of NOS, NOSI, and inquiry teaching; including greater recognition of creativity, multiple science methods, and the role of peer review. Observing experienced middle school teachers during a science camp impacted Fellows' views of teaching from teacher-centered to more student-centered. The following academic year includes a course to facilitate the translation of science research into science teaching, and a teaching practicum. This paper introduces the ExpeRTS model and results from the science research internship portion for the first cohort of undergraduates.

The Interaction of Knowledge and Pedagogical Decisions in Teaching Nature of Science

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

Stephen A. Bartos, Illinois Institute of Technology

Daniel Z. Meyer, Illinois Institute of Technology

Norman G. Lederman, Illinois Institute of Technology

Sunday, March 25, 2012

Allison Antink Meyer, Illinois Institute of Technology

ABSTRACT: Past research on Nature of Science (NOS) has focused on assessing views of NOS, pedagogical approaches to improving conceptions of NOS, and how teachers' views of NOS influence their classroom practice. What has not been examined is whether the act of teaching impacts preservice teachers' views of NOS and how these views might manifest themselves in these teachers' classroom practices over the course of their professional internship. Preservice teachers' views of NOS were assessed on three occasions using the VNOS-D+ (Lederman & Lederman, 2009): prior to, at the midpoint of, and at the end of their professional internship. The frequency and nature of inclusion of NOS in classroom practice was determined through an examination of explicit references to NOS in multiple data sources. Results provide evidence that while teachers' views of NOS are stable, they struggle to find opportunities to include NOS in their practice and tend to only include aspects for which they are most informed. Results for teachers from different science content areas provide further insight into the challenges of including NOS in classroom practice.

Developing Preservice Teachers' NOS Conceptions and Commitment to NOS Instruction Using a Process Skill-based Approach

Bridget K. Mulvey, University of Virginia, bkm2x@virginia.edu

Jennifer Maeng, University Of Virginia

Randy L. Bell, University of Virginia

ABSTRACT: We explored the effectiveness of nature of science (NOS) instruction embedded within the context of teaching science process skills on the development of secondary preservice science teachers' NOS conceptions.

Participants were five cohorts of preservice science teachers (n=52) enrolled in a two-year Master of Teaching program at large Mid-Atlantic University. During the two-semester secondary science methods course, participants were explicitly taught appropriate NOS conceptions through activities incorporating the process skills-based approach to NOS instruction. Process skills (i.e. observation, inference) provided the instructional context. Through discussion, these activities were explicitly connected to the relevant NOS tenets. All participants completed the modified VNOS-B questionnaire pre- and post-instruction and were interviewed regarding their responses. Data were analyzed using Miles and Huberman's (1994) systematic data analysis process, classifying participants' pre- and post-instruction views as alternative, transitional, or informed. Results indicated that most participants held alternative views of the majority of the NOS tenets prior to instruction. Post-instruction, participants' responses shifted substantially toward more informed NOS views, with substantial gains in informed views for each assessed tenet. The process skills-based approach can be effective in: (1) eliciting desired changes in NOS understandings, and (2) enhancing teachers' preparedness/willingness to teach the NOS.

Strand 14: Environmental Education

Related Paper Set - Young People and the Environment: International Perspectives on the Effect of Environmental Education Initiatives

1:00pm – 2:30pm, Room 103

Presider: Peter Van Petegem, University of Antwerp – IOIW

ABSTRACT: All around the globe, environmental education initiatives (EEI) intend to change the way young people perceive, appraise, feel about, and interact with the natural world. Investigating the effectiveness of the wide variety of initiatives is not simple. The paper set brings together four methodologically diverse studies from different parts of the world, each focused on a specific EEI for young people (ages ranging from 10 to 18). The first study assessed the efficacy of eco-schools through a school effectiveness perspective: does a greening of primary schools result in more pro-environmental values, more knowledge about the environment and/or a greater affective connection with nature? Study two employed concept mapping as a method to unveil conceptions and potential conceptual changes after a workshop on global climate change, as well as quantifying the intervention's impact on the participants' environmental values. The third study addressed the role that education can fulfill in the development of adolescents' environmental views and identities through a mixed method design using questionnaires, interviews, and a case study. The final study applied a mixed methods design to focus on the

Sunday, March 25, 2012

importance of post-participation reflection among participants in an international immersion environmental education program.

Eco-school Effectiveness: Children's Environmental Values, Knowledge and Affections

Jelle Boeve-de Pauw, University of Antwerp, jelle.boevedepauw@ua.ac.be
 Peter Van Petegem, University of Antwerp - IOIW

Environmental Education on Global Climate Change: Concept Mapping and the 2-MEV

Daniela Sellmann, University of Bayreuth, daniela.sellmann@uni-bayreuth.de
 Franz X. Bogner, University of Bayreuth

Young Adolescents' Views on Environmental Attitudes, Behaviors, and Identity: Seeking Truth, Adventure and Harmony

Bruce Johnson, University of Arizona, brucej@email.arizona.edu
 Amanda Jaksha, University of Arizona
 Elsa Schaub, University of Arizona
 Constantinos C. Manoli, University of Cyprus

The Impact of Post-participation Reflection on Environmental Education Program Outcomes

Mat Duerden, Texas A & M University, duerden@tamu.edu
 Peter Witt, Texas A & M University

Strand 15: Policy

Accountability Impacts on Science Education Policies

1:00pm – 2:30pm, Room 104

President: Todd L. Hutner, The University of Texas at Austin

Pre-Service Science Teachers Beliefs about the Organizational Culture of Public Schools and Accountability

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

ABSTRACT: New teachers occupy a unique role in the reform of science education. They carry much of the responsibility for bringing inquiry based reform practices into the classroom. At the same time they are most likely to enter the teaching profession at a low performing school subject to increased pressure from state and federal accountability policies. Despite the best efforts of teacher educators, these new teachers often revert to traditional methods of teaching upon entering the classroom. This paper investigates one aspect of teacher beliefs that has not been explored and may provide insight into the lack of inquiry based pedagogy in the classroom: what preservice teachers understand about accountability policy and the appropriate pedagogy within such structures. Findings indicate that preservice teachers are largely unaware of the culture within the school they are likely to enter, assuming a strong culture of teacher autonomy not only in relation to other teachers, but to school and district level administrators as well. They are also unaware of both the type of science content tested on high stakes tests and the school response to historically low test scores. Implications for teacher education and teacher retention policy are included.

When Good Intentions and Reality Meet: Large-Scale Reform of Science Teaching in Urban Schools With Predominantly Hispanic ELL Students

Carla C. Johnson, University of Cincinnati, johnsc2@ucmail.uc.edu
 Virginia Bolshakova, Utah State University

Sunday, March 25, 2012

Tammy Miller, University of Cincinnati

ABSTRACT: This study reports the on the experiences of scaling up a science teacher professional development and school reform project in the southwest United States within a large, low-performing, urban district with predominantly Hispanic ELL populations. The systemic reform diagnostic framework (Blumenfeld, Fishman, Krajcik, & Marx, 2000) was the conceptual framework used in this study to determine progress in building capability, culture, policy and management for implementing and sustaining large scale reform. Findings revealed the Transformative Professional Development Model (Author & other, 2009; Author, 2011) supported building of capability and culture for reform despite conflicting accountability policy and district priorities that impeded full implementation. Implications for future research and scaling up reform projects in science education will be shared.

The Initial Impact of No Child Left Behind With a Focus on Time for Elementary Science and Equity in Science, Math, and Reading

George W. Griffith, Trego County Unified School District #208 WaKeeney, KS, scitcher@hotmail.com
 Lawrence C. Scharmann, Florida State University

ABSTRACT: This research examines the impact of the “No Child Left Behind” (NCLB) Act on elementary science education in five Midwestern states. Elementary teachers (n=928 total for all states) responded to an online survey, which included both closed-ended and open-ended questions pertaining to the time spent on science instruction and any changes made in science instruction since the implementation of NCLB. More than half of these teachers indicated they have cut time from science instruction since NCLB became law. Follow-up questions with regard to why changes were made in science instruction were also included in the survey. This research also examines results from the National Assessment of Educational Progress (NAEP) for each of these states to determine if the changes made in response to NCLB helped meet the goal of closing the achievement gap between the disaggregated subgroups of gender, race, and socioeconomic status (SES). The data from the NAEP shows only a few statistically significant changes occurred; however, and unfortunately, some results indicated an exacerbation in the achievement gap for critical subgroups.

When Science is High Stakes: Variations among the States and the Effects on Reading and Math

Eugene Judson, Arizona State University, Eugene.Judson@asu.edu

ABSTRACT: Although only results from math and reading assessments are required to be used when Adequate Yearly Progress (AYP) of schools is calculated, some states have elected to include science achievement results either in their AYP calculations or as part of a separate dual accountability system. This study examined 2009 National Assessment for Educational Progress (NAEP) results based on how states use, or do not use, science in their accountability programs. Consideration was given to the idea that including science achievement might detract from efforts, and consequently results, in math and reading. Results from both fourth- and eighth-grade data indicated that states choosing to use science in their accountability calculations did not lose ground in math or in reading. Fourth-grade data indicates that the states using science in their accountability programs additionally had significantly higher science achievement than the other states.

Sunday, March 25, 2012

Awards Committee Sponsored Session

Symposium - Distinguished Contributions in Research

2:45pm – 4:00pm, Room 313

Presenters:

Xiufeng Liu, State University of New York at Buffalo, xliu5@buffalo.edu

Norman G. Lederman, Illinois Institute of Technology

ABSTRACT: In this symposium, Norman G. Lederman, the winner of the 2011 Distinguished Contribution to Science Education through Research Award (DCA) will reflect on his own research work in the context of what is happening in science education research internationally. In addition he will offer his thoughts on what the future might and should hold for science education research. This is an opportunity to hear from a greatly respected international leader in the field of science education and also to pay respect to his 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

Related Paper Set - Supporting Argumentation, Explanation, and Modeling Practices in Elementary and Middle School Classrooms

2:45pm – 4:00pm, Room 310

President: Brian J. Reiser, Learning Sciences, Northwestern University

Discussant: Cynthia Passmore, University of California-Davis

ABSTRACT: In science learning, scientific practices are a vehicle to develop and use scientific knowledge, and a context in which to understand how the discipline of science builds knowledge. Yet scientific practices have been conceptualized for classrooms in a variety of different ways, including constructing explanations, argumentation, and scientific modeling. These approaches overlap in central aspects, in that they all center on the community construction and negotiation of explanatory scientific ideas, but they take different slices through the aspects of this complex practice. In this paper set, we will argue that while each of these analytical and instructional approaches foreground different aspects, there are underlying core elements of practice that pervade knowledge-building practices in science: constructing explanatory ideas (explanations and models), representation, and the process of critique, negotiation, and consensus. We will explore how these aspects of practice interrelate, and we will examine empirical evidence from design efforts to support these practices in elementary and middle school classrooms. We investigate (1) what aspects of scientific practice are feasible and meaningful for K-8 learners; (2) how the elements of argumentation, explanation, and modeling interrelate; and (3) what successes and challenges students and teachers experience as they attempt to engage in scientific practices.

A Framework for Supporting and Assessing Scientific Practices

Brian J. Reiser, Learning Sciences, Northwestern University, reiser@northwestern.edu

Abraham Lo, Learning Sciences, Northwestern University

Cynthia Passmore, University of California-Davis

Students' Construction of Mechanistic Models Using Argumentation and Representation

Lisa Kenyon, Wright State University, lisa.kenyon@wright.edu

Amber Todd, Wright State University

Sunday, March 25, 2012

Middle School Students Arguing About the Construction and Application of Models

Kathleen Cruet-Villavicencio, The University of Texas, Austin, kathleen.cruet@gmail.com

Leema Berland, University of Texas, Austin

Fostering Elementary Students' Productive Engagement in Scientific Modeling

Hamin Baek, Michigan State University, haminbaek@gmail.com

Christina V. Schwarz, Michigan State University

Li Zhan, Michigan State University

Mete Akcaoglu

How Do Different Classrooms Interpret Scientific Practices?

Monica Ko, Learning Sciences, Northwestern University, monlinko2008@u.northwestern.edu

Strand 2: Science Learning: Contexts, Characteristics and Interactions

Related Paper Set - Connecting Expansive Framing to Transfer in a High School Biology Classroom

2:45pm – 4:00pm, Room 302

Discussants:

Maria Varelas, University of Illinois at Chicago

N. Sanjay Rebello, Kansas State University

ABSTRACT: Research shows that students do not commonly apply what they have learned about science to their other classes, let alone their everyday lives. This issue is classically referred to as failure to “transfer” learning. Recently, researchers have identified a new instructional mechanism for fostering transfer called expansive framing. Expansive framing is when a teacher presents lessons as relevant to multiple, interrelated contexts in order to involve students as active participants in larger intellectual conversations that extend across time, places, and people. Prior one-on-one tutoring research has shown that expansive framing is associated with higher rates of transfer. The purpose of this study is to see if expansive framing is related to transfer in a science classroom. We present a case of a high school biology classroom in which the teacher expansively framed his instruction and students successfully transferred knowledge across curricular units. We illustrate the kinds of instructional moves and other methods the teacher used to achieve this framing, and present both survey data about students’ recognition of and responsiveness to expansive framing, and assessment data indicating transfer. We further share how student perceptions of framing are related to transfer through both quantitative and qualitative analyses.

Expansive Framing in a Biology Classroom: What Does it Look Like?

Sarah L. Perez, University of California, Berkeley, salperez128@hotmail.com

Danny X. Tan, University of California, Berkeley

Hernan J. Rosas, University of California, Berkeley

Student Recognition of and Responses to Expansive Framing in a Biology Classroom

Xenia S. Meyer, University of California, Berkeley, xenia.meyer@berkeley.edu

Kathleen Zheng, University of California, Berkeley

Sunday, March 25, 2012

Evidence of Transfer in an Expansively Framed Biology Classroom

Diane P. Lam, University of California, Berkeley, danielam@berkeley.edu
Lloyd Goldwasser, University of California, Berkeley
Erica Naves, University of California, Berkeley

Student Perceptions and Uptake of Expansive Framing to Transfer: Qualitative and Quantitative Analyses

Randi A. Engle, UC-Berkeley, RAEngle@berkeley.edu
Maria Varelas, University of Illinois at Chicago
N. Sanjay Rebello, Kansas State University

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

The Nature of Science in Elementary School Classrooms

2:45pm – 4:00pm, Room 301

President: Lloyd H. Barrow, University of Missouri

How do Elementary School Science Textbooks Present the Nature of Science?

Marianne Phillips, Texas A&M University, San Antonio, marianne.phillips@tamusa.tamus.edu
Julie Vowell, Texas Wesleyan University
Young H. Lee, University of Houston
Brian Plankis, Indiana University

ABSTRACT: One of the important objectives in science education is for students to understand what the nature of science is. The National reform document, Science for All Americans (AAAS, 1990) emphasizes the importance of the nature of science in guiding science educators in accurately portraying science to students. Therefore, it is important that textbook materials convey an accurate conception of the nature of science. This study employs a content analysis to examine the chapters from first-grade, second-grade, third-grade, fourth-grade, and fifth-grade elementary school science textbooks with regard to the four aspects of the nature of science: (a) science as a body of knowledge, (b) science as a way of investigating, (c) science as a way of thinking, and (d) the interaction of science, technology, and society (Chiappetta, Fillman, & Sethna, 2004). Intercoder reliability was determined by calculating Cohen's kappa (Cohen, 1960). Kappa values were determined among three coders who independently analyzed the science content from the chapters of the elementary science textbooks. The percentages of the nature of science categories found in each of the elementary science textbooks are examined and reported for each of 20 textbooks.

Using History of Science to Teach the Nature of Science to Elementary School Students

Khadija Fouad, Indiana University, kfouad@indiana.edu
Heidi L. Wiebke, Indiana University
Valarie L. Akerson, Indiana University

ABSTRACT: Second, third, and fourth grade students were randomly assigned to two groups to compare how well they would learn aspects of the nature of science (NOS) using explicit NOS instruction with inquiry-based lessons or explicit NOS instruction in the context of lessons designed around problems based on the history of science. Both groups improved their understanding of NOS during the treatment, demonstrating that both contexts work as vehicles to embed explicit NOS instruction for elementary students. As the study population was diverse, including low SES students, students who are

Sunday, March 25, 2012

learning in a second language, and students from a variety of ethnic backgrounds, this study demonstrates that understanding of NOS is accessible to diverse student populations.

The Portrayal of the Nature of Science in Early Childhood Physical Science Instructional Materials

Brandon Schrauth, Johnston Community School District, brandon.schrauth@johnston.k12.ia.us

Joanne K. Olson, Iowa State University

ABSTRACT: Despite persistent calls for students to learn accurate concepts about the nature of science, little is known about instructional materials and how NOS is portrayed for K-6 students. This is of particular importance given teachers' misconceptions about NOS, and elementary teachers' frequent dependence on published materials to provide content knowledge and pedagogical knowledge for elementary science (Chiappetta, Ganesh, Lee, & Phillips, 2006; Bayer, 1995). This study examined eight physical science units from three kit-based programs and one textbook program for K-2 students. The study sought to determine what NOS concepts were represented, and the extent to which these concepts were accurate and explicit. Findings indicate that NOS is largely accurately portrayed (with the exception of "no single scientific method"), but is portrayed implicitly. Thus, students are encouraged to "do" inquiry-based science activities, but whether they connect this accurately to the work of scientists is left entirely to chance. This study has important implications for curriculum in early childhood education, and efforts in teacher preparation and professional development.

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

Teaching Core Concepts in Science

2:45pm – 4:00pm, Room 303

Presenter: Patricia Friedrichsen, University of Missouri-Columbia

Examining the Challenges and Successes of an Accelerated Science and Math Program for High Potential Urban Middle School Students

Toni A. Sondergeld, Bowling Green State University, tonis519@aol.com

Andrea R. Milner, Adrian College

Laurence J. Coleman, University of Toledo

ABSTRACT: As a result of a five year federal Javits Gifted and Talented Students Education Program grant award, the project Accelerating Achievement in Mathematics and Science in Urban Schools (AAMSUS) was developed and implemented. AAMSUS had the goal of raising achievement in mathematics and science using acceleration as the primary intervention and changing the attitudes and interests of economically disadvantaged, limited English proficient or disabled learners who have the potential for more advanced achievement in those content areas. The purpose of this paper is to examine the challenges and successes associated with this five year program where social and economic conditions changed and effected the implementation of the program and longitudinal research design. Specific challenges that proved problematic for program implementation will be addressed: 1) logistical issues; 2) challenges with teachers; and 3) student/familial problems. Program successes discussed will include mathematics and science achievement and attitudinal impact assessed over the program's duration. Finally, practical implications and suggestions for designing and implementing future non-required mathematics and science weekend or summer programs with urban adolescents are provided.

Sunday, March 25, 2012

Adolescent Peer-led Teaching: Improving Academic Performance and Retention

Rona M. Robinson-Hill, University of Missouri - St. Louis Rona.Robinson-Hill@slps.org

ABSTRACT: Middle school is an ideal academic level to promote and implement peer learning. Peer learning involves activities in which students work together to successfully complete assignments and increase their knowledge base. The theoretical framework is interdependence theory through cooperative learning. Adolescent peer-led teaching actively engages adolescents in the learning process by allowing them to interact and question peers that have mastered current content. The purpose of this mixed method study is to determine if adolescent peer-led groups will improve the academic performance and achievement in science of under-achieving adolescents. Under-achieving students work with classmates who have earned 85 % or higher on a content mastery assessment. Findings suggest that 1) peer-leaders display ownership and interest in the success of the students with whom they work; and 2) under-achieving students frequently discover simple errors in their study practices, that once identified can easily be remedied for future success. In depth results of this mixed method pilot study will be presented along with practical applications.

A Novel Laboratory Method for Teaching K-12 Evolution

Brad Hughes, UCI, bhughes@uci.edu

ABSTRACT: Rigorous teaching of evolution in K-12 classrooms has often been compromised by controversies that frequently accompany argument-based methods of evolution instruction. A novel revolutionary new hands on K-12 laboratory method for teaching evolution, developed by the author, utilizing techniques of modern microbial experimental evolution, is described here, along with significant resultant effectiveness data on teacher training and classroom student learning experiences with this method. Microbes used in experimental evolutionary studies are ideal for K-12 laboratory use, readily providing evolutionary fitness data so that description of adaptation need not be qualitative speculation, but rather hands-on quantitatively measurable laboratory experiences. Various supplementary curricular media are also discussed as study variables to aide in for comparisons to traditional instructional methods.

Relevant and Popular Lessons and Scientific Literacy: Application of Modules from the European Project PARSEL

Georgios Tsaparlis, University of Ioannina, Department of Chemistry, Greece, gtseper@cc.uoi.gr
 Euphrosyni Nakou, Secondary State Education, Greece

ABSTRACT: We present the results of the application to conditions of real school classroom of four modules from the European project PARSEL (Popularity And Relevance of Science Education for scientific Literacy). The applications were carried out in an upper secondary school in the south of the Greek island of Corfu, with a sample of 38 students. The modules were: (1) Growing plants: does the soil matter? (2) Milk: keep refrigerated; (3) Popcorn, a fat free snack; (4) Should vegetable oil be used as fuel? (Biodiesel). The evaluation of the applications was carried out by collecting students' opinions, who answered a 20-item semantic differential-scale questionnaire. Statistical analysis shows that in all cases there was an overwhelming superiority of PARSEL, demonstrating its capacity to fulfill its aims, being superior to traditional instructional methods, and disposing students favorably with respect to the cognitive and the affective domains, its usability, and the instructional methodology.

Sunday, March 25, 2012

The Impact of a Professional Development Workshop on Rural STEM Teachers' Self-Efficacy and Biofuels Knowledge

Kasey P.S. Goodpaster, Purdue University, scott66@purdue.edu

Omolola A. Adedokun, Purdue University

Lisa P. Kirkham, Purdue University

Peggy A. Ertmer, Purdue University

Kari L. Clase, Purdue University

Maureen McCann, Purdue University

Gabriela C. Weaver, Purdue University

ABSTRACT: The purpose of this mixed methods study was to evaluate the impact of a professional development workshop on pre- and in-service teachers' efficacy beliefs and biofuels content knowledge. As part of Purdue University's Research Goes to School program, 7 in-service teachers and 14 pre-service teachers participated in an intensive two-week workshop focused on advanced research in the global challenge area of biofuels. The workshop educated participants about using biofuels curricula to increase the relevance of STEM subjects for rural students. Participants completed pre- and post-science teaching self-efficacy and content knowledge measures, and also participated in a focus group at the completion of the workshop. Preliminary results indicated that the program enhanced participants' knowledge of biofuels concepts and their beliefs that student learning can be influenced by effective teaching. Furthermore, participants expressed that the workshop enhanced their understanding of the applications of biofuels concepts to STEM subjects and gave them a renewed sense of purpose for teaching. Future research directions and implications of the results for future professional development workshops will be discussed.

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

Constructivism in Science Learning

2:45pm – 4:00pm, Room 304

President: Yehudit Judy Dori, Technion-Israel Institute of Technology

Collaborative Group Testing: Communication and the Perceptions of Students in a Biotechnology Course for Non-Majors

Tina M. Roberts, University of Missouri-Columbia, robertsti@missouri.edu

Marcelle A. Siegel, University of Missouri-Columbia

Sharyn K. Freyermuth, University of Missouri-Columbia

ABSTRACT:

Data Interpretation along the Novice – Expert Continuum

Joseph A. Harsh, Indiana University School of Education, jharsh@indiana.edu

Adam V. Maltese, Indiana University

ABSTRACT: The goal of this mixed methods study was to examine how collaborative group testing relates to student scores and perceptions about communication in an introductory undergraduate biotechnology course. This study compared scores of 115 students on paired individual and group test questions of related concepts during three course exams. Student surveys were administered after Exams 1 and 2 to explore student ideas about communication within the testing groups. Findings showed statistically significant improvement on scores on the group scores of Exams 1, 2 and 3 ($p < .001$, $N = 115$) compared to individual scores. Student reported Likert ratings of group and personal

Sunday, March 25, 2012

participation (3.64/3.55 and 4.09/3.96 during Exams 1 and 2, respectively) in group discussions. Students expressed that group discussions were an advantage during testing. A majority of students (eighty-five percent) also reflected that group discussions enhanced their understandings and ability to answer questions on the group portion of the exams, while only a minority of students (forty percent) experienced the same benefits on the individual portion of the exam. Our findings suggest that collaborative group testing can be used as a novel, alternative assessment strategy in college classrooms by allowing students to work and communicate together effectively.

Is DNA Alive? A Longitudinal Study of Conceptual Change through Targeted Innovative Instruction

Stephen B. Witzig, University of Missouri, sbwitzig@mail.missouri.edu

Sharyn K. Freyermuth, University of Missouri

Marcelle A. Siegel, University of Missouri

Kemal Izci, University of Missouri

J. C. Pires, University of Missouri

ABSTRACT: Identifying students' conceptual scientific understanding is difficult if appropriate tools are not available for educators. The U.S. National Science Education Standards advocates that assessments should be reform-based and should align with instructional approaches. We are involved in an NSF-funded project to incorporate innovative assessments within a reform-based large-lecture biochemistry course for non-majors. We not only assessed misconceptions, but purposefully changed instruction throughout the semester to confront student ideas. Our research questions targeted student conceptions of DNA along with understanding in what ways classroom discussions/activities influence student conceptions. Research methods used included pre/post-assessments, semi-structured interviews, and analysis of student work on exams/assessments. We found that students hold misconceptions about the chemical nature of DNA, with 63% of students claiming that DNA is alive prior to instruction. This is an important fundamental concept in Science fields. We confronted this misconception throughout the semester collecting data from several instructional interventions. Case studies of individual students revealed how various instructional strategies/assessments allowed students to construct and demonstrate the scientifically accepted understanding of the chemical nature of DNA. However, the post-assessment exposed that 40% of students still held misconceptions about DNA, indicating the persistent nature of this misconception. Implications for teaching/learning will be discussed.

Constructivism in Context: The Effects of Class Size and Student Motivation on Student Learning and Satisfaction in Four Different Classrooms

Emily Borda, Western Washington University, bordae@wwu.edu

Mathew Lockett, Western Washington University

Siri Wuotila, Western Washington University

ABSTRACT: We have compared learning and student satisfaction outcomes for four courses taught by the same instructor. Three of these courses used similar versions of a constructivist chemistry curriculum. These comparisons have enabled us to assess the effectiveness of a constructivist curriculum versus a traditional lecture-style curriculum, as well as the role of class size and student goals in determining the outcomes of the curriculum. Our data suggest the constructivist curriculum was more effective than the traditional curriculum in all contexts, but that its effectiveness was mitigated by larger class size and varied student goals. We will present detailed learning gains and student evaluation data

Sunday, March 25, 2012

for each course and will lead a discussion about ways to support constructivist curricula in less than ideal classroom environments with a variety of students.

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

The Nature of Science

2:45pm – 4:00pm, Room 309

President: Dominike Merle-Johnson, University of Missouri - Columbia

Nature of Science Knowledge and Scientific Argumentation Skills in Taiwanese College Biology Students

MeiChun Lai, The Ohio State University, lai.146@osu.edu

Karen E. Irving, The Ohio State University

ABSTRACT: Although many believe that students with more mature understanding of NOS engage in argumentation more, mixed results were found in empirical studies. In argumentation studies, consensus assessment was lacking and most researchers only evaluated the structural aspects of argumentation. However in the science classroom, an assessment that examines the “content correctness” in addition to the “structural complexity” is necessary because scientific argumentation that is structurally complicated but full of misconceptions cannot be considered strong. Therefore, the goal of this study was first to develop a method to evaluate the quality of students’ scientific argumentation in both the content and structure aspects. The second goal was to examine to what extent NOS knowledge and argumentation skills correlate. Furthermore, through semi-structured interview, this study documented how students manifest their epistemic thinking in argumentation construction. Significant correlation between NOS and argumentation was found in the first year of the study (year 2010); no correlation was found in follow-up study (year 2011). The preliminary analysis of students’ NOS interview revealed that students with strong argumentation skills view science as an open entity that may be challenged and discussed. Additionally, students shed light on how Taiwanese scientific education system changed their understanding of the NOS.

Understanding the Nature of Science and Nonscientific Modes of Thinking in Gateway Science Courses

Calvin Kalman, Concordia University, Calvin.Kalman@concordia.ca

Marina Milner-Bolotin, University of British Columbia

Tetyana Antimirova, Ryerson University, Toronto

Mark W. Aulls, McGill University

Da-Min Meng, Hefei University of Technology

Elizabeth S. Charles, Dawson College Montreal

Xiang Huang, Concordia University Montreal

Ahmed Ibrahim, McGill University Montreal

Gyounggho Lee, Seoul National University

Xihui Wang, McGill University Montreal

ABSTRACT: The current study aims to achieve the following goals: to examine scientific epistemologies of students enrolled in undergraduate introductory physics courses and to help the students move along the novice-expert scientific epistemology continuum. To achieve these goals we designed and implemented the following interventions: reflective writing and critique writing activities, and collaborative conceptual conflict group exercises. The study examines the effects of these interventions via analyzing students’ pre and posttest physics scores, their scores on the instruments measuring their

Sunday, March 25, 2012

scientific epistemologies, as well as via the analysis of student interviews and writing products. The study has included hundreds of students at different colleges and universities across Canada and in four other countries.

Improving Student Learning Outcomes by Using Differentiated Activities

Muhsin Menekse, Arizona State University, muhsin@asu.edu

Micheline Chi, Arizona State University

ABSTRACT: This research evaluated the differentiated overt learning activities (DOLA) framework (Author, 2009) by classifying classroom activities as active, constructive and interactive based on their underlying cognitive processes and their effectiveness on learning. The DOLA framework asserts that different types of overt learning activities have differential effectiveness because they have different attributes and involve different cognitive processes. The claim here is that the activities designed as active are expected to engage learners more than passive instruction can do; the activities designed as constructive are expected to facilitate the generation of better and/or more new ideas and knowledge than the active activities can facilitate; and the activities designed as interactive are often expected to generate superior ideas and knowledge than constructive activities, but only when all students are contributing substantial joint intellectual effort. In this research, we designed one classroom study (N = 42) and one lab study (N = 120) with college students to discover: (1) how and to what degree differentiated activities affect students' learning outcomes; (2) what are the underlying cognitive processes and learning mechanisms that are associated with the type of activities based on DOLA framework. Analysis of findings, results and implications for educational practices were reported and discussed.

Strand 6: Science Learning in Informal Contexts

Strand Sponsored Session-Current Trends and Directions in Research about Learning and Teaching in Informal Contexts

2:45pm – 4:00pm, Room 305

Discussant: Sandra T. Martell, National Science Foundation, smartell@uwm.edu

Presenters:

Jennifer DeWitt, King's College London

Preeti Gupta, New York Hall of Science

David E. Kanter, New York Hall of Science

Leonie J. Rennie, Curtin University, Western Australia

Monya Ruffin, National Science Foundation

ABSTRACT: This interactive session introduces long-time strand members and those new to informal science education (ISE) to current trends and directions in research in informal contexts. Jennifer DeWitt reflects on challenges and benefits of working at the boundary between formal and informal environments in the United Kingdom, discussing how research outside of the informal sector informs the informal field. Preeti Gupta uses findings from federally funded projects in the United States to describe strategies addressing motivation in STEM and pursuit of STEM careers, providing ways to think about advancing research on engaging and supporting students. David Kanter speaks about a new paradigm for improving students' science learning and motivation by bridging formal and informal science learning environments with an instructional model called SciGames. Léonie Rennie's presentation explores how informal sources of science learning package and present science

Sunday, March 25, 2012

information in narrative form, as exhibits or other forms of media; how these are interpreted by a heterogeneous public; and the factors that determine successful communication. NSF Program Officer, Monya Ruffin, will speak about funding trends and directions within the Division of Research on Learning in Formal and Informal Settings. Sandra Toro Martell will provide feedback and lead a discussion with the audience.

Strand 7: Pre-service Science Teacher Education
Pre-Service Teachers' Physics Content Knowledge

2:45pm – 4:00pm, Room 306

Presider: Vanessa Kind, Durham University

Effects of Calculator Based Laboratory Usage on Pre-Service Physics Teachers' Teaching Practices

Fatma Caner, Marmara University, canerfatma@gmail.com

Feral Ogan-Bekiroglu, Marmara University

Hanife Hakyolu

ABSTRACT: The purpose of this study is to examine the influence of calculator based laboratory (CBL) usage on pre-service physics teachers' teaching practice. Case study design was guided to the research. The participants of the study were pre-service physics teachers. Results show that CBL has an influence on pre-service physics teachers' teaching practices positively. The role of teacher became facilitator by providing students more active participation in the learning process. Meanwhile, the class environment shifted from the teacher-centered teaching to the student-centered teaching when CBL technology was integrated into the lesson. Therefore, when misconceptions occurred in the students' minds, teachers supported discussions among students by encouraging them to get rid of their misconceptions in the CBL teaching environment. On the other hand, since the participants concentrated on CBL usage, they preferred to use neither an innovation nor another tool such as model and metaphor to facilitate student learning. Another finding is that usage of CBL did not have any influence on the interest of students to the lesson and on the relationship between teacher and students.

Physics Teacher Candidates' Views about Science and Scientific Knowledge after High School Physics Curricula Revisions

Kübra Eryurt, keryurt@metu.edu.tr

Özlem Oktay

ABSTRACT: Science education has been addressed for massive changes around the world, with changing educational philosophy at the end of the 20th century. The need for scientifically literate people in society became more important issue in many countries. Nature of science understanding found to be significant indicator to become scientifically literate. Emanating from this perspective, curriculum revisions took place and NOS aspects integrated into new science curricula around the world as well as in Turkey. The current study focused on pre-service physics teacher (PSPT) education programs and their influence on teachers' understanding of NOS. The participants of the study were selected among the students enrolled in fourth and fifth year of physics education program in a university. In total, twenty PSPTs included in the study. Data collection is done via a modified instrument which is formed by the questions from VNOS and EBAPS. As a result of the study, PSPTs' responses are categorized into 10 aspects of NOS (e.g. role of inference and experiment, scientific method) and some misunderstandings are identified. Even though participants take integrated courses, PSPTs have some insufficient

Sunday, March 25, 2012

comprehensions that influence definitions of science and scientific knowledge. And possible reasons are discussed in the study.

Enhancing Pre-service Science Teachers' Perceived Self-efficacy about Argumentation through Modeling and Mastery Experiences

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

Mehmet Aydeniz, The University of Tennessee

ABSTRACT: The purpose of this study is to explore the impact of explicit instruction on argumentation-based pedagogy supported by reflective teaching experiences on pre-service physics teachers' beliefs about the benefits of argumentation for science learning, their attitudes towards using argumentation in their classrooms and their perceived self-efficacy to teach science through argumentation. The participants consisted of pre-service physics teachers. Results show that the participants ranked themselves relatively high in terms of their efficacy to plan, to implement an argumentation-based lesson and to assess students' learning in an argumentation-based learning environment. The participants believed that argumentation could create unique learning opportunities for students and thus benefit them as they learn science. However, the participants thought that when students did not get the right answer at the end of argumentation their minds got very confused which might cause a lot of misconceptions among students. They consistently maintained that one could not teach science through argumentation for every topic covered by the mandated curriculum. We caution that this perceived self-efficacy to teach science through argumentation may not result in actual teaching of argumentation in the classroom because school culture has a significant impact on the type of instruction teachers can implement in their classrooms.

Students' Goals and Expectations in a Physics Course for Education Majors

Jon D. H. Gaffney, University of Kentucky, jon.gaffney@uky.edu

ABSTRACT: Education majors at our university are required to take the inquiry-based Physics and Astronomy for Teachers (PAT), which could be used as a touchstone in science education methods courses. However, because PAT is different from most science courses that students have taken in high school and at the university, the extent to which students recognize its intended purpose is unclear. Indeed, while cognitive gains are achieved, poor student evaluations of the course have persisted. The purpose of this study is to identify the students' expectations and goals for PAT, comparing them with the goals of the instructors and methods courses, and, via an Expectancy Violation framework, identify whether students initial expectations for the course are met. Students' expectations regarding the hands-on and interactive components of PAT were met, but there was substantial expectancy violation with respect to lecture, class discussions, and opportunities to practice teaching. Additionally, instructors' and students' goals often differed. Alarming, science educators stressed the need for future teachers to become excited about science, while students in PAT valued that possible outcome relatively little and reported only moderate success in its achievement. These results imply that instructors need to better communicate the role of PAT to future teachers.

Sunday, March 25, 2012

Strand 8: In-service Science Teacher Education

Related Paper Set - Virginia Initiative for Science Teaching and Achievement (VISTA) - First Year Statewide Implementation

2:45pm – 4:00pm, Room 105

President: Donna R. Sterling, George Mason University

ABSTRACT: This paper set discusses the expanded implementation and evaluation of the Virginia Initiative for Science Teaching and Achievement (VISTA), a United States Department of Education science teaching reform effort. VISTA is a partnership among 47 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 the U.S. Department of Education (Investing in Innovation Fund – i3), the goal of VISTA 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 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.

Refining Inquiry Based Science Instruction Through Professional Development Using the VISTA Model

Anne Mannarino, College of William and Mary, amannarino@wm.edu

Mollianne G. Logerwell, George Mason University

Victoria Reid, College of William and Mary

Elizabeth Edmondson, Virginia Commonwealth University

Constructing the Science Methods Course as a Shared Instructional Product

Juanita Jo Matkins, College of William and Mary, jjmatk@wm.edu

Donna R. Sterling, George Mason University

Jacqueline Theresa McDonnough, Virginia Commonwealth University

Wendy M. Frazier, George Mason University

Investigating the Impact of a New Science Coordinator/Liaison Academy

Elizabeth Edmondson, Virginia Commonwealth University, ewedmondson@vcu.edu

Eric M. Rhoades, George Mason University

Karla Ver Bryck Block, George Mason University

Donna R. Sterling, George Mason University

Victoria Reid, College of William and Mary

Virginia Science Education at the Crossroads: Connecting Science Education Faculty to a Professional Community

Jacqueline Theresa McDonnough, Virginia Commonwealth University, jtmcDonnough@vcu.edu

Donna R. Sterling, George Mason University

Juanita Jo Matkins, College of William and Mary

Sunday, March 25, 2012

Wendy M. Frazier, George Mason University

Outcomes of the Virginia Initiative for Science Teaching and Achievement (VISTA) Professional Development

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

Randy L. Bell, University of Virginia

Strand 8: In-service Science Teacher Education

Changing the Practice of Science Teachers

2:45pm – 4:00pm, Room 106

Presenter: Sheryl L. Mcglamery, University of Nebraska

The Development of Domain-specific Expertise when Experienced Chemistry Teachers Participate in a Community of Practice

Ria Dolfing, Utrecht University, Utrecht, r.dolfing@uu.nl

Onno De Jong, Utrecht University, Utrecht

Astrid M. W. Bulte, Utrecht University, Utrecht

Albert Pilot, Utrecht University, Utrecht

Jan D. Vermunt, Utrecht University, Utrecht

ABSTRACT: This study aims to describe the way in which domain-specific expertise develops when experienced chemistry teachers participate in a community of practice in order to teach a context-based chemistry unit. A case study approach resulted in a description of the development of teachers' domain-specific expertise in setting the context in class, performing the new teacher's role and teaching new content. The construct of 'teachers' domain-specific expertise' was used to analyse existing and newly-developed expertise in the domain of teaching a context-based chemistry unit about macro-micro thinking in structure-property relations in the community consisting of six teachers and a coach. The results show that the teachers developed their expertise in setting the context, but only slightly developed their expertise in terms of performing their new role as a teacher, and did not develop their expertise in teaching the content about macro-micro thinking. In addition, the organisation and management of project-teams in class hindered the development of domain-specific expertise in teaching the new content. The implications of these results for designing a professional development programme, in where teachers participate in a community of practice, are discussed.

Relationship, Time and Instructional Focus: Maximizing the Effects of Science Coaching

Ruth A. Anderson, FACET Innovations, LLC, randerson@facetinnovations.com

Jim Minstrell, FACET Innovations

Sue Feldman, Education Service District 112, Washington State

ABSTRACT:

The Effect of the GK-12 Program on Teachers: Evaluating Reciprocal Coaching as a Differentiated Professional Development Strategy for Experienced Teachers

Kirstin C. Busch, University of Texas at Austin, kirstinbusch@utexas.edu

ABSTRACT: Research has long suggested that ongoing, in-house professional development such as instructional coaching may be the most effective for impacting classroom practice. There is some evidence, for example, that coaching can help teachers to transfer their learning from professional

Sunday, March 25, 2012

trainings to classroom practice more effectively than teachers who do not receive such support. However, models of coaching vary widely, and the effectiveness of particular models and the underlying reasons for effectiveness have not been extensively studied. This is particularly true in science education, where instructional coaching is relatively rare. What are the effects of science instructional coaching on teaching and learning within a classroom and within a school? Why does coaching “work” when it does? What causes it to break down and to what extent can it be repaired? In this paper, we describe our in-depth five-year study of science instructional coaching and its findings related to teacher, student and school effects. We then delve into evidence that has emerged from more recent analyses regarding the relational factors that mediate the effectiveness of teacher-coach work. Findings from the study have implications for the implementation and maintenance of a viable and productive instructional coaching program.

Talking about Student Learning: Science and Mathematics Teachers' Collaborative Inquiry Processes

Tamara H. Nelson, Washington State University Vancouver, tnelson1@vancouver.wsu.edu

David Slavit, Washington State University Vancouver

Angie Deuel, Washington State University Vancouver

ABSTRACT: Professional development is key to improved student and school success, however research in this field is relatively new and teacher learning in PD is often lackluster. Additionally, alternative strategies are needed to address the unique professional development needs of experienced teachers. One such strategy is reciprocal coaching, such as that used in the National Science Foundation’s GK-12 program, between experienced classroom teachers and graduate student scientists. Teachers were surveyed to determine if their participation in GK-12 provided a positive professional development experience. It was found that teachers benefited from this type of professional development with a perceived increase in their science content knowledge and an overall high level of satisfaction with the program. Through interviews, common themes - such as the need for institutional organizational support and teacher attributes – were found to aid in using the teacher-scientist reciprocal coaching model as a professional development strategy outside the GK-12 system.

Strand 10: Curriculum, Evaluation, and Assessment

Studies in Engineering and Design Education

2:45pm – 4:00pm, Room 308

President: Kristin L. K. Koskey, The University of Akron

The Impact of Engineering Curriculum Units on Students' Attitudes towards Engineering and Science

Cathy P. Lachapelle, Museum of Science, Boston, clachapelle@mos.org

Preeya Phadnis, Museum of Science, Boston

Jennifer Jocz, Museum of Science, Boston

Christine M. Cunningham, Museum of Science, Boston

ABSTRACT: This paper probes whether students’ attitudes toward engineering and science are impacted as a result of participating in engineering design challenges. It presents results from data from an instrument measuring students’ attitudes about and perceptions toward engineering. The Engineering Attitudes Survey was originally developed as an assessment of middle school students’ knowledge of engineering and their attitudes toward it, and was adapted for use with elementary students. To measure the impact of the use of engineering units with students, the attitude survey was administered

Sunday, March 25, 2012

to a treatment group and a “control” group. Data about student sex, race/ethnicity, and free and reduced lunch status were also collected. The attitudes instrument was administered to students in six states in a pre/post design. Results indicate that students who completed an engineering unit were significantly more likely to report interest in being an engineer on the post-survey than control students. They were also significantly more likely than control students to report interest in and comfort with engineering jobs and skills, and to agree that scientists and engineers help to make people’s lives better.

Investigating the Impact of a Lego-based, Engineering-oriented Curriculum Compared to an Inquiry-based Curriculum on Fifth Graders' Content Learning of Simple Machines

Ismail Marulcu, Erciyes University, imarulcu@erciyes.edu.tr

Mike Barnett, Boston College

ABSTRACT: This mixed method study examined the impact of a LEGO-based, engineering-oriented curriculum compared to an inquiry-based curriculum on fifth graders’ content learning of simple machines. This study takes a social constructivist theoretical stance that science learning involves learning scientific concepts and their relations to each other. From this perspective, students are active participants, and they construct their conceptual understanding through the guidance of their teacher. Data sources included identical written tests and interviews, classroom observations and videos, teacher interviews, and classroom artifacts. To investigate the impact of the design-based simple machines curriculum compared to the scientific inquiry-based simple machines curriculum on student learning outcomes, we compared the control and the experimental groups’ scores on the tests and interviews by using ANCOVA. To analyze and characterize the classroom observation videotapes, we used Jordan and Henderson (1995)’s method and divide them into episodes. Our analyses revealed that the design-based Design a People Mover: Simple Machines unit was, if not better, as successful as the inquiry-based FOSS Levers and Pulleys unit in terms of students’ content learning. We also found that students in the engineering group outperformed students in the control group in regards to their ability to answer open-ended questions when interviewed. Implications for students’ science content learning and teachers’ professional development are discussed.

Using and Comparing Paper and Media to Improve Student Reflection in Science and Design Courses

Tamecia R. Jones, Purdue University, tameciajones@purdue.edu

Monica E. Cardella, Purdue University

Senay Purzer, Purdue University

ABSTRACT: This paper describes a four-week summer course that teaches science and engineering concepts in the context of a design studio course. Weekly engineering themes that include specific concepts in civil and electrical engineering set the stage for students to practice the design process in order to solve a problem. The instructor uses design journals, design storyboards, and video to teach reflection and document student understanding and individual student design rationale as projects progress. The design journals, design storyboards, and video footage from final presentations are analyzed and compared to assess the benefits of different media for capturing understanding and improving reflection and documentation practices of students. The goal of this data is to generate a symbolic graphical language that can be used as a pedagogical strategy and tool to improve documentation of the design rationale in science design courses.

Sunday, March 25, 2012

Strand 11: Cultural, Social, and Gender Issues

Language and Culture of Science: National and International Contexts

2:45pm – 4:00pm, Room 107

President: Rowhea M. Elmesky, Washington University in St. Louis

Place-legitimized Kenyan Scientific Knowledge and Its Relevance to Science Education

Nicole Beeman-Cadwallader, Indiana University, nbeeman@umail.iu.edu

Gayle A. Buck, Indiana University

ABSTRACT: The purpose of this study was to explore the ways that the people of Eldoret, Kenya conceptualize their “place” through the perspective of its relevance to science education. The overarching questions were: 1) What are the embedded science-related meanings that people have of their place, and to what extent are these meanings incorporated into science education? 2) How does geographic and cultural place factor into how scientific meanings are legitimized, particularly in the context of science education? Written and photographic observations, informal and semi-structured interviews, and relevant documents constituted data. Narrative thematic and visual analyses were performed. Repeatedly, knowledge cited as important deeply impacts peoples’ livelihoods and survival. Generally, this related to: 1) nutrition, home, and health, and 2) environmental degradation. Scientific knowledge legitimized in Eldoret is dynamic; indigenous influences contemporary, and vice versa. Science education that does not reflect this dynamicity does not adequately reflect the needs and values of the people for whom it is intended. If local, indigenous knowledge were to be formally recognized in science education, as in place-based pedagogy, Kenyan science education could become more relevant. While these findings relate to a specific context, the process of identifying locally legitimized scientific knowledge has broad application for science education.

Discourses of Nature and Culture of Science: A Sociocultural Study with Canadian and Indian Teachers

Anjali A. Abraham, McGill University, anjali_abraham@hotmail.com

ABSTRACT: In Canada and India science education reform policy for the 21st Century has redefined teaching and learning to align with constructivist ideology and take into account students’ sociocultural experiences (MELS, 2004; NCERT, 2005). These policies also address the need for the teaching of conventional school science such as the scientific method, specific lab skills, and the use of appropriate scientific terminology. Science teachers in these contexts are expected to incorporate both older and newer discourses of the nature and culture of school science in their teaching practice. This paper will examine the diverse discourses science teachers draw on as they navigate the new curricular requirements, and will illustrate the affordances and limitations of these discourses towards the practice of inclusive school science. This paper will also explore the role of global and local, economic and cultural, forces in shaping science teachers’ discourses. Comparative education researchers (Tabulawa, 2003) have critiqued curricular and pedagogical reform by linking them to the neoliberal agenda steering global economic structures. By illustrating how science teachers’ discourses have been shaped by various local and global conditions this paper will interrogate processes of cultural reproduction and/or transformation taking place in science classroom settings in Canada and India.

Exploring NOS with Immigrant Somali Youth in a Charter School Biology Curriculum

Nancy Albrecht, University of Minnesota, albr0137@umn.edu

Allison Kirchoff, Independent Consultant

Gillian Roehrig, University of Minnesota

Sunday, March 25, 2012

Bhaskar Upadhyay, University of Minnesota

ABSTRACT: Nature of Science (NOS) has been recognized as an important and challenging aspect of science education in K-12 educational systems for several decades. In this study we chose to explore NOS knowledge and attitudes within a population of immigrant Somali American students at a U.S. public charter school located in the Upper Midwest. Guiding questions for the study included: 1) What are Somali American students' views of NOS and science in general? 2) Do Somali American students view science through a unique cultural lens that influences their NOS knowledge and beliefs? Findings suggested that students of Muslim cultures often have mixed views of NOS, and that culture, including religion, plays a role in how these students negotiate their school learned science with their home cultures. Implications for practicing science teachers and for future research are discussed.

Mother Tongue Policy and Science Teaching in Nigeria : A Conflict Between Policy Provision and Reality

Peter A. Okebukola, Lagos State University, Lagos, Nigeria, pokebukola@yahoo.com

Tunde Owolabi, Lagos State University, Lagos, Nigeria

Foluso O. Okebukola, Lagos State University, Lagos, Nigeria

ABSTRACT: During the last ten years, the debate on the potency or otherwise of language of delivery of science instruction has heated up in countries with policies on dual language use. In Nigeria, the National Policy on Education provides for the use of the local language in teaching science at the lower levels of the basic education system and English at the upper. The dynamics of the switch from local language to English have been hypothesized to impact on the quality of teaching and learning of science. This study, conducted in twelve primary schools used an in-depth multiple case design to give an intensive holistic description of the prescriptions of the National Policy on mother tongue teaching in science in Nigerian schools. The study, among other things, found that in spite of the policy prescription, schools located in urban environments employed English language in teaching more than schools located within the rural environment with the attendant implications for quality of science instruction. The implications of the findings for curriculum development and implementation for dual or multi-lingual language policies for science teaching are drawn.

Strand 12: Educational Technology

Biotechnology, Genetics & DNA Sequencing through Technology

2:45pm – 4:00pm, Room 101

Presenter: Eva Erdosne Toth, West Virginia University

Exploring the Impact of Animation-based Genetic Instruction on Students' Perceived Cognitive Load and Learning Outcomes

Chyi Yang, New Taipei City Tucheng Junior High School, chyi51757@gmail.com

Ting-Kuang Yeh, Science Education Center

Wen-Ta Yang, China Medical University

Chun-Yeh Chang, Science Education Center

ABSTRACT: The aim of this study was to develop an animation-based curriculum and to evaluate the effectiveness of animation-based instruction. The curriculum was designed in certain principles considered cognitive load theory for reducing perceived cognitive load and improving learning. The curriculum was comprised of four subunits to teach the abstract concepts of genetics. There were 190 participants consisted of 7th grade junior high school students. 97 students participated in static graphic

Sunday, March 25, 2012

instruction (SI group) and 93 students participated in animation-based instruction (AI group). The effectiveness of the instruction was evaluated by the Genetic Concept Test (GCT test) and a self-rating cognitive questionnaire (CLQ). The results indicated that: (1) Animation-based instruction may be a good strategy to improve abstract concepts comprehensive, (2) Animation-based strategy can reduce the cognitive load than static graphic-based, when students perceived lower levels of cognitive load, they showed better learning outcome.

Helping Students Conduct Complex Research by Using a Scaffolding Software Tool

Andrew K. Vershon, Rutgers University, vershon@waksman.rutgers.edu

Susan E. Coletta, Rutgers University

Jeffrey D. Charney, Evaluator

Douglas Lownsbery, WestEd

Barbara C. Buckley, WestEd

ABSTRACT: It has been documented that high school students who are engaged in genuine scientific research gain a strong understanding of science. Many internet tools and databases that are part of the cyberinfrastructure used by practicing scientists, can provide opportunities for students to contribute to the scientific enterprise. However, the complexity of scientific research and the need to master sophisticated background material and computer skills often makes it difficult for high school students to use these resources. We have developed an authentic research project in which students analyze and publish novel DNA sequence data using scientific resources. To aid the students in the analysis of this data we have developed an online program called the DNA Sequence Analysis Program (DSAP) that can be used to guide the learner through the complexity of authentic research and bioinformatics. Embedded assessment and pre/post survey data suggested that students who use DSAP are able to learn the content background material and apply this knowledge to conduct sophisticated analyses of novel data.

Strand 13: History, Philosophy, and Sociology of Science

Socioscientific Issues & Argumentation

2:45pm – 4:00pm, Room 102

President: Jonathan F. Osborne, Stanford University

The Transfer of Nature of Science Understandings into Unfamiliar Contexts

Rola Khishfe, rk19@aub.edu.lb

ABSTRACT: The purpose of this study was to explore whether students are able to apply the acquired nature of science (NOS) understandings into other contexts. Participants were 55 7th grade students in two intact sections and who were taught by the same teacher. The treatment extended over seven weeks and involved teaching a unit that covered the topics of plate tectonics, earthquakes, and volcanoes for both groups. Only one group (treatment) was explicitly taught about NOS in relation to the topics under study. To assess the change in students' understandings, a five-topic open-ended questionnaire and individual semi-structured interviews, were used. The questionnaire included five topics addressing scientific and socioscientific contexts. One of these topics was plate tectonics, which would be "familiar" to students after the intervention. The other four topics were "unfamiliar" to students as they were not addressed in the unit. Results showed improvements in the understandings of the treatment group participants for the familiar and unfamiliar contexts. However, there were

Sunday, March 25, 2012

differential improvements in students' understandings of NOS in the context of socioscientific versus scientific topics. Implications for the transfer of NOS understandings among various "unfamiliar" contexts and the factors facilitating their transfer are discussed.

Cross-Cultural Comparisons of Epistemological Beliefs on Socioscientific Issues

Dana L. Zeidler, University of South Florida, zeidler@usf.edu

Benjamin C. Herman, University of South Florida

Mitch Ruzek, University of South Florida

ABSTRACT: The purpose of this investigation was to examine, from a cross-cultural perspective, students' epistemological patterns of reasoning about socioscientific issues (SSI), and to identify potential interactions of cultural and scientific identity. This mixed-methods design included over 300 students from Jamaica, South Africa, Sweden, Taiwan, and the United States. Students responded to instruments designed to assess their epistemological conceptualizations and justifications related to distributive justice, allocation of scarce medical resources, and epistemological beliefs over five dimensions related to scientific knowledge. Four iterations of a coding scheme produced over 97% inter-rater agreement for four independent coders. Results indicate epistemological congruity across cultures related to themes of 1) Fairness; 2) Pragmatism; 3) Emotive Reasoning; 4) Utility; and 5) Theological Issues. Statistically significant differences in terms of how students from these different countries raise scientific questions when considering SSI and epistemological conceptions of the Structure of Scientific Knowledge and Nature of Knowing and Learning were found and discussed. The results of our cross-cultural findings support the idea that students from an array of cultural identities, can engage in important reflection and justification concerning scientific issues that affect their lives. Implications for research and pedagogy are discussed.

'Visualizing' Evidence and Scientific Methods, and Implications for Science Education

Sibel Erduran, University of Bristol, sibel.erduran@bristol.ac.uk

Maria Evagorou, University of Nicosia

ABSTRACT: 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:0cm 5.4pt 0cm 5.4pt; mso-para-margin-top:0cm; mso-para-margin-right:0cm; mso-para-margin-bottom:10.0pt; mso-para-margin-left:0cm; 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;} The use of visuals (i.e. photographs, diagrams) has been part of science since it makes it possible for scientists to interact with complex phenomena, and they might convey important evidence not observable in other ways. In this paper we argue that visuals are an important aspect of science, and the purpose of this paper is to explore through two case studies how visualization is embedded and contributes to knowledge, knowledge development, growth and production in science, and how this aspect of science can have implications for the teaching and learning of science. First, we present a case study (DNA discovery) that highlights the epistemic components of visual information in science. Our intention with this case study is to provide an example scenario where visual data is used as scientific evidence in science. The second case study focuses on the cultural practices around the communication and sharing of visual data, and methods in scientific research (JOVE journal). Here the emphasis is on the identification of cultural norms that are significant to model in science classroom cultures. The study

Sunday, March 25, 2012

outlines a framework for detailing scientific practices in the context of visual information, an often overlooked aspect of the nature of science literature.

Strand 14: Environmental Education

Enhancing the Development of Ecological Literacy in K-16 Education

2:45pm – 4:00pm, Room 103

Presenter: Bruce Johnson, University of Arizona

Writing-to-Learn Activities as a Measure of Ecological Literacy in College Students

Alison M. Wallace, Minnesota State University Moorhead, wallacea@mnstate.edu

Meena M. Balgopal, Colorado State University

ABSTRACT: Science educators recognize the need for students to think scientifically about environmental issues. We tested a writing-to-learn model we developed to facilitate ecological thinking in college students. This study involved 13 students in an environmental studies course at a liberal arts college. We provided prompts for three essays addressing students' cognitive, affective, and behavioral domains for two case studies: hypoxia and genetically modified crops. Students were then assigned a "transfer" topic to further research and write an essay on in a style of their choosing. Essays were categorized as authentic, objective, subjective, or superficial. Authentic writers demonstrated the ability to recognize personal and societal dilemmas and provide evidence-supported decisions in their writing. We also developed a pre-post general ecological assessment (GEA) to provide a quantitative measure of ecological literacy. GEA scores increased after the hypoxia essays but leveled off after the GMO essays. Authentic writers scored higher for the hypoxia, but not the GMO case study. The transfer essay showed most students reverted back to a more distanced, objective way of examining the issue, rather than an authentic, ecologically literate view. Further studies will examine the effects of specific environmental issues on these quantitative and qualitative measures of ecological literacy.

Developing a Questionnaire as a Research Tool to Characterize Students' Perception of Renewable Energy

Tami Fishel, Ben Gurion University of the Negev, Israel, tamartir@bgu.ac.il

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

Hanan Ginat, Dead Sea and Arava Science Center

ABSTRACT: The world-wide energy crisis emphasizes the need to develop new energy sources and reduce energy consumption. Agenda 21 defined the importance of education in creating sustainable development and environmentally literate citizens. Therefore one of the solutions for the energy crisis is developing education to encourage renewable energy and consumption reduction. In Israel, the 9th grade junior high curriculum includes energy related science, but renewable energies are not included. In order to implement renewable energies into the curriculum, advice of experts in energy science is needed, as well as knowledge of students' perceptions of the subject. This study sought to develop a research tool to assess students' perception of renewable energy, based on the knowledge of experts in the field. Information gathered by this tool can be used in the creation of guidelines for the development of new curricula. We used a combination of qualitative tools (interviews with experts and students) and quantitative tools (specially developed questionnaires). The results derived from the experts' interviews emphasize the need for the 9th grade curriculum to recognize relationships between earth systems and humans, the importance of finite energy sources and increasing environmental

Sunday, March 25, 2012

awareness. The students expressed relatively high awareness to environmental issues, but a large gap exists between students' awareness to their actual knowledge.

Sustainability through the Lens of Earth Education: Children's Ecological Understandings and Environmental Attitudes

Constantinos C. Manoli, Universtiy of Cyprus, MANOLI@UCY.AC.CY

Bruce Johnson, University of Arizona

Andreas Ch Hadjichambis, Cyprus Centre for Environmental Research and Education

Demetra Hadjichambi, University of Cyprus

Yiannis Georgiou, Cyprus Centre for Environmental Research and Education

Hara Ioannou, Cyprus Centre for Environmental Research and Education

ABSTRACT: During the last two decades, education about sustainability has moved to the front line of environmental education aiming at educating young people for a more sustainable world. Earth education programs focus on the enhancement of ecological understandings, environmental attitudes and ecological actions may play an important role in this educational effort, as knowledge and attitudes seem to be the most basic ingredients in learning for sustainability. However, the potential contribution of earth education programs is largely unexplored. Within this framework, the present study examines children's environmental attitudes and ecological understandings before and after the implementation of an earth education program, Earthkeepers. The program was implemented with 196 students from six schools (9-14 years old), and data were collected using the 2-MEV (attitudes) and the Ecological Concept Questionnaire (ecological understandings). Also, 12 students and 9 teachers were interviewed individually. The analysis of the quantitative results showed gains in both students' understanding as well as changes toward a more pro-environmental attitude. The interviews confirmed the quantitative results and provided valuable information about students' actions. Earth education programs can have a great contribution in learning for sustainability as they have the potentials to enhance students' environmental attitudes, ecological understandings and actions.

Lessons from the Tree: How the Tree that Owns Itself Taught its Town

Debra B. Mitchell, University of Georgia, dbmitchl@uga.edu

Rachel Luther, University of Georgia

Michael Mueller, University of Georgia

ABSTRACT: We can learn a lot from a tree. In this essay we address the rights of the Tree That Owns Itself in Athens, GA and lessons that should be learned from analyzing these rights. We provide the historical account of The Tree That Owns Itself and describe how the Tree is embraced and valued in Athens Georgia (USA). We use Cormac Cullinan's discussion of "rights for nature" to evaluate philosophically the idea of rights for plants specifically in the science education curriculum, as opposed to rights more generally applied to sentient animals and physical environments such as mountaintops. We anticipate this paper and conversation with participants will elicit significant discussions in science education about the issue of rights for plants, because we suspect that most scholars will have difficulty defending plants and ecosystems beyond animal species. We raise the usual objections, with some nuanced ideas of how to address this scrutiny. We conclude with some implications for education, including ways to introduce a conversation of plant rights in the classroom as well an understanding of how opening our eyes to plant blindness fosters the ecological awareness and knowledge that leads to youth activism.

Sunday, March 25, 2012

Strand 15: Policy

Symposium - Globalization and Science Instruction

2:45pm – 4:00pm, Room 104

President: Mei-Hung Chiu, National Taiwan Normal University, Taipei, Taiwan

Discussant: Peter W. Hewson, University of Wisconsin, Madison, USA

Presenters:

Reinders H. Duit, IPN - Leibniz Institute for Science and Math Education, Kiel, Germany

John L. Bencze, OISE - University of Toronto, Canada

Lyn Carter, Australian Catholic University, Melbourne, Australia

Kyunghee Choi, EWHA Womans University Seoul, South Korea

Hyunju Lee, EWHA Womans University, Seoul, South Korea

Sonya N. Martin, Drexel University, Philadelphia, USA

Christina Siry, University of Luxembourg, Luxembourg

Sung-Won Kim, EWHA Womans University Seoul, South Korea

Peter W. Hewson, University of Wisconsin, Madison, USA

ABSTRACT: Processes of globalization have played a major role in economical and cultural development worldwide. More recently, there is a growing literature on rethinking science education from the perspective of globalization. A special issue of the Journal of Research in Science Teaching (JRST, August 2011) intends to initiate a wider discussion on consequences of globalization for science education as a research domain and for the way science is taught in schools. Three intimately linked facets are discussed: (1) the transformation of the world economies and cultures, (2) the increasing challenges faced by global socio-scientific issues (such as climate change), and (3) the globalisation of science education research. The first two facets focus on rethinking the presently dominating variants of science instruction from the perspective of globalization. To discuss consequences for teaching science addressing the challenges arising from globalization issues is the major focus of the present symposium.

Plenary Session #1

Towards an Empirically-Grounded Theory of Action for Improving the Quality of Teaching Subject Matter at Scale

4:30pm – 6:00pm, White River Ballroom A – E

President: J. Randy McGinnis, NARST President, University of Maryland

Keynote Presenters:

Paul Cobb, Vanderbilt University

Kara Jackson, McGill University

ABSTRACT: Research on the teaching and learning of both mathematics and science has made significant progress in recent years. However, this work has had only limited impact on instruction in most US classrooms. For the past four years, we have collaborated with mathematics teachers, school leaders, and district leaders in four large urban school districts to investigate what it takes to support improvement in the quality of instruction at scale. As part of this collaboration, we made recommendations based on the data we collect each year to leaders in each district about how they might revise their policies or strategies for instructional improvement to make them more effective. In the course of this work, it has become apparent that research can currently provide only limited guidance to school and district leaders who are attempting to support mathematics teachers'

Sunday, March 25, 2012

development of ambitious, inquiry-oriented instructional practices. The need for investigations that are designed to inform instructional improvement is even more urgent when the goal is to support teachers' development of classroom practices that are equitable as well as ambitious. We present the results of our work to this point by considering key aspects of a coherent theory of action for instructional improvement at scale. These elements include: curriculum materials and instructional guidance instruments such as district-developed curriculum frameworks; pull-out teacher professional development; teacher collaborative meetings; mathematics coaches' practices in providing job-embedded support for teachers' learning; school leaders' practices as instructional leaders in mathematics; and district leaders' practices in supporting the development of school-level capacity for instructional improvement. We conclude by discussing future work in which we are collaborating with leaders in two of the four districts to co-design and co-lead coordinated professional development for teachers, coaches, and school leaders. As we will clarify, one of the districts is adapting this work to provide professional development that is aligned across role groups and that focuses on specific high-leverage instructional practices in science as well as mathematics.

Membership and Elections Committee Sponsored Session

Mentor-Mentee Nexus

Informal discussion: Early career NARST members are matched with more seasoned members to help launch or expand professional networks.

6:00pm – 7:00pm, Room 101

Presiders:

Corinne Lardy, San Diego State University, corinne_lardy@yahoo.com

Mike U. Smith, Mercer University

ABSTRACT: In this informal gathering, experienced members of NARST will mentor newer members by answering questions about NARST conferences and membership in general. Please come join us if you are a new member or you are an experienced member who would like to mentor.

Research Interest Groups (RIGs) Meetings

The Continental and Diasporic Africa in Science Education

The goal of this meeting is to (a) encourage science educators to engage in research aimed at meeting the needs of people of African descent and (b) provide intellectual, professional, and personal space for science educators engaged in such research.

6:00pm – 7:00pm, Room 103

Presiders:

Mary M. Atwater, The University of Georgia

Felicia M. Mensah, Teachers College, Columbia University

Presidential/Welcome Reception

Social Event: All NARST members are welcome—free appetizers and cash bar.

7:00pm – 9:30pm, White River Ballroom F – J

Monday, March 26, 2012

External Policy Committee & Strand 15: Policy Sponsored Session

Symposium - Session 1: Next Generation Science Standards: Tracking the Federal Research Agenda

8:30am – 10:00am, Room 104

Presiders:

Andrew Shouse, University of Washington

Christopher Wilson, BSCS

Presenters:

Martin Storksdieck, NRC Board of Science Education

Philip L. Bell, University of Washington

Elizabeth A. Davis, University of Michigan

Deborah C. Smith, Pennsylvania State University

ABSTRACT: This session will feature science education research and policy leaders who have been involved in the conceptualization and development of the new framework and (forthcoming) standards. Participants will include leading researchers, representatives of federal research funding agencies, the NRC and Achieve (the organizations that administer the framework and standards development processes). Following a brief overview of the framework and standards (10 minutes), four invited presenters will describe novel features of the standards— learning progressions, practices, curriculum, and core ideas— and the associated implications for research (10 minutes each; 40 minutes total). Presentations will conclude with reflections of senior staffers from the major scientific funding agencies, responding to the four presenters and situating the standards within the priorities of the federal funding apparatus (20 minutes). The remaining 10 minutes will be devoted to audience Q and A.

Publications Advisory Committee Sponsored Session

Symposium - Discussion with the Editors of Various Science Education Journals

8:30am – 10:00am, Room 103

Presiders:

Carolyn S. Wallace, Indiana State University

Jan H. Van Driel, ICLON Leiden University Graduate school of Teaching, The Netherlands

ABSTRACT: This session will allow participants to hear commentary and ask questions about the nature, scope and foci of several of the major journals in science education as a guide to judging the best outlet for manuscript submissions. Editors or editorial representatives from journals such as, Science Education, International Journal of Science Education, Research in Science Education, Journal of Science Teacher Education, Cultural Studies in Science Education, Studies in Science Education, Journal of Science Education and Technology, and Journal of Research in Science Teaching will serve as panel members to discuss the types of manuscripts that are the most suitable for their journal, characteristics of high quality manuscripts, and special advice for junior and/or international authors on getting published. The session will provide a unique opportunity to meet and interact with science education journal editors first hand.

Monday, March 26, 2012

Strand 1: Science Learning, Understanding and Conceptual Change

Related Paper Set - Using Learning Progressions Research to Teach for Environmental Science Literacy

8:30am – 10:00am, Room 310

ABSTRACT: The papers in this session all focus on the general goal of environmental science literacy—on preparing students to act as informed citizens with respect to environment issues—and on using learning progressions to improve classroom assessment, curriculum, and instruction. 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) water: processes that move water and substances in water through connected natural and engineered systems. Paper 1 explains how we analyze students' accounts of carbon-transforming processes in term of practices or learning performances and use those practices to organize instruction. Paper 2 relates students' learning to teachers' understanding of learning progression-related goals for instruction. Paper 3 explains the development of valid and reliable procedures to analyze students' constructed responses to test questions. Paper 4 reports on learning about carbon at the college level. Paper 5 describes the development and use of learning progression-based formative assessments and tools for reasoning about water systems.

Analyzing Students Learning Performances in Terms of Practices for Developing Accounts

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

Li Zhan, Michigan State University

Dante Cisterna, Michigan State University

Charles W. Anderson, Michigan State University

Students' Learning Performance and its Relation to Teaching Practice

Li Zhan, Michigan State University, zhanli@msu.edu

Dante Cisterna, Michigan State University

Charles W. Anderson, Michigan State University

Developing and Validating Scoring Procedures for Students' Written Accounts of Carbon-transforming Processes

Jennifer H. Doherty, Michigan State University, dohertyjh@gmail.com

Karen Draney, University of California, Berkeley

Analyzing College Students' Learning about Carbon-transforming Processes

Jonathon Schramm, Michigan State University, schram25@msu.edu

Jennifer H. Doherty, Michigan State University

Charles W. Anderson, Michigan State University

Using a Water Systems Learning Progression to Design and Test Formative Assessments and Tools for Reasoning

Beth A. Covitt, University of Montana, beth.covitt@umontana.edu

Kristin L. Gunckel, University of Arizona

Monday, March 26, 2012

Strand 2: Science Learning: Contexts, Characteristics and Interactions

Related Paper Set - Models and Modeling as a Foundation for Science Education

8:30am – 10:00am, Room 302

ABSTRACT: The overall objective of this paper set is to present and substantiate the argument that models and modeling are not just one aspect of science education, they are foundational to supporting the complementary aims of helping students understand scientific knowledge, participate in scientific practice, and develop sophisticated beliefs about the epistemology of science. We have created a representation, which we call the Models Pyramid to help us organize and communicate our theoretical claims. A full description of the theoretical and empirical basis for the ideas represented in this pyramid is given in the introductory paper to this paper set. Each of the three subsequent papers draws on a different curricular context to further elaborate and instantiate the argument with empirical analyses from model-based classrooms. By presenting the theoretical argument and illustrating it with data from a number of our projects, we hope to help participants understand our position and the potential of it more broadly in such a way that we might motivate and facilitate important discussions among scholars about the role of models and modeling in science education.

Introducing the Models Pyramid: Building Foundation, Structure, and Substance for Science Education

Cynthia Passmore, University of California, Davis, cpassmore@ucdavis.edu

Julia Svoboda, University of California, Davis

Authentic Scientific Practices Emerge from a Model-centered Physics Course

Wendell Potter, University of California, Davis, whpotter@ucdavis.edu

Cassandra Paul, University of California, Davis

Julia Svoboda, University of California, Davis

Teachers Use of Models to Give Coherence and Meaning to Scientific Content

Rich Hedman, Sacramento State University, hedmanrd@csus.edu

Connie Hvidsten, Biological Science Curriculum Study

Arthur Beauchamp, University of California, Davis

Cynthia Passmore, University of California, Davis

Modeling and the Substance of a Sophisticated Epistemology of Science

Julia Svoboda, University of California, Davis, jmsvoboda@ucdavis.edu

Cynthia Passmore, University of California, Davis

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

The Language of Science

8:30am – 10:00am, Room 301

Presenter: Josephine Shireen Desouza, Ball State University

Development of the Blended / Tiered Approach to Scaffolding Academic Vocabulary within Inquiry Science Instruction for English Language Learners

David T. Crowther, University of Nevada, Reno, crowther@unr.edu

Monday, March 26, 2012

ABSTRACT: Most academic vocabulary instruction for English Language Learners utilizes a frontloading dominant approach found within direct instruction methods. This research utilizes a combination of a Blended approach to scaffold vocabulary across a learning cycle (Carr, Sexton & Lagunoff, 2006) while utilizing the Tiered vocabulary distinction (Beck, McKeown, & Kucan, 2002 & 2008) to develop academic vocabulary for English Language Learners while engaging in inquiry science. 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 science lesson (Lee, Adamson, Maerten-Rivera, Lewis, Thornton, & LeRoy, 2008). Additionally, teachers need to identify target academic vocabulary and scaffold the target vocabulary into tiers based upon life experience, language acquisition level, and previous science knowledge. Once vocabulary has been identified and tiered, educators must know when to explicitly execute appropriate tiered vocabulary within the lesson for optimal language learning (Crowther, Wallstrum, Tibbs, Storke & Leonis, 2011). This paper describes the blended / tiered strategy and summarizes five separate studies utilizing the strategy. Finally, the studies are compared through effect size analysis to demonstrate the practical effectiveness of the strategy in K-6 classrooms.

Better Science Learning through Imagery

Marisa T. Cohen, St. Francis College, MarisaTCohen@gmail.com

ABSTRACT: This study examined the effect of imagery interventions for the presentation of novel science vocabulary. Eighty-nine students from two schools in Long Island participated in this study and were randomly assigned to four interventions: Picture Presentation, Image Creation- No Picture, Image Creation- Picture, and Word Only. Results demonstrated that students in the imagery intervention groups scored higher on the outcome measures at both immediate and delayed recall. It was also shown that the deeper the students processed the “to be learned” vocabulary words, the higher they scored on the outcome measures. Such a study has implications as to the most effective way to integrate science and literacy and successfully present novel concepts in the classroom.

Science Language and Conceptual Understanding in Second Grade: Promoting Gains Across Levels of English Proficiency

Sheryl L. Honig, Northern Illinois University, shonig@niu.edu

ABSTRACT: This study examined the effects of Language-Enriched Science Instruction (LESI) on children's science vocabulary and conceptual knowledge. Three second-grade classrooms participated in the school district textbook instruction, while the other three classrooms implemented Language Enriched Science Instruction, which included multiple informational trade books, hands-on activities, vocabulary activities, read-alouds, partner reading, and journal writing. Results suggest that LESI was more effective in increasing children's vocabulary and conceptual knowledge. In addition, children who participated in LESI wrote longer explanations, using a wider range of scientific vocabulary at a higher rate of complexity, expressing more complete science concepts. Finally, type of instruction was found to be a stronger predictor of children's outcomes than was prior vocabulary knowledge.

Monday, March 26, 2012

**Strand 4: Science Teaching--Middle and High School (Grades 5-12): Characteristics and Strategies
Symposium - Global Warming Climate Change: Perspectives on Student Learning and Adaptation of
Instructional Materials**

8:30am – 10:00am, Room 313

President: J. Randy McGinnis, University of Maryland

Presenters:

Anita Roychoudhury, Purdue University, aroychou@purdue.edu

Daniel Shepardson, Purdue University

Bruce Patton, The Ohio State University

Melissa George, Tecumseh Junior High School

Susie Burton, Tecumseh Junior High School

Joel Wilson, Frankfort Middle School

Nicole Goodwine, Benton Middle School

ABSTRACT: In this symposium we will discuss two important topics of our time – global warming and climate change - from the perspectives of science educators, scientists, and teachers. We will also present the findings from a project focused on teaching and learning of these topics. 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 successes 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 4: Science Teaching--Middle and High School (Grades 5-12): Characteristics and Strategies
The Pedagogy of Argumentation**

8:30am – 10:00am, Room 303

President: Vanessa Kind, Durham University

Mapping Model to Argument -based Inquiry as an Approach to Support Middle School Teachers in Teaching Climate, Weather, and Energy Topics

Morgan B. Yarker, University of Iowa, morgan-e-brown@uiowa.edu

Charles O. Stanier, University of Iowa

Cory T. Forbes, University of Iowa

Soonhye Park, University of Iowa

ABSTRACT: The use of science models is common practice throughout the scientific community; however models are most predominately experienced by the general public by way of weather and climate forecasting. Although familiar with weather forecasts on television and the Internet, most people do not understand the process of using computer models to generate weather and climate forecasts as a process of drawing claims from evidence. As a result, the public often misunderstands claims scientists make about their daily weather as well as the state of climate change. According to the National Science Education Standards, teachers are encouraged to science models into the classroom as a way to aid in the understanding of the nature of science. However, there is very little description of what constitutes a science model so teachers often use models as visual representations; but the purpose of science models is often overlooked. This paper will discuss the concept of science modeling and how model-based inquiry can be conceptualized as a form of argument-based inquiry. With this

Monday, March 26, 2012

perspective, a professional development model was implemented for 6-9 grade teachers as a way to support them in the effective use of science models in the classroom.

Using Laboratory Activities that Emphasize Argumentation and Argument to Help High School Students Learn how to Engage in Scientific Inquiry and Understand the Nature of Scientific Inquiry

Victor D. Sampson, Florida State University, vsampson@fsu.edu

Jonathon Grooms, Florida State University

Patrick J. Enderle, Florida State University

Sherry A. Southerland, Florida State University

ABSTRACT: This study explored the extent to which high school students enrolled in high school Biology developed better inquiry abilities and a more nuanced understanding of the nature of scientific inquiry as a result of their participation in a series of laboratory activities. The laboratory activities were designed using the Argument-Driven Inquiry (ADI) instructional model. The results suggest that this sample of students' inquiry skills improved with each semester of ADI-based laboratory instruction and their understanding of the nature of scientific inquiry improved by the end of the year. The study described in this proposal provides further evidence of the benefits of integrating argument focused lab instruction into the teaching and learning of science.

Effective Teaching Strategies to Promote Argumentation Skills about Socioscientific Issues

Vaile Dawson, Curtin University of Technology, v.dawson@curtin.edu.au

Grady J. Venville, University of Western Australia

ABSTRACT: The ability to justify and defend a decision using a well constructed argument is an important outcome of science education. Students need to develop the skills to participate in reasoned debate and to make informed personal choices about socioscientific issues (SSI). Using a mixed methods research design seven biology teachers participated in professional development on argumentation, decision-making and SSI before introducing argumentation skills and SSI to Grade 9 or 10 students studying genetics. The students' (n=193) ability to construct an argument was measured using pre and posttest and compared to a control group of students (n=186) from the same schools. Students who were explicitly taught about argumentation improved significantly more in their argumentation skills. Qualitative data sources included classroom observations, lesson transcripts, teacher and student interviews. Modelling of argumentation skills, writing frames, whole class and small group discussion contributed to an improvement in students' argumentation skills. This presentation will focus on the types of teaching strategies used by teachers that were most likely to promote the development of students' argumentation skills. These strategies included: encouraging ideas and valuing different positions; prompting students for evidence; encouraging critique of evidence and claims: and encouraging reflection on the argumentation process.

Constructing and Negotiating Claims and Evidence in Scientific Inquiry Investigations

Aeran Choi, Kent State University, aeran-choi@hotmail.com

Jeonghee Nam, Pusan National University

ABSTRACT: This study examined the extent to which Korea 7th grade students construct and negotiate claims and evidence through group/class discussions as well as with reading resources in an argument-based inquiry approach, the Science Writing Heuristic (SWH) approach. Four 7th grade science teachers from three middle schools located in the second largest city in Korea participated in this study. Writing samples were collected from two-hundred forty students from eight classes of the four teachers. The

Monday, March 26, 2012

total number of writing samples was one thousand two hundreds with respect to five activities such as 'relationship between states of matter and mass,' 'diffusion,' 'gas temperature and volume,' 'forces,' and 'friction.' Video records of 50 min from each of the four teachers on the topic, 'gas temperature and volume' were collected and transcribed. Data analyses indicate that students refined claims through group negotiation and proposed more accurate and sufficient claims at the group level. Students also developed a supportive claims-evidence relationship by providing more sufficient and accurate evidence and provided more evidence with detailed description of data/observation from a lab activity after group and class negotiations. Students provided evidence using more multiple modal representations as they were given reading resources.

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

Science and Mathematics Integration

8:30am – 10:00am, Room 304

Presenter: Penny J. Gilmer, Florida State University

A Faculty Learning Community for Integrating Quantitative Statistical Analysis into Undergraduate Biology: Preliminary Impacts and Lessons Learned

Loran Carleton Parker, Purdue University, carleton@purdue.edu

Annwesa Dasgupta, Purdue University

Omolola A. Adedokun, Purdue University

James Forney, Purdue University

Dennis J. Minchella, Purdue University

ABSTRACT: Transformation of research in all biological fields necessitates the design, analysis and, interpretation of large data sets. Preparing students with the requisite skills in experimental design, statistical analysis and interpretation, and mathematical reasoning will require both curricular reform and faculty who are willing and able to integrate mathematical and statistical concepts into their life science courses. A year-long faculty learning community (FLC) was created to assist in the transformation of the life sciences curriculum at a large, Midwestern research university. Participants were interviewed after participation and surveyed before and after participation to assess the impact of the FLC on participants' attitudes toward teaching, perceived pedagogical skills, and planned teaching practice. Overall, the FLC had a meaningful positive impact on participants' attitudes toward teaching and perceived pedagogical skills. However, after participating, faculty's enthusiasm for the teaching process and for viewing teaching-as-research exhibited a meaningful decline. Implications for the creation and development of FLCs for science faculty are discussed.

College Students' Views of the use of Mathematics in Physics: A Case Study of Two Cohorts

N. Sanjay Rebello, Kansas State University, srebello@phys.ksu.edu

Carina M. Rebello, University of Missouri

ABSTRACT: Several research studies have shown that novice learners tend to use equation-based means-ends strategies in solving science problems. Comparatively few studies have explored how students think of mathematical equations as they apply to science. We adapted a framework used by mathematics educators to characterize students' use of mathematics in physics. This framework provides a lens to investigate how students view the use of equations in physics. Here we present a case study with two cohort groups, one from an algebra-based physics course and another from a calculus-

Monday, March 26, 2012

based physics course. We interviewed seven students from each cohort to characterize the ways in which they described the relationship between mathematics and physics and the meaning and use of physics equations. Our results indicate that students in both cohorts typically think of equations as tools, with no conceptual underpinning. Students' descriptions of unfamiliar equations were more diverse than descriptions of familiar equations. Further we also interviewed the instructors of these two courses. Their views and instructional goals for these two classes might help explain why students in our two cohorts, with different levels of mathematical preparation – algebra and calculus, had similar views about the use of mathematics in physics.

Secondary Preparation for College Calculus: A Phenomenography of Mathematics Professors' and Mathematics Teachers' Perspectives

Carol H. Wade, Harvard University, cwade@cfa.harvard.edu

Zahra Hazari, Clemson University

Gerhard Sonnert, Harvard University

Phil Sadler, Harvard University

ABSTRACT: Abundant evidence indicates many students in the United States are not adequately prepared for college calculus. How to implement instruction to adequately prepare students for college calculus is a concern to both college mathematics professors and secondary mathematics teachers. This is important because readiness for success in college calculus is a known gatekeeper for success in STEM majors. The data used in this study was drawn from the Factors Influencing College Success in Mathematics (FICSMath) study, which focused on finding evidence for effective strategies that prepare students for college calculus success. The FICSMath study followed the Factors that Influence College Science Success (FICSS) study after secondary mathematics was found to be a significant predictor of success in college biology, chemistry, and physics. Mathematics professors and secondary mathematics teachers across the nation responded to an online survey. Professors were asked, "What do high school teachers need to be doing to prepare their students for college calculus success?" and mathematics teachers were asked, "What are you doing that you think prepares students for college calculus success?" Phenomenographical analysis compared the commonalities and variation between the mathematics professors and secondary mathematics teachers' responses.

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

Students' Reasoning and Science Learning

8:30am – 10:00am, Room 309

Presider: Janell Nicole Catlin, Teachers College, Columbia University

Students' Reasoning and the Level of Interactivity in Science Content Courses for Future Elementary Teachers

Dean A. Zollman, Kansas State University, dzollman@phys.ksu.edu

Mojgan Matloob-Haghanikar, Winona State University

Sytil Murphy, Shepherd University

ABSTRACT: As part of a study of the science preparation of elementary school teachers, we investigated the quality of students' reasoning and explored the relationship between sophistication of reasoning and the degree to which the courses were measured to be interactive. First, we devised written content exam questions, which were open ended and required students to apply recently learned concepts in a

Monday, March 26, 2012

new context. All the questions developed were based on a common template that required students to recognize and generalize the relevant facts or concepts and apply them. To evaluate students' answers, we developed a rubric based on Bloom's taxonomy as revised and expanded by Anderson et al. Along with analyzing students' reasoning, we visited 20 universities, observed the courses and used the RTOP to determine their level of interactivity. Statistical analyses indicate some relationship between the students' reasoning on the exams and the level of interaction in the class.

Exploring the Role of Non-Adaptive Reasoning in Students' Evolutionary Explanations

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

Ross H. Nehm, The Ohio State University

ABSTRACT: Non-adaptive evolutionary causes, such as genetic drift, comprise an important element of biologists' explanatory models of evolutionary change, and yet science education research has focused almost exclusively on student ideas and misconceptions about natural selection. After instruction that includes non-adaptive causal factors (such as genetic drift), how do students construct evolutionary explanations? We used clinical interviews, open-response and multiple-choice instruments to investigate undergraduate students' non-adaptive reasoning (NAR) patterns. After instruction, we found NAR to be very uncommon in students' explanatory models of evolutionary change in both written assessments and clinical interviews. However, when NAR was used by students it was conceptualized in an expert-like way; that is, non-adaptive factors were modeled as alternatives to selection. Interestingly, non-adaptive reasoning was not found to be associated with greater understanding of natural selection in interviews or written assessments, or with fewer misconceptions of natural selection. Thus, NAR appears to be a distinct facet of evolutionary thinking. Greater attention to NAR in biology education is needed given how uncommonly students use it to explain evolutionary change.

The Development and Validation of Critical Thinking, Multiple Choice Items for Introductory College Biology

Lauren J. Ivans, University of Georgia, LJIvans@uga.edu

Julie M. Kittleson, University of Georgia

ABSTRACT: An alarmingly high percentage of college and university graduates—even those with science degrees—fail to develop critical thinking skills. College science educators are therefore under pressure to push their students to become critical thinkers. Designing assessments that require critical thinking is one way to push students to think. Unfortunately, large enrollments of many university science courses necessitate easy to score multiple choice exams and these exams tend to be mostly recall. Our research addresses this issue by developing and validating multiple choice questions that require critical thinking for an introductory biology class. To validate that the items we write require critical thinking skills we: seek expert review from biologists, university science educators, and educational measurement specialists; test our items in cognitive think-aloud sessions with students, obtain written reports from introductory biology students on how they processed our items, and apply an Item Response Theory model to our large scale pilot test data. The validation data we collect provide a window into the cognitive processes of college science students and insight into how to assess critical thinking. The test items we validate become tools for increasing the cognitive rigor of introductory biology exams and for challenging students to think critically. An alarmingly high percentage of college and university graduates—even those with science degrees—fail to develop critical thinking skills. College science educators are therefore under pressure to push their students to become critical thinkers. Designing assessments that require critical thinking is one way to push students to think. Unfortunately, large

Monday, March 26, 2012

enrollments of many university science courses necessitate easy to score multiple choice exams and these exams tend to be mostly recall. Our research addresses this issue by developing and validating multiple choice questions that require critical thinking for an introductory biology class. To validate that the items we write require critical thinking skills we: seek expert review from biologists, university science educators, and educational measurement specialists; test our items in cognitive think-aloud sessions with students, obtain written reports from introductory biology students on how they processed our items, and apply an Item Response Theory model to our large scale pilot test data. The validation data we collect provide a window into the cognitive processes of college science students and insight into how to assess critical thinking. The test items we validate become tools for increasing the cognitive rigor of introductory biology exams and for challenging students to think critically.

Correcting Misconceptions in an Introductory Biology Course

Camille E. Naaktgeboren, College of Southern Nevada, Microbiology Instructor,
 Camille.Naaktgeboren@csn.edu
 Barbara A. Austin, Wittenberg University

ABSTRACT: The analysis of a survey of common biology misconceptions administered to students in an introductory biology laboratory indicates that students are capable of changing misconceptions with certain teaching techniques. We found that when students receive the opportunity to be told why certain ideas are incorrect and have laboratory exercises to support the correct understanding of a topic there is a statistically significant decrease in the number of misconceptions held by students. However, when students engaged in small group discussion of concepts with peers, fewer misconceptions were corrected even when the same instruction was used. We also found that different types of misconceptions may be easier or more challenging to change than others. Misconceptions involving the use of vocabulary specific to the biological sciences appear to have been more easily changed than those not using biological terminology.

Strand 6: Science Learning in Informal Contexts

Professional Development for Educators: Identity Development and Learning in Informal Institutions

8:30am – 10:00am, Room 305

Presenter: Anita Welch, North Dakota State University

The Long Term Impact of Working as a Floor Facilitator in a Science Center

Preeti Gupta, New York Hall of Science, pgupta@nysci.org

ABSTRACT: Many informal science institutions choose to use youth as floor staff and invest a considerable amount in training and preparing them to interact with visitors, be comfortable with the content of the exhibits and present effectively. While we can easily determine how youth develop and grow while in our programs, how can we know what happens to them as a result of this experience in the long term, especially as related to interests in science as a career and general science literacy? In this paper we describe the long-term impact of working as floor facilitator in one particular science center make claims about the specific activities that youth facilitators engage in which may mediate the long-term impact.

Monday, March 26, 2012

Characterizing Farmworker Pesticide Educators in a Southeastern State: An Examination of Informal Science Educators' Beliefs about Teaching, Pesticides, and Self

Catherine E. LePrevost, North Carolina State University, celeprev@ncsu.edu

Margaret R. Blanchard, North Carolina State University

Gregory Cope, North Carolina State University

ABSTRACT: Pesticide educators function as informal science educators and risk communicators for the at-risk farmworker population. Despite the key role of pesticide educators in promoting farmworker science literacy, safety, and health, data regarding pesticide educators are absent in the literature. Educator beliefs shape practices; therefore, this mixed-method, multi-case study investigated the beliefs of 19 farmworker pesticide educators from four types of institutions in one southeastern U.S. state. Beliefs about teaching, pesticide risks, and self were selected for examination. Teaching beliefs of pesticide educators ranged from traditional to reform-based, with most being transitional (i.e., focused on educator/farmworker relationships). Findings indicate that these pesticide educators have expert-like beliefs about pesticide risk. A positive correlation ($r = 0.455$, $p = 0.0578$) existed between concern about adverse health outcomes associated with pesticides and farmworker-centered teaching beliefs. Self-efficacy scores ranged from low to moderate, lower than is typically found in science teachers. Interestingly, findings suggest an inverse relationship ($r = -0.468$, $p = 0.0503$) between self-efficacy and farmworker-focused beliefs about teaching. Patterns of beliefs were found by institutional affiliation and number of training sessions provided. Study results have direct implications for modifications to teacher belief constructs and for pesticide educator professional development.

Experience, Capacity and Identity: Understanding Teachers at the Boundary between Schools and Informal Science Institutions

James F. Kisiel, California State University, Long Beach, jkisiel@csulb.edu

ABSTRACT: Although many science educators espouse the importance of using informal learning contexts (such as museums, aquaria and the like) to support science instruction in formal (school) settings, the pairing of the formal and informal learning contexts has proven to be challenging. This investigation attempts to identify those factors that distinguish 'avid-users'—those who report using informal science education institution (ISEI) resources more frequently—from other teachers as a way to better understand how we might help teachers make better use of such community resources. Findings reveal that frequent use of ISEIs for student field trips is not correlated with use of other ISEI resources (e.g. outreach programs, website resources, professional development), suggesting different kinds of avid-users. In addition, the investigation revealed the importance of previous exposure (via visits as a student or family member) as well as perspectives of success and school organization. Factors that didn't distinguish avid- and average-users included lack of funding, years of teaching experience, and a school's NCLB status. Qualitative data (via teacher interviews) further strengthen these findings. Results suggest a particular teacher identity reflective of their participation in a community of practice—specifically a practice at the boundary between formal and informal science learning contexts.

"Wow! Look at That!": The Impact of Professional Development in Informal Science Contexts on Teachers' Discourse

Gary M. Holliday, University of Akron, g.holliday@mac.com

Norman G. Lederman, Illinois Institute of Technology

Judith S. Lederman, Illinois Institute of Technology

Monday, March 26, 2012

ABSTRACT: Currently, it is not clear whether professional development staffs at Informal Science Institutions (ISIs) are considering the way exhibits contribute to the social aspects of learning as described by the Contextual Model of Learning (Falk & Dierking, 1992, 2000). In order to move beyond only preparing science teachers for field trips, while necessary, it is also important to understand the role exhibits play in influencing teachers' content related social interactions while engaged in ISI professional development. This study looked at two life science courses that were offered at and taught by education staff of a large science and technology museum located in the Midwest. Elementary and middle school teachers that taught science (n = 124) were audio and videotaped while participating in the courses and when interacting with the museum's exhibits. When considering the two factors within the sociocultural context of CML: within-group sociocultural mediation and facilitated mediation by others, the use of exhibits during both courses generally did not fully take into account these elements. Recommendations are made for ISI professional development and includes: PD for ISI educators, a central knowledge framework for ISI educators (Tran & King, 2007), provision of reflection opportunities and debrief during teacher PD, and preparation of instructional materials that allow for teacher conversations with explicit content connections during ISI PD.

Strand 7: Pre-service Science Teacher Education

Chemistry Teacher Preparation

8:30am – 10:00am, Room 306

Presenter: Lloyd H. Barrow, University of Missouri

Developing Topic Specific PCK in Pre-service Chemistry Teachers

Elizabeth M. Mavhunga, Wits University, Elizabeth.Mavhunga@wits.ac.za

Marissa S. Rollnick, Wits University

ABSTRACT: The study explored the effect of an intervention to improve pre-service teachers' understanding of Topic Specific Knowledge for Teaching (TSKfT) chemical equilibrium in developing the corresponding topic specific PCK. TSKfT is a theoretical construct comprised of five content specific teaching components collectively thought to effect transformation of subject matter knowledge (SMK). A mixed method approach was used in a case study of 17 pre-service physical science teachers in their final year of study. The treatment consisted of an intervention in the form of a course that explicitly promoted understanding of TSKfT for chemical equilibrium. A topic specific tool for PCK was used to measure the quality of pre- and post-PCK. Understanding of SMK of the topic was determined using pre- and post- diagnostic tests. The PCK instrument was found reliable and both tests showed significant pre-post differences at the 0.05 level using a Wilcoxon paired signed ranks test. The major finding was that improved understanding of TSKfT for a chemical equilibrium, improved the quality of the topic specific PCK. Another unexpected finding was that teaching content matter with explicit engagement of TSKfT is effective for improving SMK.

Differences in the Degree of Scientific Realism of Secondary Pre-Service Chemistry and Physics Teachers

Norman F. Riehs, University of Duisburg-Essen, norman.riehs@uni-due.de

Stefan Rumann, University of Duisburg-Essen

ABSTRACT: Theoretical works of different authors lead to the assumption that the subject of study influences the epistemological stances of the students. Within the group of pre-service science teachers views on aspects of Nature of Science can differ between biology, physics, and chemistry student

Monday, March 26, 2012

teachers. A questionnaire was carried out to measure the degree of scientific realism of pre-service secondary physics and chemistry teachers (students and Ph.D. students; n = 41). The results are insightful. The chosen items are comprehensible and show a good reliability. The size of the sample admits of partial credit modeling. The difference of the degree of scientific realism is both huge and significant, multiple regression analysis shows the degree of scientific realism as to be influenced by the subject of study and the interest in philosophy of science. Chemistry teachers tend to scientific realism- physics teachers tend rather to anti-realism. The findings are of interest in respect to the development of curricula including aspects of Nature of Science—both in school and university curricula.

Development of Pre-service Chemistry Teachers' Pedagogical Content Knowledge for Teaching Nature of Science

Betul Demirdogen, Middle East Technical University, dbetul@metu.edu.tr

Deborah L. Hanuscin, University of Missouri

Esen Uzuntiryaki, Middle East Technical University

Fitnat Koseoglu, Gazi University

ABSTRACT: The purpose of this study is to delve into the complexities of development of preservice chemistry teachers' science teaching orientation, knowledge of learner, knowledge of instructional strategies, and knowledge of assessment during Pedagogical Content Knowledge (PCK) for Nature of Science (NOS) instruction. 30 pre-service chemistry teachers enrolled Research in Science Education course participated to the study. Case study, one of the qualitative research methods, was used as research design. PCK for NOS spanned two semester weeks including learning nature of science and learning how to teach nature of science parts. This study only involved the collection of qualitative data sources including responses given to an open ended instrument, interviews, observations, and documents such as lesson plans and reflection papers. The in-depth analysis of explicit PCK and constant comparative method was used as data analysis method. Although all participants developed PCK for NOS in some extent and nevertheless the participants' PCK for NOS were different from each other in terms of both the degree of integration among the components and the degree to which these components and connections manifest themselves in their lesson plans and reflection papers.

Strand 8: In-service Science Teacher Education

Related Paper Set - Supporting and Retaining High Quality Secondary Science Teachers: Evidence from the Knowles Science Teaching Foundation

8:30am – 10:00am, Room 105

Presider: Nicole Gillespie, Knowles Science Teaching Foundation

Discussant: Mark St. John, Inverness Research

ABSTRACT: Over the last decade, warnings have come from multiple directions that unless we improve math and science teacher quality, we will make little progress towards national goals for equity, an informed citizenry, science/technological progress, or a 21st century workforce. However, teacher retention studies suggest that increasing numbers will not necessarily increase quality. Nearly half of all beginning teachers leave the field within five years, and the most academically qualified candidates often are the first to go. Each year, since 2002, The Knowles Science Teaching Foundation rigorously selects high quality secondary science teacher candidates who are committed to teaching and teacher leadership and supports them with a multi-year teaching fellowship. The overall goal of this session is to share what we have learned during the past 10 years of ongoing research and evaluation studies of the

Monday, March 26, 2012

teaching fellowship program about essential components for supporting both teacher quality and retention. We will also raise questions and challenges for the next 10 years, not only for ourselves as an organization, but for those who share in the work of ensuring the next generation of committed, professional, high quality science teachers and teacher leaders.

Recruitment and Selection of High Quality Teacher Candidates

Jodie Galosy, Knowles Science Teaching Foundation, jgalosy@kstf.org
Howard Glasser, Knowles Science Teaching Foundation
Erin Rizor, Knowles Science Teaching Foundation
Nicole Gillespie, Knowles Science Teaching Foundation
Mark St. John, Inverness Research

Progress and Challenges in Developing a Professional Learning Community to Support Teacher Learning and Retention

Zora Wolfe, Knowles Science Teaching Foundation, zwolfe@kstf.org
Paul Wendel, Knowles Science Teaching Foundation
Jodie Galosy, Knowles Science Teaching Foundation

Key Practices for Supporting the Development of Pedagogical Content Knowledge

Roseanne Rostock, Knowles Science Teaching Foundation, rrostock@kstf.org
Michele Cheyne, Knowles Science Teaching Foundation
Jodie Galosy, Knowles Science Teaching Foundation
Nicole Gillespie, Knowles Science Teaching Foundation

Developing a Continuum for Teacher Leadership

Carol Rulli, Knowles Science Teaching Foundation, crulli@kstf.org
Jodie Galosy, Knowles Science Teaching Foundation
Erin Rizor, Knowles Science Teaching Foundation

Strand 8: In-service Science Teacher Education

Promoting the Teaching of Inquiry

8:30am – 10:00am, Room 106

Presider: Carol L. Stuessy, Texas A&M University

Science by Doing: Enhancing Teachers' Skills in Inquiry-Based Teaching through a Resource-Supported Professional Learning Approach

Leonie J. Rennie, Curtin University, l.rennie@curtin.edu.au
Denis Goodrum, Australian Academy of Science
Amelia Druhan, Australian Academy of Science

ABSTRACT: The Professional Learning Approach (PLA) of the Science by Doing (SbD) program is based on the premise that the most effective and self-sustaining model of professional learning is a team of teachers – a professional learning community (PLC) – working together to improve their students' learning. The SbD PLA has four components to assist the PLC: leadership, professional learning resources, curriculum resources, and support. During a two-term trial of the PLA, SbD Coordinators from

Monday, March 26, 2012

each school experienced the resources during an initial leadership workshop, followed by school visits by members of the SbD team during the trial period. A final workshop “debriefed” Coordinators, and various student work samples and annotated resource materials were collected. The PLA model was evaluated during the trial by collecting data from surveys administered during the initial and final professional learning workshops; interviews with Coordinators, teachers and principals in 9 of the 28 participating schools; and field notes taken during the workshops and school visits. Data analysis indicated that the PLA experienced considerable success attributable to the Coordinators’ familiarity with the resources, the clear focus on student outcomes; and the value of the resources. Based on feedback from the trial, the resources have been further enhanced.

Tracking Teachers' Change in Teaching Science as Inquiry: Different Teachers, Different Journeys

Daniel K. Capps, University of Maine, danielkcapps@gmail.com

Barbara A. Crawford, Cornell University

ABSTRACT: This study examined teaching practice related to inquiry and nature of science (NOS) of teachers before and after participating in a professional development (PD) program. Twenty, 5th-9th grade teachers participated in a six-day summer institute. Teachers participated in geologic field trips, engaged in the curriculum and investigation from the perspective of learners, and learned about reform-based teaching practices. We followed a subset of these teachers into their classrooms to investigate the ways in which they changed their practice after participating in the program. Data sources included: application materials, pre-post institute video, pre-post institute interviews, teacher reflections, and interviews with teachers as they enacted the curriculum. Findings indicated that most teachers began to incorporate reform-based practices into their teaching after the institute. However, instructional practice varied based on teachers’ understandings of subject matter and views of inquiry and NOS. Interestingly, change was not always permanent. After several months even some of the most promising teachers used less inquiry and NOS in their practice. The findings from this study help us to better understand the complexities of teacher change related to inquiry and NOS. Results from this investigation may benefit future studies that aim to support teachers in changing their teaching practice.

Middle and High School Science Teachers' Inquiry Lesson Development and Implementation

Sue Ellen DeChenne, University of Nebraska - Lincoln, sdechenne2@unlserve.unl.edu

Gina Kunz, University of Nebraska - Lincoln

Gwen Nugent, University of Nebraska - Lincoln

Linlin Luo, University of Nebraska - Lincoln

Brandi Berry, University of Nebraska - Lincoln

Katherine Craven, University of Nebraska - Lincoln

April Riggs, University of Nebraska - Lincoln

ABSTRACT: Despite a continued emphasis on inquiry at the national and state levels, many science teachers do not know how to teach inquiry. Although well designed professional development can improve teachers’ inquiry knowledge and skills, teachers rarely successfully implement new teaching strategies, learned during summer workshops, in their classrooms. A summer professional development experience for science and mathematics teachers was developed that included: modeling, science inquiry coaching, feedback, and practice. Four science teachers and their coaches were selected for a case study of this professional development experience. Results indicated that most teachers and coaches increased their inquiry knowledge, became more confident in their ability to teach using guided-inquiry, and produced a guided inquiry lesson. Students in their classes had high levels of

Monday, March 26, 2012

engagement during the guided-inquiry lesson. Coaches were important for lesson development and implementation for three of the four teachers. A coach/teacher relationship based on respect and trust was important for effective coaching. Coaches provided feedback on ideas, lesson structure, focus, and implementation. They also provided encouragement, especially for the least experienced teachers. Teachers also indicated time for lesson development and the opportunity to practice the lesson were important elements. Implications for in-service and pre-service teachers are discussed.

A Teacher Professional Development Model Focused on Authentic Science Practices in the Classroom

Barbara A. Crawford, Cornell University, bac45@cornell.edu

Daniel K. Capps, The University of Maine

Maya Patel, Ithaca College

Xenia S. Meyer, University of California, Berkeley

Robert Ross, The Paleontological Research Institution

ABSTRACT: In this paper we focus on developing a viable research-based model to enhance teachers' knowledge and classroom practice of scientific inquiry and nature of science (NOS). This conceptual paper is built on a framework for teacher learning and describes our designed professional development model focused specifically on science practices in the classroom, that supports students in carrying out authentic work and learning about NOS. We argue that an effective professional development model should immerse teachers in experiencing authentic scientific inquiry in meaningful contexts, and be similar to what and how they will teach in their classrooms. Further, the model focuses on content and pedagogical knowledge, supports teachers in developing their own inquiry-based lessons, and challenges teachers to examine their knowledge and beliefs and reflect on their teaching practice, all taking place within a community of learners. We propose an integrated approach, situating teachers in both science and school issues. We have over three years of project data that suggests when teachers experience the PD model and use the curricular materials there are statistically significant changes in teacher and student learning; there is positive influence on content knowledge and understandings of inquiry and NOS of teachers and their students.

Strand 10: Curriculum, Evaluation, and Assessment

Strand Sponsored Symposium - New Generation of Science Curriculum and Assessment: International Perspectives

8:30am – 10:00am, Room 308

Presider: Ling L. Liang, LaSalle University, USA

Presenters:

Gavin W. Fulmer, National Science Foundation, USA

Michael J. Reiss, Institute of Education, University of London, UK

Lingbiao Gao, South China Normal University, China

Larry D. Yore, University of Victoria, Canada

Joseph S. Krajcik, University of Michigan, USA

ABSTRACT: The National Research Council (NRC) recently released its much-anticipated report that presents a new framework for K-12 science and engineering education. According to the new framework, "K-12 science and engineering education should focus on a limited number of disciplinary core ideas and crosscutting concepts, be designed so that students continually build on and revise their knowledge and abilities over multiple years, and support the integration of such knowledge and abilities

Monday, March 26, 2012

with the practices needed to engage in scientific inquiry and engineering design." In this invited strand session, the panelists from the UK, China, Canada, and the US will talk about new initiatives for science curriculum and/or assessment in their countries and present their perspectives on the trends and issues in the curriculum and/or assessment development in an international science education research context.

Strand 11: Cultural, Social, and Gender Issues

Cultural and Linguistic Diversity: Implications for Career Choices and Classroom Learning

8:30am – 10:00am, Room 107

Presider: Christina Siry, University of Luxembourg

A Case Study Exploring Latina Girls' Perceptions of Pursuing a Career in Biology

Yeni Violeta Garcia, University of Northern Colorado, yeni.garcia@unco.edu

ABSTRACT: The future of this country depends on utilizing human intellectual resources from varying viewpoints to make informed decisions on issues from conservation biology to bioengineering. An increase in Latina students in biology would bring a variety of viewpoints, as well as personal and cultural experiences. To insure that we have enough biology experts in the future, we must look into a resource that has not been previously used to the fullest. A career in biology referred to professions that require an expertise in biology that is gained by completing bachelor's degree in biology or an affiliated field. This study explored the experiences that two Latina students, one documented and the other undocumented, are encountering in their final two years of high school, and to investigate the nature of the experiences related to their decision to pursue a career in biology. I used interviews, artifacts, life narratives, and cultural descriptors to gain an understanding of the girls' past, present, and future decisions regarding the feasibility of pursuing a degree in biology. Cross-case analysis were explored through a Critical Race Theory lens, focusing on barriers within the cultural commons that act against Latina choices of career.

Immigrant Generation as Predictor for Pursuing Careers in Life Sciences, Physical Sciences and Engineering

Florin D. Lung, Clemson University, florinlung@gmail.com

Geoff Potvin, Clemson University

Gerhard Sonnert, Harvard-Smithsonian Center for Astrophysics

Philip M. Sadler, Harvard-Smithsonian Center for Astrophysics

ABSTRACT: Investigation of socio-cultural characteristics, such as nationality, race, ethnicity, gender, and socio-economic status, is able to provide valuable insights into the decisional process college students undergo when choosing to pursue careers in sciences. Here we investigate the differences in the likelihood of choosing a career in sciences by new immigrants, children of former immigrants, and non-immigrants. The concepts employed to describe such individual choices made by students moving from a cultural space to another (immigrants) or within their own cultural space (US-born) are the career field (rules of the game), habitus (feel of the game) and capital (as crystallized form of habitus). Data from a US-representative sample of college freshman students are used. Exploration of data using correspondence analysis of data suggests that first generation immigrants are significantly more likely to opt for careers in life sciences, physical sciences and engineering than their US-born counterparts. This reflects the picture of individual career habituses formed under direct influences of structurally distinct

Monday, March 26, 2012

cultures. Subsequent statistical analysis confirmed the hypothesis even controlling for immigrant generation covariates. Acknowledging this result can potentially have a significant impact on students' educational choices, instructors' teaching and colleges' recruiting strategies, and public policies toward education and immigration.

Microcosmos: A Culturally Relevant Science-Learning Environment for 2nd Generation Latino Elementary Students

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

Consuelo J. Morales, University of Michigan, Ann Arbor

Teresa Satterfield

ABSTRACT: Hispanics perform worse than their Anglo- and Afro-American peers academically (Gándara & Contreras, 2010). As science educators, we are responsible for responding to the urgent need of helping the growing population of Hispanic children to develop inquiry skills that help them succeed at school. We contribute to this goal by designing a culturally relevant science-learning environment: Microcosmos. This case study investigates the features of a science-learning environment that make it culturally relevant for 2nd generation Latino children, while also fostering scientific inquiry skills. Microcosmos incorporates scientific discourse and practices into students' ways of understanding and talking about the world, while simultaneously learning about ecological concepts, and notable Hispanic scientists. 15 students participated in Microcosmos as part of a Spanish Saturday School. Results show, through sustained observation of natural phenomena with supports for parents to get involved, and by valuing students' cultural identities, students can/do learn science concepts and abilities necessary to match the performance of children deriving their knowledge from formal school settings. We present Microcosmos' features possible to implement in classrooms elsewhere that proved to be culturally relevant for children and parents. Our study generates needed information in the area of equity in science education (Lee et al., 2006).

How One Teacher Promoted Science Discourse among English Learners: Describing Pedagogical Successes and Continued Challenges

Lauren H. Swanson, Whittier College Whittier, California, lswanson@whittier.edu

ABSTRACT: Two physical science lesson sequences were investigated to describe one teacher's pedagogical decisions surrounding the use of science discourse among English learners. Data sources included videotape of whole class and small group interactions, teacher and student focus-group interviews, and curricular materials such as lesson plans, handouts, and assessments. The teacher characterized science discourse along three dimensions: 1) the use of evidence-based explanations; 2) the practice of sharing one's science understandings publically; and 3) the importance of using precise language. Furthermore, the teacher believed that promoting science discourse would enhance students' English language skills. Analysis of student participation during in-class activities highlighted how the teacher's pedagogical decisions provided opportunities for English learners to develop science discourse skills. They generated evidence-based explanations of scientific phenomena; shared their ideas with peers; and took up several of the specialized academic vocabulary used during instruction. However, analysis of student interactions also revealed that some of the teacher's instructional decisions yielded an unintended outcome: English learners were less likely to participate in whole class discussions. Though these students participated in small group discussions, they rarely shared their own or their group's ideas with the larger class.

Monday, March 26, 2012

Strand 12: Educational Technology

Cognitive Reasoning with Technology

8:30am – 10:00am, Room 101

Presenter: Barbara C. Buckley, WestEd

Levels of Reasoning among Girls Engaged in Technology-Enhanced Science Inquiry in an Urban Elementary Classroom

Amy Trauth-Nare, Indiana University, amtrauth@indiana.edu

Gayle A. Buck, Indiana University

Nicole Beeman-Cadwallader, Indiana University

ABSTRACT: The purpose of this study was to examine girls' learning as they engaged in technology-enhanced science inquiry. We attempted to determine the extent to which girls used technology proficiently to collect and represent data as well as levels of reasoning they displayed in their interpretations of data. Girls' written documents were subjected to a content analysis to determine the content and form of their reasoning during three inquiry lessons that incorporated handheld data collection devices. While preliminary results indicate the girls became more proficient in collecting and representing data, their interpretations and inferences regarding data showed mixed levels of reasoning. We provide implications for promoting higher levels of reasoning during technology-enhanced inquiry.

Being Smart About SmartGraphs: An Experimental Trial in Physical Science Classrooms

Rachel E. Kay, The Concord Consortium, RKay@concord.org

Andrew Zucker, The Concord Consortium

Carolyn Staudt, The Concord Consortium

ABSTRACT: The primary purpose of this two-year study is to determine whether and to what extent the use of new, free, open-source, web-based software called SmartGraphs improves the performance of eighth- and ninth-grade students in Physical Science classes compared to their peers using the same textbooks who do not use the software. SmartGraphs software allows students to interact with graphs, for example by clicking on a portion of a graph to answer questions. This study uses a pre-post experimental design with teachers randomly assigned to treatment (SmartGraphs) and control (regular curriculum) conditions. Results of this study will reveal differences in graph understanding (if any) between students using the SmartGraphs software to study motion and students studying motion without this software.

Avatar Attributes and a Third Space: Supporting Positive Affect in Learning Science through Virtual Digital Assistants

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

Jennifer London, North Carolina State University

Gail M. Jones, North Carolina State University

John Bedward, North Carolina State University

ABSTRACT: This study investigated the visual characteristics of avatars, representing virtual science assistants, that engender positive or negative affect in students. In particular, the affect of the avatar was considered important because previous literature has suggested that students empathize with perceived emotion, which in turn supports engagement and learning in digital environments. Also of interest was the relationship students wanted to have with their digital assistant, and whether they

Monday, March 26, 2012

wanted it to exist in the school space, the home, space, or a “third space.” This presentation will report on a set of student focus group dialogues designed with the goal of helping unravel what visual characteristics of a virtual digital assistant, and in what context, engender positive affect towards learning science in 4th and 5th grade students. The focus group findings suggest that students were sensitive to the perceived affective state of the avatar and preferred those that displayed positive affect. They also preferred avatars representing a “third space” that exists in a virtual context different from school or home. Avatars older than the children seem to be preferred, but students did not gravitate to a particular age range.

Strand 13: History, Philosophy, and Sociology of Science
Chemistry Education

8:30am – 10:00am, Room 102

Presenter: Linda Keen-Rocha

Why Has the Bohr-Sommerfeld Model of the Atom been Ignored by General Chemistry Textbooks?

Liberato Cardellini, Università Politecnica delle Marche, Italy, l.cardellini@univpm.it

Mansoor Niaz, Universidad de Oriente, Venezuela

ABSTRACT: Bohr’s model of the atom could not explain the spectra of atoms containing more than one electron. In order to increase the explanatory power of the model, Sommerfeld hypothesized the existence of elliptical orbits. Objectives of this study are: 1) Formulation of criteria based on a history and philosophy of science framework; 2) Evaluation of general chemistry textbooks based on the criteria, published in Italy and U.S.A. Presentation of a textbook was considered to be ‘satisfactory’ if it included a description of the Bohr-Sommerfeld model along with diagrams of elliptical orbits. Of the 28 textbooks published in Italy, only five were classified as ‘satisfactory’. Of the 46 textbooks published in U.S.A., only three were classified as ‘satisfactory’. Educational implications: a) Sommerfeld’s elliptical orbits, helped to restore the viability of Bohr’s model; b) Bohr-Sommerfeld’s model went no further than the alkali metals, which led scientists to look for other models; c) Scientific models are tentative in nature; d) Inclusion of the Bohr-Sommerfeld model in textbooks can help our students to understand how science progresses.

Midgley, Tetraethyl Lead and CFCs: A Historical Case Study for Chemical Education

Paulo A. Porto, Instituto de Química - Universidade de São Paulo (Brasil), palporto@iq.usp.br

Hélio E. B. Viana, Universidade Federal da Bahia (Brasil)

ABSTRACT: This work presents a historical case study aimed at promoting reflections for chemistry educators. In the first decades of the 20th century, Thomas Midgley, Jr. (1889-1944) used the periodic table to predict the behavior of molecules that could answer the increasing demands of American industry. Among the many compounds developed by Midgley, this work focuses on tetraethyl lead and the chlorofluorocarbons (CFCs). In the 1920s, the use of internal combustion engines in cars was gaining popularity in the USA, but the control of octane rating of gasoline was a serious obstacle. Initially by trial and error, and then guided by the periodic table, Midgley tested the effectiveness of various groups of elements combined in organic compounds, finally arriving at tetraethyl lead as the best antiknocking agent. The development of the CFCs was also related to an industrial need: the search for a new fluid for refrigerators. The way Midgley designed molecules offers a basis for a case study that can be used with undergraduate students and teachers in continuing education, providing an approach to teaching science in context through reflections on periodic properties, the nature of scientific knowledge, ethics in science and technology, and the different dimensions of chemical risks.

How Chemistry Works? Reflections on Triadic Approaches and a Contribution From Peircean Semiotics

Karina A.F.D Souza, Instituto Federal de São Paulo, karina_souza@ifsp.edu.br

Paulo A. Porto, Instituto de Química - Universidade de São Paulo

Monday, March 26, 2012

ABSTRACT: Despite the apparent simplicity and obviousness of the question “How does Chemistry work?”, possible answers may give origin to important philosophical questions, which reflect in its productive activities, in its public image and in the way it is taught. Examples are the many attempts to describe the activity fields of chemists present in the literature, among which we can highlight Johnstone’s triangle. Such proposals are marked by the multiplicity of approaches and absence of consensus, which ultimately reflect the lack of philosophical basis of many of them. Given the central role that representations have in the construction of chemical knowledge, it is proposed that semiotics, especially Charles Sanders Peirce’s approach, can offer a theoretical foundation to analyze the proposals in the literature and help in the understanding of the structure of chemical enterprise.

Monday, March 26, 2012

Equity and Ethics Committee Sponsored Session

Re-Imagining Our Research by Using New Theoretical Frameworks in Science Education

10:15am – 11:45am, Room 313

Presiders:

Felicia M. Mensah, Teachers College, Columbia University

Julie A. Bianchini, University of California, Santa Barbara

Presenters:

Heidi Carlone, University of North Carolina-Greensboro

Pauline Chinn, University of Hawaii-Manoa

Alberto J. Rodriguez, San Diego State University

Randy Yerrick, University of New York-Buffalo

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

ABSTRACT: The Equity and Ethics Committee sponsors this session for individuals who are interested in learning about new and exciting frameworks and methodologies in science education research, particularly sociocultural frameworks and critical race theory. The frameworks are not “new” but have been under-utilized in science education. The panel of presenters for this session will discuss the trajectory of their ideas as researchers, how they conceptualize a research and professional agenda in science education, and how their research has taken on new meaning and focus by engaging in new theoretical or methodological approaches.

External Policy Committee & Strand 15: Policy Sponsored Session

Session 2: Opting In: State Education Agencies and the Next Generation Science Standards

10:15am – 11:45am, Room 104

Presiders:

Andrew W. Shouse, University of Washington

Christopher Wilson, BSCS

Presenters:

Tom Keller, National Research Council

Stephen Pruitt, Achieve

Peter McLaren, Rhode Island Department of Education

ABSTRACT: This session is being developed in collaboration with the State Science Supervisors Association and Achieve, the organization that is developing standards based upon the NRC framework. It will feature state science education policy decision-makers who will be responsible for implementing the Next Generation Science Standards in their state, including representatives of selected “lead” states who act in an advisory capacity to the Achieve standards development process. The Next Generation Standards are distinctive from prior standards in both form and substance. Consequently they present novel challenges to states. Substantively, the inclusion of engineering, core ideas, crosscutting features, emphasis on science practices, learning progressions, etc. – present a new, distinctive approach to learning. This will touch the very core of state-level education: curriculum and professional development policies and programs, materials adoption, definitions of teacher quality, science teacher credentialing, etc. In form, the standards represent a fundamental shift from state-level standards to a national (but optional) model. How will state science resources be deployed within this structure? Given the changing landscape for state science education policy decision-makers this is an opportune moment for NARST researchers to explore how they do and can collaborate on implementation of the standards. This session will focus on 3 states as cases of state science standards implementation. Following an overview of the session and review of the domain of state science policy (15 minutes), individual state policy-makers will co-present with a NARST researcher to describe the challenges, technical assistance, development, and research that will be needed to advance the Next Generation Standards in their state. Each case presentation will be allotted 15 minutes (45 minutes total). An additional 15 minutes will be devoted to cross-talk among the three policy/research case presentations. The final 15 minutes will be devoted to audience Q and A.

Monday, March 26, 2012

Strand 1: Science Learning, Understanding and Conceptual Change

Biology Instruction and Assessment

10:15am – 11:45am, Room 310

Presider: Anat Yarden, Weizmann Institute of Science

Reliability and Validity of Scores on the Transformative Experience Questionnaire on Matter and Genetics

Kristin L. K. Koskey, The University of Akron, koskey@uakron.edu

Toni A. Sondergeld, Bowling Green State University

Victoria C. Stewart, The University of Toledo

Kathryn Vuchak, The University of Akron

Kevin J. Pugh, University of Northern Colorado

ABSTRACT: The Transformative Experience Questionnaire (TEQ, Pugh et al., 2004) was previously developed for the area of science and administered to assess students' degree of engagement with science topics such as weather and natural selection. A lack of literature exists on the reliability and validity of the scores produced from the TEQ when adapted for other science topics. We applied the Rasch model to investigate the reliability and construct validity of scores on the TEQ when adapted for the topics of properties of matter and genetics. Middle school (n = 108) and high school (n = 179) students completed the TEQ and a card sorting activity and then completed the TEQ again 2-3 weeks later. A sub-sample completed a cognitive interview while completing the TEQ. The scores on the TEQ yielded acceptable test-retest reliability and congruent validity with a measure of task-value, and fit indices supported a unidimensional construct overall progressing from items targeting in-class engagement to outside-of-class engagement. A differential item functioning analysis (DIF) revealed that the definition of the construct was stable across forms. The cognitive interview results provided insight on how to modify item wording. Implications for use of the TEQ in science teaching are discussed.

Eighth Grade Students' Conceptions of Energy Flow through Ecosystems

Ashlie M. Beals, University of Kentucky, ambeal0@uky.edu

Rebecca M. Krall, University of Kentucky

ABSTRACT: The need for environmental education to help students become scientifically aware of issues such as global climate change and water quality is increasingly important. However, in today's world of high-stakes testing K-8 science in general, particularly environmental education, has taken a back seat to other more frequently tested subject areas, particularly literacy and mathematics. Thus it is not surprising that, although students are expected to be familiar with basic concepts related to energy flow through ecosystems, research indicates that children of all ages often hold non-scientific conceptions about this topic. What are these non-scientific conceptions, and how do they compare to scientific concepts students should understand about this topic at various stages in K-8 education? This status study examines 40 eighth grade students' understandings of energy flow through ecosystems. Students completed a 9-item forced-choice instrument with common non-scientific conceptions embedded in the distractor options, as well as explanations and confidence ratings. Quantitative data analyses included calculation of frequencies and percentages for the overall student scores as well as scores for each answer option by low, middle, and high performing subgroups. Data analyses revealed several troublesome areas, especially regarding the original source of energy for ecosystems. Findings and implications will be discussed.

Students' Systemic Reasoning of Food Webs at Lower Elementary Level (Grades 1-4)

Hayat Hokayem, Michigan State University, alhokaye@msu.edu

Amelia Wenk Gotwals, Michigan State University

ABSTRACT: The framework for the new National Science Education Standards identified ecology as a key topic in the life sciences (NRC, 2011). Several studies have investigated students' ecological reasoning in upper elementary, middle and high school, but there is paucity of research that investigates students' reasoning at lower elementary level which is what we attempt to do in this study. Taking a systems approach to the food web, 20 Lebanese students from grades 1 till 4 were interviewed in order to investigate students' reasoning and find out the consistency of their thinking. The results showed that students' causal reasoning about the food web system was

Monday, March 26, 2012

classified into four levels with the first considering aesthetic or anthropocentric reasoning and the last being branching causal reasoning that considered the influence on several branching food chains. Those categorical levels were similar to the ones identified with elder students. However, students' levels were not consistent with the various interview questions, rendering the influence of some populations more important than others. Those results have theoretical implications for considering a learning progression for ecology and practical implications for construction of appropriate instructional approaches to foster students' systemic reasoning at early grades.

Feeling of Certainty: Uncovering a Missing Link between Knowledge and Acceptance of Evolution

David L. Haury, The Ohio State University, haury.2@osu.edu

Minsu Ha, The Ohio State University

Ross H. Nehm, The Ohio State University

ABSTRACT: Our study examines the significance of a novel variable unexplored in previous studies of acceptance of evolutionary theory: the feeling of certainty (FOC). Our study is grounded in an emerging understanding of brain function that acknowledges the contributions of intuitive cognitions in making decisions, such as whether or not to accept a particular theoretical explanation of events. Specifically, we examine the relationships among religious identity, level of education, level of knowledge, FOC, and level of evolutionary acceptance. We employ widely used measures—the CINS, MATE, and ORI—in addition to new variables in multiple regression and path analyses in order to test the interrelationships among FOC and acceptance of evolutionary theory. We explore these relationships using a sample of 124 pre-service biology teachers found to display comparable knowledge and belief levels as reported in previous studies on this topic. All of our hypothesis tests corroborated the idea that FOC plays a moderating role in relationships among evolutionary knowledge and beliefs. Educational research into acceptance of evolutionary theory will likely benefit from increased attention to non-conscious intuitive cognitions that give rise to feeling of knowing or certainty.

Strand 2: Science Learning: Contexts, Characteristics and Interactions

Argumentation and Discussion

10:15am – 11:45am, Room 302

Presider: David L. Fortus, Weizmann Institute of Science

The Influence of Students' Acceptance of Evolution on SSI Negotiation

Samantha R. Fowler, Clayton State University, Samantha.fowler@clayton.edu

Dana L. Zeidler, University of South Florida

ABSTRACT: The purpose of this study was to explore the evolution science content used during college students' negotiation of biology-based socioscientific issues (SSI) and examine how it related to students' conceptual understanding and acceptance of biological evolution. Specifically, the question, what is the nature of the interaction between evolution understanding and evolution acceptance as they relate to depth of use of evolution content during SSI negotiation, was addressed. Sixty upper level undergraduate biology and non-biology majors were assessed for their depth of use of science content during SSI negotiation, evolution understanding, and evolution acceptance. A multiple regression analysis tested for interaction effects between the predictor variables, evolution understanding and evolution acceptance. The hypothesis that the extent of one's acceptance of evolution is a mitigating factor in how evolution content is evoked during SSI negotiation was supported by the data. Results indicate that researchers and teachers who examine the science content students use to negotiate biology-based SSI need to take students' acceptance of evolution into consideration when interpreting their results.

Beyond "Doing the Lesson": The Nature of Argumentation in a Fifth-Grade Classroom

Ying-Chih Chen, University of Minnesota, chen2719@umn.edu

Brian M. Hand, University of Iowa

Soonhye Park, University of Iowa

Monday, March 26, 2012

ABSTRACT: Argumentation is seen as a core practice and goal for making students scientifically literate. The purpose of this study was to examine how fifth-grade students developed an understanding of argumentation for public negotiations over sixteen weeks when participating in an argument-based inquiry classroom. Six students were selected to be interviewed intensively. First, the study identified six core components of argumentation: information seeking, elaborating, challenging, supporting, defending, and rejecting. As students had more opportunities to practice, they developed and used more argumentative components. The focus of negotiation was shifted from asking about the correctness of a claim to stressing the relationship between question, claim, and evidence. Students came to understand the value of peer feedback which led them to be more willing to revise their original ideas and engage in effective negotiating processes. Second, students' ability to craft a written argument improved over time in five aspects: (1) the accuracy of claims, (2) the sufficiency of evidence, (3) the quality of reasoning, (4) the relationship between claims and questions, and (5) the relationship between claims and evidence. The result, with a parallel shift between oral argumentative practices and the quality of written arguments, indicates that talk and writing are interdependent.

Comparing Students' Written and Verbal Scientific Arguments

Amanda M. Knight, Boston College, knightam@bc.edu

Katherine L. McNeill, Boston College

ABSTRACT: Scientific argumentation is an authentic scientific practice in which knowledge is socially constructed through evaluating scientific claims, weighing evidence, and assessing alternative explanations. While argumentation has become a noteworthy goal for science education, incorporating it into science classrooms is challenging and can be a long-term process for both teachers and students. Science talk has been shown to support science writing, and participation in science writing increases conceptual understandings and science achievement. Yet, the differences in the ways students construct oral and written scientific arguments have not been established. Consequently, our research with one middle school class in an urban New England school district addresses the following question: What are the similarities and differences between students' oral and written scientific arguments? Data sources included pre- and post- tests and interviews for a focus group of four students as well as transcripts from videotaped classes and associated student work. Our study suggests that there are commonalities and differences between modalities that teachers can explicitly address in an effort to strengthen students' arguments—both verbal and written—and conceptual understanding.

For whom is Argument and Explanation a Necessary Distinction?

Leema Berland, University of Texas, Austin, leema.berland@mail.utexas.edu

Katherine L. McNeill, Boston College

ABSTRACT: While scientific argumentation and explanation have been highlighted as important for K-12 science education in recent reform documents, and science education research literature, the terms argument and explanation are used inconsistently in the literature. Osborne and Patterson (2011) respond to this lack of clarity by arguing that researchers and educators must carefully define these terms for both themselves and K-12 students. In this paper, we argue that the synergistic relationship between the goals and products of explanation and argumentation suggest that this differentiation between the practices might be counter-productive in K-12 classrooms. We examine this hypothesis by summarizing the implications current research on the two instructional strategies of emphasizing the distinction between the two practices and selecting one term to encompass both goals, thereby emphasizing their interdependency. We argue that current research suggests benefits and limitations to both options and it is currently an empirical question of which is more effective for K-12 classrooms.

Monday, March 26, 2012

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

Language and Literacy in the Elementary Classroom

10:15am – 11:45am, Room 301

Presider: Sarah J. Carrier, North Carolina State University

Lexical Complexity of Science Read-aloud Texts and Discussion

Rory J. Glass, University of Albany, rcbglass@aol.com

ABSTRACT: With the adoption of the Common Core State Standards (CCSS) by the majority of states and that documents call for the incorporation of non-fictional literacy in addition to existing standards for elementary school science how these readings are facilitated is of growing importance. Unfortunately, previous research has also shown that teachers consider these types of books too complicated for their students. By comparing the language used within these texts and that of the teachers during discussions surrounding the texts we can develop an understanding of this disparity and the ways in which teachers contextualize content for their students. The results reported here support the previous findings and show that teachers do use a less complicated lexis during discussions than those found in the texts and that the complexity of the texts correlate positively with the amount of time spent in discussion.

Using Pictorial Models in Elementary Science Read-Alouds to Communicate Science across Grade Levels

Michael Mastroianni, University at Albany, SUNY, mastroim@gmail.com

Seema Rivera, Suny Albany

Rory J. Glass, University of Albany

Alandeom W. Oliveira, University at Albany, SUNY

Francine Wizner, University at Albany, SUNY

ABSTRACT: The study examined three elementary school teachers and their use of science trade books to perform a science read-aloud. The researchers examined both the types of pictures in the book and the modes of communication the teachers used to read and enhance their read-aloud. Generally speaking, our examination of the three teachers' performance of science read-alouds revealed several oral practices that clearly supported students' development of visual literacy skills, including highlighting key visual attributes of pictorial models, helping students scan and navigate visual images, etc. However, the teachers did not always adopt pedagogical strategies aimed specifically at addressing the unique challenges posed by each different type of pictorial model. Our findings emphasize the need for elementary teachers to be more conscious of how narrative and conceptual pictorial models in non-fiction science texts are incorporated and presented during multimodal read-alouds to help students make meaning and advance science knowledge.

Reading Pictorial Models in Elementary Read-Alouds

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Rory J. Glass, University at Albany, SUNY

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Francine Wizner, University at Albany, SUNY

ABSTRACT: This study examines how three elementary teachers and their students co-construct meanings with different forms of pictorial representation (photographs, drawings, and cartoons) in children's science books being read aloud. Science read-alouds are conceived as multimodal communicative events or engagements wherein teachers and students make sense of pictorial representations by co-deploying and integrating multiple communicative channels (visual and oral), modalities (pictorial, gestural, and spoken), and forms of semiotic signification (symbolism, indexicality, and iconicity). It is reported that teacher-student engagements with pictorial representations took different interactional forms (references, monologues, or dialogues). Nearly half of these engagements were dialogic, entailing two distinct forms of meaning-making: multimodal description (teachers and students combined descriptive symbolism with indexical gesturing as they pinpointed and verbalized iconically

Monday, March 26, 2012

depicted similarities or regularities in physical appearance such as the hexagonal shape of snowflakes and the matching colors of blended-in characters) and multimodal explanation (teachers and students integrated explanatory symbolism and iconic gesturing to explain the functioning of biological and physical systems -- human eye and light refraction). It is argued that elementary teachers need to become more cognizant of the communicative affordances and constraints of using pictorial representations as springboards for engaging students in multimodal scientific meaning-making during science read-alouds.

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

Related Paper Set - Multiple Approaches to Video as a Tool for Exploring Teachers' Pedagogical Content Knowledge

10:15am – 11:45am, Room 303

Presenter: Alicia C. Alonzo, Michigan State University

Discussant: Julie A. Luft, The University of Georgia

ABSTRACT: Efforts to move beyond theoretical considerations of pedagogical content knowledge (PCK) and to support teachers' development of PCK depend upon methods for capturing this often tacit form of teachers' knowledge. The papers in this set take four different approaches to the use of video to explore experienced teachers' PCK. Video allows us to capture the complexity of classrooms and to explore teachers' PCK as revealed in authentic tasks: teaching, responding to students' thinking, and reflecting on practice. The first two papers infer teachers' PCK from evidence in videos of specific episodes of classroom instruction—formative assessment conversations and enactments of a demonstration. The third and fourth papers elicit teachers' PCK through the use of video clips—a set from each teacher's classroom instruction and a standard set focused on student thinking, respectively. Because all four studies involve the same group of experienced teachers, this set of papers provides opportunities for triangulation and for systematic consideration different methods for capturing PCK. In addition, these papers present specific examples of PCK for teaching force and motion.

Exploring Teachers' Pedagogical Content Knowledge in Formative Assessment Conversations

Kristin Mayer, Michigan State University, kristi.mayer@gmail.com

Alicia C. Alonzo, Michigan State University

Exploring Teachers' Pedagogical Content Knowledge through Enactments of a Newton's Third Law Demonstration

Sarah Guile, Michigan State University, guilesar@msu.edu

Alicia C. Alonzo, Michigan State University

Exploring Teachers' Pedagogical Content Knowledge Elicited with Video Clips from Their Own Classroom Instruction

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

Alicia C. Alonzo, Michigan State University

Exploring Teachers' Pedagogical Content Knowledge Elicited with Video Clips Focused on Student Thinking

Alicia C. Alonzo, Michigan State University, alonzo@msu.edu

Jiwon Kim, Michigan State University

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

Conceptual Understanding - Biology

10:15am – 11:45am, Room 304

Presenter: Peter A. Okebukola, Lagos State University

Investigating the Relationship between College Students' Acceptance of Evolution and Tree Thinking Understanding

Kristy L. Halverson, University of Southern Mississippi, kristy.halverson@usm.edu

Emily Walter, University of Missouri

Monday, March 26, 2012

Carrie J. Boyce, University of Southern Mississippi

ABSTRACT: Evolutionary theory is accepted in the scientific community. However, the majority of people in the non-scientific community do not accept evolutionary theory. The purpose of this study was to quantitatively investigate the relationship between tree thinking understanding and acceptance of evolutionary theory for 92 university non-science majors before and after an introductory biology course. We found that the majority of students taking this biology course held strong religious affiliations but were still open to and accepted evolution as a valid scientific theory. Students started and ended the course with a high acceptance of evolutionary theory, but the nature of their acceptance changed significantly and we documented several shifts. We also found a significant increase in their scientific understanding of tree thinking. There was a low correlation between evolution acceptance and tree-thinking knowledge for our population of non-science majors. Our investigation demonstrated that targeted evolution instruction using a tree thinking approach can alter students to acceptance of evolution even if they initially held strong anti-evolution ideas. By learning how college students understand and develop ideas about evolution using a visual approach we can better target areas of confusion and begin forming the foundation for developing an effective evolution instruction.

Undergraduate Biology Students' Conceptions of the Term 'Animal'

Andrea Bierma, Western Michigan University, andrea.m.kryger@wmich.edu

Renee S. Schwartz, Western Michigan University

ABSTRACT:

Microbiology Instruction: Students' Perceptions of Risks Related to Microbial Illness

Gail M. Jones, NC State University, Gail_Jones@ncsu.edu

Grant E. Gardner, East Carolina University

Tammy M. Lee, East Carolina University

Sarah Robert, NC State University

Kayla Poland, NC State University

ABSTRACT: During their secondary education, students are expected to increase their understanding of organismal diversity, which is essential for understanding the relatedness of organisms (AAAS, 2009), and, therefore, evolution. However, several studies have indicated that lower-level post-secondary students hold several alternative conceptions of the term 'animal' (e.g., Bell, 1981). The purpose of this study was to assess via survey and then interview which conceptions of the term 'animal' are held by upper-level undergraduate students with biology-related majors. We found that participants provided mostly common mammals and broad vertebrate terms when asked to name animals and these ideas were commonly triggered by personal pets, television shows, and the classroom. Most participants also knew that the number of invertebrates is much larger than vertebrates; however, when asked to provide a representative list of the diversity of the animal kingdom, a large number of the total responses were of vertebrates. Finally, most participants viewed movement as a key characteristic of animals. Although this is typically appropriate, it can lead to misconceptions about atypical examples. Overall, it was found that students typically have more than one conception of the term 'animal,' but do understand the scientific concept.

College Freshmen Students' Conceptions of Natural Selection and Evolution

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ABSTRACT: This study is a cross-cultural comparison between the ideas of 22 American and 31 Turkish freshmen non-biology students about the concepts of natural selection and evolution. Students' ideas were explored by a questionnaire and clinical interviews. The findings of the study indicated that both groups of participants shared similar views and they had poor understanding of evolution. Variations in students' beliefs about natural selection were also common. There was a strong evidence to suggest that Turkish undergraduate students possessed more negative beliefs and attitudes about evolutionary concepts. Most Turkish students were opposing to evolutionary concepts and they did not find the theory of evolution credible. The U.S. participants were less hesitant in accepting the theory of evolution as a credible theory. Overall, it was evident that the U.S. students' conceptions of evolution appeared to be somewhat more sophisticated than the Turkish participants'. However, this was not

Monday, March 26, 2012

the case in students' perceptions of natural selection in which the Turkish students' responses indicated more elaborate understanding of the concepts of natural selection.

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

Learning through Experiences

10:15am – 11:45am, Room 309

Presenter: Geoff Potvin, Clemson University

Undergraduate Science Course Reform: Impacts on Faculty and Students

Dennis W. Sunal, The University of Alabama, dwsunal@bama.ua.edu

Cynthia Sunal, The University of Alabama

Mason Cheryl, San Diego State University

Dean A. Zollman, Kansas State University

ABSTRACT: This paper examines levels of teaching reform implemented in undergraduate science courses and the perceptions that undergraduate students have of their learning environment. Both observed teaching by faculty and for the student learning environment were measured. Instructors teaching in reformed undergraduate science courses were observed to be using instructional methods that were significantly different from instructors in the comparison science classes. Narrative descriptions of observations in courses where the instructor was highly rated as a result of observations indicated the students spent the majority of the time interacting with each other to develop their own ideas about the content that they were learning. There was extensive student to teacher interaction, but this interaction was different than lecturing to the students or giving them the "correct answers". Undergraduate students were found to have significantly higher and more positive ratings of the learning environment in reform classes as compared to students in comparison science classes. It was concluded that in order for students to perceive their learning environment as being different from a traditional classroom, an instructor would need a significantly high student-centered classroom lesson rating.

Learning through Undergraduate Research: Practice of Inquiry and Understandings about Nature of Science and Nature of Scientific Inquiry

Maya Patel, Ithaca College, Cornell University, mpatel@ithaca.edu

Barbara A. Crawford, Cornell University

Deborah Trumbull, Cornell University

ABSTRACT: This paper continues our research into student learning through participation in summer, undergraduate research experiences in biotechnology and genomics. We describe: 1) interns' laboratory research projects, 2) intern-mentor transactions and 3) relationships between the above, practice of inquiry, and understandings about nature of science (NOS) and nature of scientific inquiry (NOSI). We employed a mixed-methods approach: pre-post assessment of gains, and exploratory investigation of the laboratory research situation. We found that multifaceted, molecular-genetics research projects (both observational and hypothesis-driven investigations) and tool development (a type of non-investigation) provided multiple opportunities to practice more advanced aspects of inquiry (e.g. design, evaluating evidence, revising assumptions and hypotheses, and constructing arguments) in this setting. We found that interns in mentor-centric transactions, those most highly prescribed, generally achieved lower program inquiry scores than interns in balanced and intern-centric situations. Interns engaged in more indeterminate projects, where methods were less prescribed and outcomes less predictable, generally made greater gains in understandings about NOSI. Gains in understandings about NOS showed no relationship with project or transaction type. In some cases, gains in NOS were linked to critical incidents that occurred during the research, particularly the discovery of anomalies and the interpretation of non-numerical data.

Monday, March 26, 2012

Teaching Teamwork & Communication: Faculty Beliefs in Engineering Education

Andrea M. Motto, Virginia Tech, andreamotto@vt.edu

Holly Matusovich, Virginia Tech

Marie Paretti, Virginia Tech

ABSTRACT: Communication and teamwork skills remain essential requirements for engineering graduates in both academic and industry settings, however novice engineers frequently struggle with enacting these skills in practice. Research that demonstrates effective strategies for teaching teamwork and communication or that examines faculty and student beliefs about these skills is limited. This three-year mixed methods study seeks to explore faculty beliefs about teaching these topics within engineering curricula, the impacts of those beliefs on students, and effective ways to influence these beliefs. In this paper, we present qualitative findings from Phase 1 of the project, specifically findings in which we identify and characterize faculty beliefs about who should teach teamwork and communication skills and how and where they should be taught.

Metacognition and Learning Gain in Foundation Chemistry: A Case Study

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Kgadi Mathabathe, University of Pretoria

Salome Human-Vogel, Department of Educational Psychology, University of Pretoria

ABSTRACT: In this study we investigate the relationship between accuracy of self-evaluation as an expression of metacognitive skill, and learning gain in stoichiometry. We investigated whether overconfidence before instruction is corrected upon exposure to teaching of the topic and analyse the underlying reasoning informing metacognitive judgments on performance. The context is an academic development program at the University of Pretoria, South Africa, offered for under-prepared students enrolled for science and engineering. Exaggerated levels of confidence in performance are common for these students, but it could potentially place them at risk by negatively affecting decisions regarding time management and self-regulation. We followed an experimental mixed methods approach and analysed quantitative and qualitative data collected in a pre- and posttest. The picture that emerged is the following: Accuracy of posttest performance evaluation was associated with both a reduction in the prevalence of vague subjective judgments and with higher learning gain. Overconfidence was not a debilitating disposition when demonstrated in the pretest provided that it is corrected during teaching and learning. We recommend a proactive and constructive response by educators which may prevent the damage caused by failure and preserve the positive contribution of confidence, albeit excessively positive.

Strand 6: Science Learning in Informal Contexts

Related Paper Set - Designing for Science Learning: Accounting for the Role for Families and Parents in Supporting Youth

10:15am – 11:45am, Room 305

President: Heather Toomey Zimmerman, Pennsylvania State University

Discussant: Lynn D. Dierking, Oregon State University

ABSTRACT: In this related paper set, authors report on five research studies that consider the role of parents and families in supporting youth learning in out-of-school spaces. Sharing the perspective that learning is a social process, the authors' collective goal is to distill design implications from their empirical work that can lead to the development of more supportive science learning environments for families and for youth. These papers will interest researchers studying learning in informal contexts, using design-based research methods, developing formal or informal curriculum, connecting learning across settings (i.e., home to school), and studying the sociocultural aspects of learning environments.

Understanding How Families use Observational Tools during Nature Center Hikes

Heather Toomey Zimmerman, Pennsylvania State University, heather@psu.edu

Lucy R. McClain, Penn State University

Michele Crawl, Pennsylvania State University

Monday, March 26, 2012

Lynn D. Dierking, Oregon State University

Connecting School Science Learning with At-home Activities: Documenting Learning through a Science Backpack Program

Carrie T. Tzou, University of Washington, tzouct@northwestern.edu
 Elyse Litvack, Maple Elementary

Tools for Talk: Strategies for Supporting the Observational Capacity of Families

Catherine Eberbach, Rutgers University, catherine.eberbach@gse.rutgers.edu

Disciplinary Talk by Design: Identifying Expert and Novice Patterns of Parent-child Engagement with Exhibits

Sasha Palmquist, Institute for Learning Innovation, s.palmquist@gmail.com

Exploring the Impact of Family Involvement on Youth Engagement in a Creative Robotics Workshop

Debra Bernstein, TERC, debra_bernstein@terc.edu
 Emily Hamner, Carnegie Mellon University

Strand 7: Pre-service Science Teacher Education

Elementary Science Teacher Preparation I

10:15am – 11:45am, Room 306

Presider: Gail L. Dickinson, Texas State University

Preservice Elementary Teachers in Service Learning Settings: Developing Ideas about Teaching, Learning and Teacher Identity

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

ABSTRACT: Recent studies in elementary preservice science teacher education have described how practice teaching in traditional classroom settings often poses insurmountable barriers to novice teachers' learning of reform-based science teaching strategies. One proposed solution to this problem is to locate early preservice teacher experiences in informal science settings where they are free of many constraints of the ordinary classroom. The aim of the current study was to examine the developing understandings about teaching and learning science, and teacher identity for preservice elementary science teachers participating in a methods class that was integrated with service learning in informal science settings. The research design was an interpretive, qualitative content analysis of written responses to open-ended questioning prompts. Twenty volunteer participants constituted a sample of convenience. In general, the data indicate that the preservice teachers constructed positive ideas about teaching with reform-based strategies from the service learning experiences. For example, participants indicated a shift in their ideas of teaching from teacher as teller of information first, then hands-on to a learning cycle, inquiry-based approach. Implications and suggestions for future research are discussed.

Encouraging Elementary Teacher Candidates' Understandings of Ambitious Science Instruction

Julianne A. Wenner, The University of Georgia, jakent@uga.edu
 Julie M. Kittleson, The University of Georgia
 Janna Dresden, The University of Georgia

ABSTRACT: One of the challenges facing science educators involves improving the quality of instruction in classrooms. Therefore it is imperative to prepare elementary teachers who are able to implement ambitious, content-rich science instruction. Consequently, we have embedded a model we call the Supported, Collaborative Teaching Model (SCTM) into our methods courses. In the SCTM, teaching ambitious elementary science is scaffolded as we provide tapering assistance to the teacher candidates throughout the semester in terms of

Monday, March 26, 2012

learning science content, planning lessons, and reflecting on potential evidence of student learning. Through interviews, reflections on the SCTM, and course assignments, we have explored the teacher candidates' responses to the SCTM. Overall, the SCTM helped us provide a low-risk environment in which teacher candidates could try out implementing ambitious, content-rich science instruction. A tension we had to balance, however, was that while providing model lessons for teacher candidates prompted them to teach a lesson that was more ambitious than what they tended to plan for themselves, it impacted their willingness to invest in preparing to teach the lesson. Given trends associated with elementary science instruction and teacher preparation, this study provides insight into types of support that might be valuable.

Learning to Support Elementary Students' Scientific Reasoning: Preservice Elementary Teachers and the Evidence-Explanation Continuum

Laura Zangori, University of Iowa, laura-zangori@uiowa.edu
Cory T. Forbes, University of Iowa
Mandy Biggers, University of Iowa

ABSTRACT: Effectively-designed science learning environments revolve around students' use of evidence to ground explanations about natural phenomena. This Evidence-Explanation continuum serves as the foundation for sense-making components of scientific practice. However, little research has been carried out on elementary teachers' learning to promote students' sense-making in elementary (K-6) classrooms. The purpose of this qualitative study is to explore how preservice elementary teachers understand, implement, and scaffold students to give priority to evidence in formulating explanations. We found that preservice elementary teachers' conceptions of evidence and explanation are often misaligned with descriptions of these essential sense-making components articulated in contemporary science education reform. Further, the preservice teachers were frequently unable to implement their conceptions of the Evidence-Explanation continuum due to the classroom cultures that stressed time management and teacher-centered pedagogy they encountered in their field placements. These findings, which complement and extend those of other studies focused on early-career and experienced inservice elementary teachers, suggest that a lack of emphasis on sense-making components of scientific practice could be an endemic issue across the teacher professional continuum for which elementary teachers require ongoing and multi-faceted forms of support.

Pre-service Elementary Teachers' Learning to Integrate Science and Language Instruction for Linguistically Diverse Students

Youngjin Song, University of Northern Colorado, youngjin.song@unco.edu
Elizabeth Franklin, University of Northern Colorado
Teresa Higgins, University of Northern Colorado

ABSTRACT: This study investigated pre-service elementary teachers' understanding about inquiry-based science and language instruction to English Learners (ELs) in the context of a science afterschool program. The qualitative case study was conducted with nine pre-service elementary teachers who were simultaneously enrolled in their science methods class after completion of one English as a Second Language (ESL) methods course. The main sources of data were classroom observations and in-depth interviews. The findings from inductive analysis of the data indicated that during this experience, pre-service elementary teachers broadened their perspective of inquiry-based instruction for ELs. They also developed in their understanding of the importance of integrating language into inquiry-based science a) by teaching vocabulary words, b) by reading and writing, and c) by incorporating opportunities for oral interactions. Moreover, the pre-service elementary teachers considered the experiences they had as meaningful learning opportunities to connect theory and practices in the real science classrooms. Through continuous reflection, they developed pedagogical content knowledge such as knowledge of instructional strategies to teach science to ELs and knowledge of ELs. The findings of this study will help science teacher educators prepare pre-service teachers to provide effective science and language instruction to linguistically diverse students.

Monday, March 26, 2012

Strand 8: In-service Science Teacher Education

Development and Characteristics of Science Teacher Leaders

10:15am – 11:45am, Room 105

Presider: Jodie Galosy, Knowles Science Teaching Foundation

The Relationship between Effectual Reasoning and Implementing Innovations among K-12 Science Teachers

Anita M. Martin, University of Illinois, abmartin@illinois.edu

Fouad Abd-El-Khalick, University of Illinois

Ray Price, University of Illinois

Elisa Mustari, University of Illinois

ABSTRACT: This study examined the relationship between effectual reasoning usage by entrepreneurial teacher leaders and their level of innovation in the classroom, building, or district. It examined whether the development of entrepreneurial knowledge and confidence can, in fact, encourage higher levels of innovation (which supports the notion that entrepreneurial skills and mindsets can indeed be taught and that they may enhance increased levels of teacher change). This mixed methods longitudinal study included 103 teachers in K-12 science education across a Midwestern state. Data sources: Effectual Reasoning (ER) Survey, an Entrepreneurial Teacher Skill and Confidence (ETSC) Survey. This study found that the ER Survey held predictive power on 15 out of 19 items in the identification of teachers who were considered “high innovators,” and that “high innovators” use effectual reasoning logic. Secondly, we report findings on the ETSC Survey that show significant correlations with two of the ER Survey factors related to the Commitment and Confidence dimensions. The use of effectual reasoning verses causal reasoning seems to be a distinguishing factor between teachers who implement procedural/surface changes and those who venture beyond the classroom/building/district to create substantive innovations that truly impact student learning opportunities in K-12 science education.

Science, Technology, Engineering, Mathematics, and World Language Teachers: Fostering Teacher Leaders for the 21st Century

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Rebecca K. Fox, George Mason University, Fairfax, Virginia

Mollianne G. Logerwell, George Mason University, Fairfax, Virginia

ABSTRACT: This qualitative study explored the effects of a professional development program for Science, Technology, Engineering, and Mathematics (STEM) and World Language (WL) teachers from two countries. A total of 38 teachers participated in the study. Of these, 25 teachers traveled to the partnering country for field experience in participants’ schools; professional development designed by university faculty, in-country partners, and local administrators; and a cultural component designed by university faculty in cooperation with in-country partners. The program seeks to foster teacher leaders who understand and can teach diverse students in a rapidly changing world by purposefully joining STEM and WL teachers to encourage dialogue and content-based learning across disciplines, and to address the role that language plays in teaching, learning, and professionalism. Data were collected through electronic surveys, direct observations, teacher portfolios, and focus group interviews. Data highlight the positive impact of the project on teachers’ confidence for exploring ways in which STEM and language instruction can be integrated in a problem-based learning context and conducting action research on their efforts while highlighting the challenges of implementing an international professional development program focused on continuing collaboration when teachers return to their home countries.

Exploring Ninth-Grade Science Teachers' Path of Leadership for Implementing Educational Reform Efforts: A Case Study

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Ya-Wen Cheng, University of Missouri

Somnath Sinha, University of Missouri

Deborah L. Hanuscin, University of Missouri-Columbia

Monday, March 26, 2012

ABSTRACT: To enact new educational reform efforts, it is recognized that teacher leaders are essential to bring about the needed expertise to implement and sustain such efforts. Yet, little is known about how to support teacher leaders and why teachers implement certain leadership tasks. In order to support teacher leaders, it is essential to understand how teachers define teacher leadership within their professional context, what functions do teachers play as leaders, and what resources facilitate or inhibit their leadership functions. We report on a case study analysis of three 9th grade science teachers operating within a district implementing a new reform effort – Physics First. Data from multiple sources – demographics questionnaire, individual interviews, individualized leadership action plans, mid-year and year-end action plan progress reports, and teachers’ written definitions of teacher leadership – were used to inform this study. Results suggest that eight material/social/cultural resources facilitate teacher leaders implement leadership actions: colleague, administrative, parent and student support; time for professional development; technology; professional development support; collaborative/collegial environment; and confidence/introspective. Teachers’ self-image as a leader may influence the choice of leadership functions fulfilled and how they might utilize available resources.

Developing Science Teacher Leaders through Long-Term Professional Development: A Cross-Case Analysis of Four Teachers

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 Abeera P. Rehmat, University of Nevada, Las Vegas
 Doug Lombardi, University of Nevada, Las Vegas
 Edward Keppelmann, University of Nevada, Reno

ABSTRACT: Educational reform movements emphasize the importance of professional development as a means of enriching teacher content knowledge, leadership skills, and student learning. This case study examines a three-year [State] Mathematics and Science Leadership Cadre ([S]MSLC) professional development program in which teacher professional growth is heightened in these areas. The program provided teachers from various backgrounds and school settings an opportunity to take part in online coursework, professional collaboration with other science and mathematics teachers, and the tools to design and implement a professional development program within their district based on their experiences in the Cadre program. This research study involved a cross-case analysis of four of the teacher-participants. These four teachers were selected primarily due to their commonalities of powerful networking or collaboration and its effect on their teaching and student learning. The data indicate that the professional development program fostered enhanced leadership qualities amongst the teachers considered. The longevity of the program offered an opportunity to groom the participants into more confident leaders, potentially enhancing subsequent professional development implemented by the participants in their school districts. The [S]MSLC professional development program was successful in achieving sustainable leadership qualities.

Strand 8: In-service Science Teacher Education

Research Experiences for Science Teachers

10:15am – 11:45am, Room 106

President: Donna R. Sterling, George Mason University

When are Teachers Prepared to Implement Reform Science Practices?

Katrina Roseler, Florida State University, kr09e@my.fsu.edu

Giang Nguyen

Barry Golden, University of Tennessee

ABSTRACT: In order to transition from teacher-centered direct instruction and replace it with learner-centered, inquiry-based experiences, teachers need to engage in inquiry. Research experiences for teachers (RETs), are a path that supports the development of learning through inquiry. Although RETs are available around the US, research on effectiveness RETs in modifying teacher practice is limited. This research examines the effectiveness of two RET’s through pre/post program analysis. Results indicate that these RETs promote gains in regards to

Monday, March 26, 2012

teacher-beliefs and practices. Additionally, results show that the use of the pedagogical discontentment instrument may offer a means of identifying teachers who can most benefit from intense professional development targeting reform-based science teaching practices.

The Impact of RET's on Elementary and Secondary Grade Level of Teachers' Views of Scientific Inquiry

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Barry Golden

Beth Kostka

Semra Mirici

Giang Nguyen

ABSTRACT: This study explores the impact of a professional development workshop on in-service elementary and secondary science teachers' beliefs of Nature of Scientific Inquiry. Participant teachers attended a six week Research Experience for Teachers (RET) summer workshop to work with scientists to engage in authentic scientific inquiry. Before and after the summer workshop, teachers completed the Views of Scientific Inquiry (VOSI) questionnaire. Their answers were analyzed according to their fit into three categories: naive, informed and sophisticated. The results of this study show that all teacher participants showed improvement in the understanding of Nature of Scientific Inquiry after the six-week RET summer workshop. Even though both grade levels of teachers showed improvement in their understandings of NOSI, secondary science teachers started and finished with a higher understandings. Elementary teachers improved on only two of seven questions. Analysis is provided as to which items the Elementary and Secondary teachers improved on.

Assessing the Value of Research Experiences for Teachers: Building Knowledge, Skills, Credibility, and Identity

Sanlyn R. Buxner, University of Arizona, buxner@email.arizona.edu

ABSTRACT: Proponents for science education reform are increasingly calling for experiences to help teachers change their practice to include more student-engagement in science. Research experiences for teachers are being used to help teachers experience doing research firsthand alongside experts which are intended to help teachers create similar experiences for their students. External evaluation of these programs have shown benefits aligning with facilitator goals including increases in content knowledge, understanding of how science is conducted, interest in science, being able to talk knowledgeably about careers, and increases in using reformed teaching methods. This study documented experiences of participants who completed one of three summer research experiences for teachers. This study explored what teachers reported valuing about their experiences as they progressed through the programs and returned to their classrooms. Teachers reported valuing increased knowledge and skills in science, insider information about professional science, increased credibility, professional and personal growth, and improvements in students' knowledge and engagement in science and research. Many of valued aspects went beyond what facilitators had intended for participants. Additionally, data analysis revealed that participation in these programs had an influence on some participants' identities related to doing science, being a scientist, and teaching science.

Challenges and Benefits of Implementing Authentic Inquiry-Based Instruction through a Research Experience for Teachers Program

Lisa C. Benson, Dept of Engineering and Science Education, Clemson University, lbenson@clemson.edu

Carol H. Wade, Harvard/Smithsonian Center for Astrophysics

ABSTRACT: This paper characterizes the experience of secondary science teachers as they deepen understanding of inquiry-based instruction through a Research Experience for Teachers (RET) program. Teachers worked in research labs and developed inquiry-based instructional modules to connect research experiences to standards they teach. Data includes exit interviews and field notes taken from classroom observations. Exit interviews are presented in a phenomenological fashion, which describes the process of developing a deeper understanding of inquiry-based learning in science, technology, engineering, mathematics (STEM). Eight themes emerged, which revealed teachers' belief that inquiry-based instruction is important, but also their struggles in providing meaningful inquiry-based learning experiences. Themes also reveal teachers' beliefs that inquiry-based instruction

Monday, March 26, 2012

is not a panacea for secondary science instruction. Field notes resulted in an iconic representation of the requirements for creating authentic inquiry-based instruction and how students benefit from inquiry-based learning experiences. Elements of requirements from teachers include connections to the teacher's research, integration of multiple science standards, planning for extra time needed for inquiry, and materials connecting STEM research to activities. These benefited students through evidence of the importance of STEM learning, connecting problem-solving to real life problems, need for collaboration, and integration of STEM topics.

Strand 10: Curriculum, Evaluation, and Assessment

Curriculum and Implementation

10:15am – 11:45am, Room 308

Presider: Mary M. Atwater, The University of Georgia

Conceptual Demand of Science Curricula: Studying Practical Work in High School Biology and Geology

Sílvia Ferreira, University of Lisbon, Portugal, silviacferreira@gmail.com

Ana M. Morais, University of Lisbon, Portugal

ABSTRACT: The paper addresses the issue of the level of complexity of practical work in science curricula and is focused on the discipline of Biology and Geology for high school. It is part of a broader study which analyzes the Ministry of Education and Science (MES) guidelines with respect to practical work in this discipline and their recontextualizing processes in terms of teachers' conceptions and practices. It is psychologically and sociologically grounded, particularly on Bernstein's theory of pedagogic discourse. The study used a mixed methodology. Results depart from the MES broad intentions by indicating that practical work is poorly represented in the curriculum, particularly in the case of the laboratorial work with an investigative character. This is compounded by the fact that practical work has a low level of conceptual demand as given by the complexity of scientific knowledge and of cognitive skills and also by weak intra-disciplinary relations. These results are discussed and their consequences in terms of scientific learning are explored. The mode of analysis used in the study has the potential of highlighting the level of a science curriculum, in terms of specific aspects of the what and the how of learning related to practical work.

A Framework of Active Learning by Concept Mapping

Wang-Kun Chen, Jinwen University of Science and Technology, wangkun@just.edu.tw

Ping Wang, Ching Yun University

ABSTRACT: This study presents a student-centered teaching model based on concept mapping and problem solving. The model apply the idea of concept map and use it as a tool for teaching. The curriculum was developed by way of concept mapping, and the evaluation method was also constructed by the skill too. A case-base teaching on the subject of building energy conservation was conducted in this study. The results of this case study, which includes text of teaching case, teaching plan, evaluation tool, and auxiliary software, were shown in this article.

A Case for Reconceptualizing Coherence in Science Curricula

Tiffany-Rose Sikorski, University of Maryland, College Park, tsikorsk@umd.edu

ABSTRACT: To establish curriculum coherence, researchers often rely on their own understandings of the discipline to arrange topics in an order that appears logical to them. The hope is that by presenting topics in this order, students will construct understandings that have this same form of coherence; historically, however, these efforts have demonstrated only limited success. We suggest that one limiting aspect of such work is the conceptualization of coherence as something that exists in the sequences of, and relationships between, concepts in a curriculum. We explore weaknesses and inherent contradictions in this perspective. Finally, we suggest an alternative conceptualization of coherence as something that exists within the dialogue, thinking, and activity of the students, rather than in the structure of the discipline or curriculum.

Monday, March 26, 2012

Connecting Curriculum Materials and Teachers: Elementary Science Teachers' Enactment of a Reform-based Curricular Unit

Amber M. Schultz, University of Michigan, aschul@umich.edu

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 characterize teachers' enactment of curriculum materials with regard to educative supports for teachers and content learning opportunities within the unit for both teachers and students. This study was prompted by previous research on curriculum materials as tools that teachers interact with to foster student learning, and the call to use these tools to educate teachers, as well as students. To analyze how teachers use and adapt the curriculum materials, two teachers in the same school were observed and interviewed regarding their enactment of a reform-based, inquiry curriculum. Findings revealed the teachers' challenges with enacting segments of lessons related to scientific practices, specifically those with limited educative supports in the curriculum. During interviews, teachers demonstrated difficulty understanding the rationale for various scientific practices and how to enact them. Since teachers had difficulty enacting the scientific practices, the students' learning opportunities—represented by student pre- and post-assessments of science content—were also affected. These findings have implications for curriculum developers and teacher educators by identifying the need for more educative supports in curriculum that provide teachers with rationales and adaptation guidance about scientific practices to better support both teacher and student learning.

Strand 11: Cultural, Social, and Gender Issues

Urban Children and Science: Identity, Representation, and Implications for Science Education

10:15am – 11:45am, Room 107

Presider: Gale A. Seiler, McGill University

Language, Identity, & Cognition: Disaggregating Science Instruction for Urban Students

Bryan A. Brown, Stanford University, brbrown@stanford.edu

ABSTRACT: Learning the language of science can prove to be one of the most difficult aspects of students' science learning. In an effort to address this challenge, we explored the potential of using students' everyday 'science' discourse as a way of improving students' learning. Two teachers alternated their teaching practices using an aggregate approach and a disaggregate approach in each class. The results revealed that students in the disaggregate (treatment) condition experience a learning gain of 34.80% compared to the 29.92 percent learning gain experienced by the aggregate instruction (control). The results of this preliminary study indicated that students taught using everyday language first improved the science understanding. The results have implication for urban teaching practices with diverse student populations.

The Electricity Went Out and My Teacher Said,

Bhaskar Upadhyay, University of Minnesota, bhaskar@umn.edu

Nancy Albrecht, University of Minnesota

Kristina Maruyama Tank, University of Minnesota

Geoffrey Maruyama, University of Minnesota

Martin Adams, University of Minnesota

Timothy Sheldon, University of Minnesota

Brian Fortney, University of Texas at Austin

ABSTRACT: This study examines how students from non-dominant groups in an inner city poor urban elementary school setting import their cultural, social, and contextual experiences in doing and learning science. The study uses interpretive case study design to investigate the question. We draw from the theories of socio-cultural nature of learning (Gutierrez & Rogoff, 2003) to analyze our data and understand why and how culture and history matters in teaching and learning science. We particularly focused on how students' immediate home

Monday, March 26, 2012

experiences influenced what they wanted to learn and what the purposes of learning science were for our students. We found that students not only saw science very closely related to their experiences and useful to them but they also saw direct link of science to larger global issues of food shelf life, food transportation, and food choices and habits. This study makes a major contribution in helping science teachers and educators understand the importance of socio-cultural experiences in teaching and learning science.

Recognition in the Classroom: Examining the Physics Identity Development of Marginalized Students through Case Studies

Carrie E. Beattie, Clemson University, cbeatti@g.clemson.edu

Zahra Hazari, Clemson University

Cheryl A.P. Cass, North Carolina State University

ABSTRACT: Prior research has noted the relationship between a student’s formation of a “science identity,” which heavily depends on recognition by others, and their likelihood of engaging and persisting in science. This study focuses on examining the ways in which students, particularly underrepresented groups such as females and minorities, are recognized in the physics classrooms of four exceptional teachers who were purposefully sampled (from a national study) because they had been successful in helping students identify with physics. To document these enactments of recognition, we conducted one-week observations and selected a diverse range of students (n=29, 7-8 per teacher) for interviews. Multiple themes emerged from the data, including various forms of explicit and implicit recognition which were categorized according to likeness into two overarching groups labeled “recognition as a good physics student” and “recognition through playing expert.” The findings, which are consistent with existing work, are presented to facilitate the adoption of these recognition-enhancing strategies by physics teachers so that more students, especially females and minorities, may feel recognized and can begin forming a “physics identity.”

Students Awareness and Varied Use of Classroom as Social Construct

Adriane M. Slaton, slatonad@msu.edu

ABSTRACT: Using a sociocultural lens, this ethnographic study considers the role of talk and social interaction amongst teacher and students in an urban science classroom. While this research has investigated the social nature of classrooms, it is not well understood how students understand the social nature of learning and how they contribute to it. Using grounded theory, several themes emerged from the data and are presented in two parts. In Part One, the researcher describes the context of the study and analyzes how teacher and students contribute to the social nature of the floor. In Part Two of the study, two claims are presented: 1) talk and social interaction influence learning as demonstrated through mapping the evolution of participant thinking to analyze who and what influenced the changes in their thinking; and 2) participants are aware of their roles in the social construction of the classroom and use this meta-knowledge in varied ways.

Strand 12: Educational Technology

Games, Simulations, Virtual Environments, & GIS

10:15am – 11:45am, Room 101

Presenter: Karen E. Irving, The Ohio State University

Investigating Students’ Ideas about Buoyancy and the Influence of Haptic Feedback

James Minogue, North Carolina State University, james_minogue@ncsu.edu

David Borland, Universitat de Barcelona and IDIBAPS Barcelona, Spain

ABSTRACT: Relatively recent advances in technology have made the addition of “touch” to computer-generated virtual environments possible. While haptics (simulated touch) represents a potential breakthrough technology for science teaching and learning, there is little research to guide instructional designers. The proposed poster session describes the testing of a haptically-enhanced simulation for learning about buoyancy and adds to the burgeoning research base on haptics in education. Despite a lifetime full of everyday experiences, a scientifically sound

Monday, March 26, 2012

explanation of buoyancy remains difficult to construct for many. It requires the integration of domain-specific knowledge regarding density, fluid, force, gravity, mass, weight, and buoyancy. Prior studies suggest that novices often focus on only one dimension of the sinking and floating phenomenon. Our simulation was designed to promote the integration of the subconcepts of density and buoyant forces and stresses the relationship between the object itself and the surrounding fluid. The study employed a randomized pre-test-post-test control group research design and a suite of measures including an open-ended Why Things Sink and Float (WTSF) prompt, a concept mapping task, and objective content questions to provide insights into the influence of haptic feedback on undergraduate students' thinking about buoyancy.

Integrating Geographic Information Systems in a Science Methods Course-Preservice Teachers Examining STS Issues
 Josephine Shireen Desouza, Ball State University, Muncie, Indiana, jmdesouza@bsu.edu

ABSTRACT: This poster presentation is relevant to the NARST theme of reimagining research for the 21st century as it attempts to study the process of integrating GIS technology in the teacher preparation curriculum. Through hands-on projects preservice teachers experience decision making about real world data is a key component to finding solutions to societal issues and that GIS technology can be used as an analytical tool requiring students and teachers to use problem solving and critical thinking skills. This project provides preservice teachers an insight into designing projects of their own and the understanding of the capability of GIS technology in integrating data from science and other disciplines to display the results in a spatial form.

Immersing Preservice Science Teachers in Serious Educational Games

Leonard A. Annetta, George Mason University, lannetta@gmu.edu
 Richard L. Lamb, George Mason University
 James Minogue, North Carolina State University
 Rebecca Cheng, George Mason University
 David B. Vallett, George Mason University
 Shawn Y. Holmes, North Carolina State University
 Elizabeth Folta, College of Environmental Science & Forestry

ABSTRACT: Built using next generation Web technologies (Web 2.0) a three-dimensional Serious Educational Gaming application that provides learning materials and strategies to engage science teachers in real world classroom issues was constructed. This game advances science teacher preparation and development by creating modules that immerse the teacher in scenarios once deliverable only through hypothetical case study. This project examines emerging forms of game play interaction taking place in the STIMULATE (Science Training Immersive Modules for University Learning Around Teacher Education) Serious Educational Game world to determine how to effectively engage learners in order to deepen their understandings of the pedagogy of science, technology, engineering, and math (STEM), as well as stimulating interest in invention and discovery. We augment and enrich the teacher experiences as they engage in technology-enhanced environments using a "guided inquiry" approach. A STIMULATE game guide directs users to examine and monitor their own thinking, gain new knowledge, and revise existing schemata with the aid of cognitive scaffolds.

Virtual Learning Environment Preference, Perception of Helpfulness, and Achievement in Taiwanese Earth Science Students

Ming-Chao Lin, National Taiwan Normal University, 89344006@ntnu.edu.tw
 Shane Tutwiler, Harvard University
 Chun-Yen Chang, National Taiwan Normal University

ABSTRACT: Using 3D simulation software, 82 tenth grade senior high school students in central Taiwan took a virtual field trip to the Hsiaooyukeng Walking Area at Yangmingshan National Park in Taiwan. 40 of the students watched a teacher guide them through the environment, and 42 students explored the environment in teams of 4. Pre and post intervention content knowledge was assessed, as were affective traits. Based on pilot studies, the assessments results were used to fit a linear multiple regression model. We found that 90% of the students thought that the intervention was helpful and that 87% preferred the student team-based treatment. In addition,

Monday, March 26, 2012

we found that the type of treatment the pre-test score, type of treatment preferred, and degree to which the student found the intervention helpful were all statistically significant predictors of post-test variability.

Strand 13: History, Philosophy, and Sociology of Science

Strand Sponsored Session - Teaching and Assessment of Inquiry and Nature of Science with Early Childhood Students

10:15am – 11:45am, Room 102

Presenter: Norman G. Lederman, Illinois Institute of Technology

Presenters:

Valarie L. Akerson, Indiana University

Judith S. Lederman, Illinois Institute of Technology

Leon Walls, University of Vermont

Gayle A. Buck, Indiana University

Erin Peter Burton, George Mason University

ABSTRACT: Understandings of scientific inquiry (aka, science practices) and nature of science have been emphasized as important learning outcomes for K-12 students. The rationale for addressing these topics is their clear connection to the overall goal of scientific literacy. However, most research reported focuses on middle and secondary level students. When elementary level students are discussed, they are usually in grades 4-6. Early childhood students present a variety of "problems" with respect to the teaching and assessment of inquiry and nature of science. It is not clear what very young students can understand. In short, are understandings of scientific inquiry and nature of science to abstract and developmentally inappropriate for very young students? In addition, assessment of such students' understandings is difficult using the typical paper/pencil (both open and closed-ended) and interview instruments. Very young students do not necessarily have the writing, reading, and speaking skills needed for the typical assessments that do exist. This session will present a variety of research projects that illustrate how inquiry and nature of science can be taught to very young students, what very young students can understand, and how their understandings can be validly and reliably assessed.

Strand 14: Environmental Education

Science Teacher Education as a Context for Environmental Literacy Improvement

10:15am – 11:45am, Room 103

Presenter: Bryan H. Nichols, University of South Florida

Conceptualizing In-service Secondary School Science Teachers' Knowledge Base for Climate Change Content

Devarati Bhattacharya, University of Minnesota, Minneapolis, devarati@umn.edu

Engin Karahan, University of Minnesota, Minneapolis

Younkyeong Nam, University of Minnesota, Minneapolis

Jeremy Wang, University of Minnesota, Minneapolis

Shiyu Liu, University of Minnesota, Minneapolis

Benjamin Tierney, University of Minnesota, Minneapolis

Keisha Varma, University of Minnesota

Gillian Roehrig, University of Minnesota

ABSTRACT: The NASA-funded Global Climate Change Education (GCCE) project, "CYCLES: Teachers Discovering Climate Change from a Native Perspective", is a 3-year teacher professional development program designed to develop culturally-responsive approaches for teaching global climate change (GCC). It promotes the understanding of GCC in Native American populations using traditional and cultural knowledge, data simulation, and technology-enhanced tools. In this study, we assessed the changes in secondary teachers' content knowledge about GCC. The content provided to the teachers during a week-long summer workshop was organized to reflect the similarities between Native American and scientific explanations of the natural world as an interconnected and cyclical

Monday, March 26, 2012

processes. The content was thematic, indigenous and focused on the five elements of the Native American medicine wheel-Earth, Fire, Air, Water, and Life (Figure 1). We used a phenomenographical approach to analyze data. Photo-elicitation techniques and concept mapping were used for a qualitative assessment of different ways in which the teachers conceptualized climate change. Our findings indicate that while teachers understand a diverse array of topics related to the science of global climate change, they have different perceptions about timescale, data projections using modeling and the level of uncertainty in the data. (Figures are included in the PDF document).

Pre-service Elementary Teachers' Outdoor Experiences: How Do These Translate into Beliefs on Taking Students Outdoors?

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

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 a phenomenon called "nature-deficit disorder," which characterizes the generation of technology-savvy youth that is growing up today, often unexposed to the natural environment around them. In relation to teacher education, it is unclear if current pre-service elementary teachers have experienced the outdoors themselves or are part of this "nature-deficit" generation. This study investigates the outdoor experiences of undergraduate students in a pre-service elementary teacher program at an urban college in the Northeastern United States, and consequently their own beliefs about bringing their students outdoors. The participants include 60 pre-service teachers enrolled in a Methods of Teaching Elementary Science course. Utilizing a sociocultural approach, the study methods include written essay responses, interviews, and videotape of classroom dialogue. The study findings reveal a surprising number of positive experiences of the pre-service elementary teachers in nature or with outdoor play in their youth, and the value many of them place upon exposing their own students to nature and the outdoors.

Exploring Teachers' Barriers to Implementing System Dynamics Tools for Sustainability Education

Heather J. Skaza, University of Nevada-Las Vegas, skazah@unlv.nevada.edu

Kent J. Crippen, University of Florida

Kristoffer Carroll, Clark County School District

ABSTRACT: STEM education continues to move up the national priority list with the broad goal of creating learners literate in STEM content, able to make sound sustainable decisions. To this end, systems thinking tools and system dynamics simulations can provide a valuable means for helping students think their way around complex environmental problems. This study reports on the results of a web-based survey regarding the use of systems tools in secondary science classrooms and teachers' understanding of the tools already available to them. Teachers identified the barriers to implementing systems simulation activities as both computer access and their own understanding. A test of teachers understanding of systems principles reveals inconsistencies in the way they interpret models, based on their previous understanding of the system. Survey results will be used to design questions for a closer look at teachers' perspective through a focus group study. This study speaks to this year's conference theme-Re-Imagining Research in 21st Century Science Education for a Diverse Global Community-because it focuses on the adoption of a technology and framework that has the potential to be effective across disciplines in helping students and teachers communicate with each other about complex global problems.

Exploring Science Teacher Attitudes towards Instruction Through Foods, Investigations, Soils, and Healthy Habits (FISHH)

Christopher D. Murakami, University of Missouri, cdmvk7@mail.missouri.edu

Parker E. Stuart, University of Missouri

Stephen B. Witzig, University of Missouri

Anna M. Waldron, University of Missouri

ABSTRACT: Weaver-Hightower (2011) calls on education researchers to consider food issues in their research because of their impact on student learning, environmental sustainability, and public health. Schoolyard gardening

Monday, March 26, 2012

is one way for science and environmental educators to address food issues and improve science achievement, environmental attitudes, physical activity, and student food-choice behavior (Klemmer, Waliczek, & Zajicek, 2005; Morris & Zidenberg-Cherr, 2002; Ozer, 2007; Ratcliffe, Merrigan, Rogers, & Goldberg, 2009; Waliczek & Zajicek, 1999). Researchers have explored teacher attitudes towards school gardening and found that there are positive attitudes toward gardening programs but a perceived dearth of teacher knowledge, relevant curricula, and training experiences (Graham & Zidenberg-Cherr, 2005). The current study was conducted to address the gap in garden teaching knowledge and to further explore teacher belief systems and attitudes related to food education. Research yielded a sociocultural model of intern science teachers' embedded belief system for teaching through Foods, Investigations, Soils, and Healthy Habits (FISHH). Data from a weeklong FISHH Professional Development program and field-experience was used to construct this belief system for teaching about FISHH. This model shows that the interns positively viewed FISHH instruction but maintained the perception that teacher knowledge is the main barrier to teaching FISHH.

Monday, March 26, 2012

Equity and Ethics Committee Sponsored Session

Symposium - Developing a NARST Code of Ethics

1:15pm – 2:45pm, Room 103

Presenters:

Sarah Barrett, York University, sbarrett@edu.yorku.ca
 Julie A. Bianchini, University of California, Santa Barbara
 Brian S. Fortney, University of Texas at Austin
 J. Randy McGinnis, University of Maryland
 Felicia M. Mensah, Teachers College, Columbia University
 Matthew Weinstein, University of Washington, Tacoma

ABSTRACT: As a proactive initiative, the NARST Equity and Ethics Committee is working to craft a NARST Code of Ethics. This initiative speaks to the continuing maturing of our association to support members' expectations of ethical behavior in professional societies. This is not in reaction to a crisis facing the association. A code of ethics sets forth the principles and ethical standards that underlie researchers' professional responsibilities and conduct. Our intent is to develop a NARST code that includes all the best ideas from other associations' codes as well as novel ideas suggested by our diverse membership. We encourage members to attend this session, examine and discuss possible versions of a NARST code, and provide additional suggestions and insights in small groups and in written exit cards. Our goal is for the NARST Code of Ethics to be an exemplar for other professional associations worldwide.

International Committee Sponsored Session

Symposium - Contributions from the European Science Education Research Association: Addressing Diversity in Science Education through Research about Cultural Diversity of Students, Brain-type and Motivation, Multiple Workplace Policies and Multiple Representations

1:15pm – 2:45pm, Room 313

Presiders:

Sibel Erduran, University of Bristol
 Manuela Welzel-Breuer, ESERA, Germany

Dialogic Research in a Diverse Globalizing World: Ways of Valuing Local Voices in Multi-Partner Design Research Including both Developing and Developed Countries

Michiel van Eijck, Eindhoven University of Technology, The Netherlands,
 Ralf van Griethuijsen, Eindhoven University of Technology, The Netherlands
 SweeChin Ng, Tunku Abdul Rahman College, Malaysia
 SiewChee Choy, Tunku Abdul Rahman College, Malaysia
 Saouma B. Boujaoude, American University of Beirut, Lebanon
 Sugra Chunawala, Tata Institute of Fundamental Research, India
 Chitra Natarajan, Tata Institute of Fundamental Research, India
 Huseyin Bag, Pamukkale University, Turkey
 Ayse Savran Gencer, Pamukkale University, Turkey
 Helen Haste, University of Bath, UK/Harvard Graduate School of Education, USA
 Nasser Mansour, University of Exeter, UK
 Alun Morgan, University of Exeter, UK
 Keith Postlethwaite, University of Exeter, UK

ABSTRACT: The science education literature is by and large limited to cases in individual countries of which the majority is Western. Consequently, little is known of the actual practice of doing research in the 21st century science education for a diverse global community which includes both developing and developed countries. By drawing on our experiences in a global research project entitled Science Education for Diversity we aim at concretizing this practice. The purpose of this collaborative research project between the UK, the Netherlands,

Monday, March 26, 2012

Turkey, Lebanon, India and Malaysia was to (i) understand how the partner countries address the issue of diversity and (ii) use the results to improve science education in terms of responding more effectively to the new cultural diversity of students and benefit students in Western and non-Western countries involved in the project. Particularly, in this contribution, we highlight the dialogic way according to which the project was setup and by which we are currently collaborating, that is, by valuing the local voices as they are in a project with both developing and developed countries. Furthermore, we identify several successes and challenges in this kind of multi-partner global research, and how they are related to social, cultural, and practical aspects of our research. In so doing, we develop a number of principles for the practice of doing research in the 21st century science education for a diverse global community.

Brain Type- a Cross Cultural Constant of Motivation to Learn Science?

Albert Zeyer, University of Zurich, Switzerland,
 Ayla Çetin-Dindar, Middle East Technical University, Ankara, Turkey
 Ahmad Nurulazam Md Zain, Universiti Sains, Malaysia
 Mojca Juriševič, University of Ljubljana, Slovenia
 Iztok Devetak, University of Ljubljana, Slovenia
 Freia Odermatt, University of Zurich, Switzerland

ABSTRACT: Sex is considered to be one of the most significant factors influencing attitudes towards science. However, the so-called brain type approach from cognitive science (Baron-Cohen, Knickmeyer, & Belmonte, 2005) suggests that the difference in motivation to learn science does not primarily differentiate the girls from the boys, but rather the so-called systemisers from the empathizers. Boys are, on average, more motivated to learn science, not because they are boys but because boys tend to be systemizers, and vice versa for girls. Previous research on Swiss students (Zeyer & Wolf, 2010; Zeyer, Bölsterli, Brovelli & Odermatt, in press) has shown full mediation between sex and motivation to learn science, measured by the Science Motivation Quotient SMQ (Glynn & Koballa, 2007). The present study was conducted in order to confirm this relation in a cross-cultural study. It involved four countries (Malaysia, Slovenia, Switzerland, and Turkey) and 1100 students in upper secondary level. The study used structural equation modelling in order to test the hypothesised relationship. The results confirm the full mediation of systemizing between sex and motivation to learn science. The results are stable and the model fit is excellent. Systemizing explains 27% of the motivation to learn science. The indirect impact of sex on motivation is significant but low. The results are invariant across all four cultures. It is therefore concluded that students' brain type, seen as a basic cognitive personal trait, is more important as a predictor for motivation to learn science than sex. It should be taken into account both in science teaching and research of science education.

Balancing Multiple Policies in the Workplace: Teachers' Experiences of Science Curriculum Reform

Jim Ryder, University of Leeds, UK,
 Indira Banner, University of Leeds, UK
 Jim Donnelly, University of Leeds, UK

ABSTRACT: There has been much written about the 'failures' of successive school curriculum reform efforts (Kahle, 2007). However, there has been limited research into the mechanisms through which educational reforms become 'realised' within specific school settings (Fensham, 2009). This paper takes a situated perspective on teacher activity (Cobb, McClain, de Silva Lamberg, & Dean, 2003; Spillane, 2006) to develop an understanding of why teachers respond as they do to a major curriculum reform. The context for our analysis is a reform to the national science curriculum for 14-16 year olds in England. This curriculum reform enhances the range of available science courses and emphasises the teaching of socio-scientific issues and the nature of science – a curriculum trend of global significance. A designed sample of 22 teachers discussed their experiences of the reform within a semi-structured interview. Our analysis considers how the external and internal structures within which teachers work interact with the personal characteristics of teachers to condition their experiences of the curriculum reform. Teachers' professional goals are not purely personal characteristics of the teacher. Rather these goals are partially constituted by the characteristics of the school and department in which the teacher works. We also show how experiences of curriculum reform can extend beyond the learning of new knowledge and associated pedagogies to

Monday, March 26, 2012

involve changes in teachers' professional identities. We argue that curriculum reformers need to recognise the inevitability of multiple teaching goals within a highly differentiated department and school workplace. We also argue for the extended use of teacher role models within local communities of practice to support changes in teachers' professional identities.

Representational Competence and Understanding of Scientific Experiments, Phenomena and Concepts: At a Crossroad of Progress for the Science Education of the 21st Century

Jochen Scheid, University of Landau, Germany,
 Rosa Hettmannsperger, University of Landau, Germany
 Jochen Kuhn, University of Landau, Germany
 Wolfgang Schnotz, University of Landau, Germany
 Andreas Müller, University of Geneva, Switzerland

ABSTRACT: Recent European and world-wide research has emphasized the role of multiple representations for a proper understanding of scientific experiments, phenomena and concepts. This is true for several aspects considered as essential for the future development of science education, such as diagnostics, cognitive activation, and new approaches to misconceptions. Several related studies have been conducted in the field of ray optics. In a first study, a test for representational competence was developed for diagnostics, probing for completeness, consistency and coherence of representations. Validation by standard procedures yielded a field-tested instrument of reasonable length and reliability (13 items, $\alpha_C=0.75$). In a second study, domain specific representational analysis tasks (RATs, such as completing and mapping representations; RATs are typically based on two or more forms of representations) were developed to focus on cognitive activation. The comparison of a treatment based on RATs to a control group dealing with the traditional construction of ray diagrams and with only one type of representation at a time yielded a considerable effect on representational competence (ANCOVA: $p<0.001$; $\omega^2=0.22$). Finally, a third study examined the impact of RATs related specifically to misconceptions. Considerable conceptual learning was found in the pre-post comparison, but no difference when comparing to a control group working on the same misconceptions, but without a representational focus. The methodological features of the above studies are discussed (control measures, instruments, etc.) as well as the significance of their results for theory and classroom practice, including their limitations, perspectives and an outlook on future research.

Strand 1: Science Learning, Understanding and Conceptual Change

Related Paper Set - Immersion into Argument-based Inquiry: Understanding Critical Elements for Classroom Practice

1:15pm – 2:45pm, Room 310

Discussants: Brian M. Hand, University of Iowa

ABSTRACT: This paper set addresses several theoretical and practical issues regarding science learning through immersive argument-based inquiry (ABI) approaches. The researchers focus on student achievement, literacy practices, the development of conceptual understanding through text and various modal representations, professional development (PD), as well as the use of argument as an instructional tool. The Turkish, Korean, and U.S. studies contribute to theoretical frameworks that consider how students and teachers appropriate scientific discourse and practices through immersion and how this impacts science learning. Study 1 reports on the effect of implementing an ABI approach on student achievement scores in grades 6, 7 & 8. Study 2 reports on how various science writing formats, e.g. ABI, informal, traditional report writing, are used as a learning tool. Study 3 reports on classroom instruction that encourages the integration of multimodal representations in grades 6-11. Study 4 reports on the orientation of PD programs and leaders to ABI. Study 5 offers a theoretical case for conceptualizing science instruction as argument cycles. Collectively, these ABI studies offer insight and challenges our current perspectives about learning, science epistemology, language and pedagogy.

The Effect of the SWH Implementation in Turkish School System: Results from a Scale up Research Project
 Murat Gunel, AHT Euran University, mgunel@yahoo.com

Monday, March 26, 2012

Recai Akkus, Abant Izzet Baysal University, Turkey
Melike Ozer-Keskin, Gazi University, Turkey
Nilay Keskin-Samanci, Gazi University, Turkey

The Impacts of Writing in Argument-Based Inquiry on Science Learning
Hyeongjeong Kil, Pusan National University, hj9620@hanmail.net
Jeonghee Nam, Pusan National University

Modeling Scientific Communication with Multimodal Writing Tasks: Impact on Students at Different Grade Levels
Mark McDermott, Wartburg College, mark.mcdermott@wartburg.edu
Audrey Sturtz, Manson-NW Webster High School
Jake Mohling, Humboldt Middle School

Examining Professional Development Programs and PD Leaders' Orientation to Immersive Argument-based Inquiry Practices
Mary Grace Villanueva, University of Iowa, marygrace-villanueva@uiowa.edu
Brian M. Hand, University of Iowa

Argument as a Linchpin between Learning, Teaching, and Science: Conceptualizing Science Instruction as Argument
Andy Cavagnetto, Binghamton University, acavagne@binghamton.edu

Strand 2: Science Learning: Contexts, Characteristics and Interactions

Related Paper Set - High School Science Teacher Professional Cultures that Successfully Retain Teachers and Prepare Students in Science

1:15pm – 2:45pm, Room 302

Presenter: Carol L. Stuessy, Texas A&M University

Discussant: Timothy Scott, Texas A&M University

ABSTRACT: This paper set takes you inside the walls of 50 randomly selected high schools in a large, southwestern state. We characterize the schools' science teacher professional cultures (STPC) with the use of an evolving conceptual model that allows cross-comparisons of schools on a number of school support and teacher variables and on student outcomes of science proficiency and college readiness. Eight dissertations, clustered by topic, highlight their findings to describe schools' practices and teachers' professional activities in successfully retaining high school science teachers and preparing students for life after high school graduation. Paper 1 introduces the conceptual framework, focuses on research methods used to create and query common datasets used by all researchers, and introduces visual profiles characterizing the STPCs of the 50 sampled schools. Paper 2 focuses on school support practices of STPCs for science teachers at three stages (recruitment, induction, professional development) in the teacher professional continuum. Paper 3 focuses on teachers holding positions within the STPC, describing relationships between and among teachers' professional activities, levels of job satisfaction, and mobility status. Paper 4 synthesizes research to describe the achievement gap among STPCs in relation to science teachers' working conditions students' science proficiency and college readiness.

Conceptualize, Contact, Collect, Connect: Using Mixed Methods to Characterize the High School Science Teacher Professional Culture

Todd D. Bozeman, Texas A&M University, dbozeman71@tamu.edu
Carol L. Stuessy, Texas A&M University
Caroline V. Rosado, Texas A&M University
Tyrone Blocker, Texas A&M University

Monday, March 26, 2012

Recruit, Induct, Engage, Renew: School Support in a Healthy High School Science Teacher Professional Culture

Ra'sheedah Richardson, Texas A&M University, sheedah@tamu.edu

Laura E. Ruebush, Texas A&M University

Toni Ivey, Oklahoma State University

Activity, Job Satisfaction, Mobility: Teachers as Contributors and Consumers of the Science Teacher Professional Continuum

Sara E. Spikes, Texas A&M University, sspikes@tamu.edu

Todd D. Bozeman, Texas A&M University

Achievement Gap: Working Conditions and Science Teacher Professional Culture in Low- and High-Achieving Schools

Carol L. Stuessy, Texas A&M University, c-stuessy@tamu.edu

Victoria Hollas, Texas A&M University

Implications for Higher Education and the Preparation of High School Science Teachers

Timothy Scott, Texas A&M University, tim@science.tamu.edu

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

Science as Inquiry

1:15pm – 2:45pm, Room 301

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

Dichotomous Inquiry Practices: Characterizing Teaching Practice based on Essential Features of Inquiry

Brian R. Pinney, University of Iowa, brian-pinney@uiowa.edu

ChingMei Tseng, University of Iowa

Jee Kyung Suh, University of Iowa

Cory T. Forbes, University of Iowa

Mandy Biggers, University of Iowa

Laura Zangori, University of Iowa

ABSTRACT: This research project focuses on how teachers visualize and utilize the essential features of inquiry in their teaching practice with a focus on alternative explanations (NRC, 2000). Our data set included three elementary teachers with 2, 10, and 20 years teaching experience. In this study, the teachers were each using a kit-based science curriculum. Two general approaches to the essential features were conceptualized prior to data analysis; one that values and seeks alternative explanations and one that sees them as competing with the science explanation. Pattern matching was then used to characterize the teachers (Yin, 2009). Ultimately, even though different approaches were seen, all three cases resulted in similar discourse patterns that are inconsistent with effective student discourse (Erduran & Dagher, 2007; Kuhn, Kenyon & Reiser, 2006). The examined cases were expected to be typical of science teaching and retained a sense of traditional science instruction. Implications of this research suggest knowledge of inquiry categories was insufficient to enact effective utilization of those categories in an inquiry setting.

Characteristics of Scientifically-oriented Questions and the Nature of Inquiry in Elementary Classrooms: A Multiple-case Study

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Nattida Promyod, University of Iowa

Cory T. Forbes, University of Iowa

Mandy Biggers, University of Iowa

Laura Zangori, University of Iowa

Monday, March 26, 2012

ABSTRACT: The five essential features of inquiry (NRC, 2000) describe key aspects of inquiry-based classrooms. This study is conducted as a part of multi-year professional development project for elementary science to specifically focus on the first of the five essential features of inquiry: engaging students in scientifically-oriented questions. To investigate the characteristics of teachers' scientific questions, we conducted a multiple case study with three in-service elementary teachers to illustrate how and what kind of questions they use with their students in the science classroom, as well as characterize their reasoning for engaging students in particular questioning practices. Data were analyzed by using constant comparative method as well as reliance on theoretical propositions. The data analysis revealed that the teachers articulated an understanding about the importance of questions in the process of inquiry. Even though each teacher's experience with inquiry-based pedagogy varied, they all emphasized the importance of questions to promote higher order thinking skills and student sense-making about science. Our findings suggest that teachers' ideas and orientations about the nature and use of scientifically-oriented questions are reflected in their classroom practice and characteristics of the learning environments they foster.

Cultural Themes as the Center of Inquiry Science Curricula in American Indian Head Start Classrooms

Mia Dubosarsky, University of Minnesota, dubo0053@umn.edu
 Gillian Roehrig, University of Minnesota
 Stephan Carlson, University of Minnesota
 Jennifer Jones, University of Minnesota
 Barb Murphy, University of Minnesota
 Linda Frost, University of Minnesota

ABSTRACT: Science education contributes to the development of critical thinking and problem solving skills. Extensive research has shown that acquiring skills and experiences during the first years of life provides a foundation for future learning and development. Unfortunately, science is often missing from early childhood classrooms. The problem is even greater in minority populations, and especially American Indian populations. One of the reasons is the disparity between the culture of schooling – and school science - and the home culture of the students. Culturally based science education is recommended by the National Association for Education of Young Children as well as by numerous science educators and researchers. This approach advocates for customizing science teaching to students' cultural background, and was found to increase students' accessibility and engagement with science. This presentation introduces a model for designing culturally based science units for early childhood classrooms, and two sample units. The model was developed as part of Ah neen dush, a professional development program for Head Start teachers on an American Indian reservation. Program's data shows that focusing on cultural, familiar themes helped engage both teachers and children, and led to a long lasting learning of the concepts introduced during the units.

The Impact of Equitable and Inquiry-based Science Teaching on American Indian Students' Test Scores

Bruna Irene Grimberg, grimberg@montana.edu
 Edith Gummer
 Judith Devine

ABSTRACT: This study analyses the relationship between science instructional practices and science performance for students in K-8 classrooms near or on American Indian reservations in Montana. The study employed a quasi experimental pre/post design and multiple regression analysis to examine the relationship between student-centered, equity-focused and inquiry-based instruction on students' science tests scores gains. Data sources included treatment and comparison group teachers' classroom observational data, survey data on enacted curriculum and practices, and students' scores on science tests administered before and after year-long science instruction. Results of the analyses indicate that the interactions among teaching practice variables differ for control and treatment teachers. Teachers' perception of their ability to implement an equity-focused instruction correlates with their perception of the accuracy and appropriateness of science content presented in the classroom for treatment teachers, but not for control teachers. The predictive models that explain the treatment and control students' scores variability include different variables. The results obtained from this study contribute

Monday, March 26, 2012

to the characterization of the interactions among instructional strategies adopted by teachers that integrate culturally responsive approaches to their science teaching, and assist in identifying science instructional practices that are conducive to gains in science test scores for American Indian students.

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

Related Paper Set - Promoting Reform through Instructional Materials that Educate

1:15pm – 2:45pm, Room 303

ABSTRACT: In this paper set, we examine the theoretical framework, interventions, and results that shaped a six year study designed to improve the teaching of high school biology by focusing on Pedagogical Content Knowledge (PCK). This project worked from the hypothesis that the development of teachers' PCK is a route to enhanced student learning. To test this hypothesis we focused on a two-part intervention that leveraged extant parts of the high school system: textbooks and professional development (PD). Our results showed positive increases in multiple teacher knowledge bases. In addition, there were statistically significant relationships established between increases in teachers' content knowledge and student achievement. The link to changes in practice, however, is more complex: and though this link was evident in interviews with teachers, but not as compelling only teachers' general pedagogical knowledge had a statistically significant relationship with practice when measured empirically. This could be due to the time required for changes in teachers' knowledge to become integrated into teachers' practices, and/or to the need for much greater PD support in making the translation from knowledge to practice.

Part 1 of the Intervention: Educative Curriculum Materials

Janet Carlson, BSCS, jcarlson@bscs.org
 Joseph A. Taylor, Biological Science Curriculum Study
 April L. Gardner, Biological Science Curriculum Study
 Julie Gess-Newsome, Willamette University

Part 2 of the Intervention: Curriculum-based, Transformative Professional Development

April L. Gardner, Biological Science Curriculum Study, agardner@bscs.org
 Janet Carlson, BSCS
 Julie Gess-Newsome, Willamette University

Linking the Intervention to the Evidence (or Linking the Evidence to the Intervention)

Molly Stuhlsatz, BSCS, mstuhlsatz@bscs.org
 Joseph A. Taylor, Biological Science Curriculum Study
 April L. Gardner, Biological Science Curriculum Study
 Julie Gess-Newsome, Willamette University
 Janet Carlson, BSCS
 Christopher Wilson, BSCS

Considering Personal and Contextual Influences

Julie Gess-Newsome, Willamette University, jgessnew@willamette.edu
 April L. Gardner, Biological Science Curriculum Study
 Janet Carlson, BSCS
 Joseph A. Taylor, Biological Science Curriculum Study

Monday, March 26, 2012

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

Argumentation in Science Learning

1:15pm – 2:45pm, Room 304

Presider: Vicente A. Talanquer, University of Arizona

Using a Science Laboratory Course to Enhance Undergraduate Students' Arguments Related to Socioscientific Issues

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

Victor D. Sampson, Florida State University

ABSTRACT: This quasi-experimental study uses a pre-/post-intervention approach to investigate the quality of undergraduate students' arguments in the context of socioscientific issues (SSI) based on experiencing a semester of traditional "cookbook" instruction (N=79) or a semester of argument-based instruction (N=73) in the context of an undergraduate science laboratory course. Findings from this study indicate that the students experiencing the argument-based instruction generated significantly better arguments than students in the traditional course after the intervention. Specifically, the students in the treatment group were better able to include rationales in their arguments supporting their stance on the SSI task. Implications for instruction in undergraduate science laboratory courses are discussed.

Exploring the Impact of Argumentation on College Students' Conceptual Understanding of The Properties and Behavior of Gases

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

Pinar S. Cetin, Bolu Abant Izzet Baysal University

Aybuke Pabuccu, Bolu Abant Izzet Baysal University

Ebru Kaya, Selcuk University

ABSTRACT: The purpose of this study was to explore the impact of argumentation-based pedagogy on college students' conceptual understanding of the properties and behaviors of gases. The sample consists of 108 students (52 in the control group and 56 in the intervention group) drawn from two general chemistry college courses taught by the same instructor. Data were collected through pre and post-tests. The results of the study show that the intervention group students performed significantly better than the control group students on the post-test. The intervention group students also showed significant increase in their test scores between pre and post-test. While at least 80% of the students in the intervention group abandoned their initial ideas on all of the misconceptions (n=17) but one, the percent of student abandoning their initial ideas in the control group was less than 50. The discussion focuses on the implications of these results for addressing students' misconceptions, promoting the argumentation-pedagogy in college science courses and the challenges associated with the use of argumentation in college science classrooms.

Negotiation and Argumentation among Engineering Students

Nicholas Fila, Purdue University, nfila@purdue.edu

ABSTRACT: The purpose of this study was to examine how engineering students engage in argumentation during problem solving and why they struggle with this during engineering analysis. The participants were 73 first-year engineering students, who engaged in an hour-long engineering analysis task. Students worked in teams of three or four. Results showed that students relied on divide-and-conquer strategy, engaged in limited argumentation, and failed to recognize significant calculation errors. The nature of activities (e.g., amount of time given for argumentation) and instructional focus (e.g., explicit teaching in argumentation) should be reviewed if argumentation is desired from engineering students.

Disjunction as a Facilitator to Enhance Argumentation Quality in Problem-Based Learning

Chia-Hui Hung, National Taiwan Normal University, beautycathy1121@gmail.com

Chen-Yung Lin, National Taiwan Normal University

ABSTRACT: This study investigated the catalyst role of disjunction as effective strategies for initiating and improving quality of argumentations in science learning. A group of thirteen college students participated in the

Monday, March 26, 2012

problem-based learning units. A case scenario with four scenes as learning materials was employed and totally the research lasted six weeks. The four scenes contained various concepts, attitudes, and skills which hold critical disjunction from those that students had and were used to facilitate students' argumentations in the PBL. Students were guided in the tutorial phase and later worked along the scenarios to contrast their argumentations. The problem-based learning in study was videotaped. The number of arguments constructed, the rebuttals generated, and the quality of arguments were then scored. The data showed that the scene with more skills content resulted in higher level argumentations. Similarly, the scene with skills closer to clinical practices facilitated more rebuttals. These findings suggested that problem-based learning with catalysts of disjunction, like new skills, could help students to develop better argumentation ability and translated knowledge into practice.

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

College Faculty Development

1:15pm – 2:45pm, Room 309

Presider: Grant E. Gardner, East Carolina University

Faculty Development via Sharing and Documenting Course Activities for Flexible Adoption/Adaptation across Multiple Institutions

Dedra N. Demaree, Oregon State University, demareed@physics.oregonstate.edu

Sissi L. Li, Oregon State University

Nam-Hwa Kang, Oregon State University

Dennis Gilbert, Lane Community College

Gregory Mulder, Linn-Benton Community College

Corinne Manogue, Oregon State University

ABSTRACT: This paper outlines a model for sustainable multi-institutional, multi-faculty curriculum reform that bases itself in sharing and documenting activities in a way that builds a Community of Practice, shares Pedagogical Content Knowledge, and creates a natural environment for faculty professional development. Participants include faculty, instructors, adjuncts, and graduate students at an R1 university and at two nearby community colleges. An observer takes data in individual classrooms and has regular discussions with the course instructor, activities and observations are documented on a shared wiki page. Faculty adapt far more than adopt, so in the summer, all participants meet and discuss specific activities, goals, and assessments for the purpose of documenting activities in a way that will allow for flexible implementation while maintaining the broader 'hidden-curricular' goals, active engagement, classroom discourse, and coherence between institutions. This model has thus far been used in the 2010-2011 academic year and evaluation has shown that it is meeting the project goals. Our motivation, process, assessments, and preliminary findings are reported. This project is supported by a grant from the National Science Foundation.

Developing the Grass-Roots Choir: STEM Faculty Agency In Undergraduate Reform

Jana Bouwma-Gearhart, Assistant Professor, STEM Education, University of Kentucky, jlbo226@uky.edu

ABSTRACT: The literature on faculty work overwhelmingly focuses on the challenges of those working within institutions of higher education at the expense of documenting their triumphs. Research concerning faculty at universities with greatest research output is especially negative and lacks practical recommendations towards improving education within modern universities. This research documents the accomplishments towards improving postsecondary STEM education in light of realities at modern universities, with explicit focus on realities most pertinent to STEM faculty and instructors. This proposed presentation and associated paper reports on data collected and analyzed across five research-focused universities into factors that foster successful postsecondary STEM reform endeavors in terms of increasing undergraduate student success, including factors regarding engagement of STEM faculty and instructors. In addition, informed by analysis at the level of reform endeavor and institution, this paper reports on the intersection of factors and the key individuals seemingly needed to inspire and secure successful postsecondary STEM education reform. The research provides insight to a wide array of

Monday, March 26, 2012

stakeholders attempting to improve undergraduate STEM teaching and learning in light of the realities of postsecondary structures and practices and, specifically, the realities of STEM faculty and instructors who hold such great power with respect to undergraduate success.

Constructing College Chemistry Instructors' Worldviews

Mary Chang, mkhchang@hawaii.edu

ABSTRACT: Traditional introductory level college science courses often provide broad information-based material of a field leaving more focused and conceptual learning to upper and graduate level courses. For students who do not continue to study science, their connection to science is influenced, if not shaped, by introductory level science courses, which often do not reflect what it is that scientists do. This case-study/narrative finds that college chemistry instructors' personal experiences learning chemistry shape not only their worldviews of learning chemistry, but also their expectations of students. By contextualizing chemistry instructors' experiences learning chemistry, teachers will be able to more clearly articulate the reference points and framework of a college science education. In conjunction, explicit articulation of expectations of students and the sharing of instructors' own personal experiences and sophisticated strategies for learning chemistry, can empower students to take responsibility of their science learning both inside and beyond the classroom.

Preparation of University Graduate Teaching Assistants: Challenges, Expectations and Participation in Professional Development Activities

Gili Marbach-Ad, University of Maryland, gilim@umd.edu

Kathryn L. Schaefer, University of Maryland

Katerina V. Thompson, University of Maryland

ABSTRACT: This study measured graduate teaching assistants' (GTAs) participation in and satisfaction with a disciplinary Teaching and Learning Center (TLC) in the chemical and life sciences. The TLC has developed a variety of programming (i.e. prep course for teaching, workshops, individual and group assistance, university teaching certificate program) to enhance the training and professional development of GTAs in STEM education. We created a survey to assess the preparation of GTAs for their university teaching responsibilities. The survey was administered twice: 52 GTAs completed the survey in 2007 and 97 completed it in 2011. Around 60% of GTAs reported that they benefited in some way from the TLC's assistance. In 2007, 70% of the GTAs reported that they benefited from the prep course and in 2011, all GTAs reported that they benefited. In addition, these opportunities have precipitated a growth in GTA participation and presentations in teaching and learning conferences. We plan to continue to assess and refine our programs according to the feedback provided by GTAs and through future GTA surveys. This effort incorporates nationally recommended approaches for teaching and learning and we hope it will serve as a national model for GTA training practices.

Strand 6: Science Learning in Informal Contexts

Tools and Technologies Facilitating Informal Learning

1:15pm – 2:45pm, Room 305

President: Leonie J. Rennie, Curtin University of Technology

Evaluation of an Out-of-School Time (OST) Genetics Program using a Multidimensional Conceptual Change Perspective

Marty D. Coon, Van Andel Education Institute, marty.coon@vai.org

ABSTRACT: We report on the findings from one semester of a three-year Biodiversity and Human Health Program which focuses on Genetic Diversity and Human Health developed in a non-traditional out-of-school-time program. The research sample comprised 21 students in 7th and 6th grade who participated two days per week from 4pm to 6pm over a 15-week period. This research was guided by two interwoven questions: 1. What are the social/contextual factors present in the learning environment? and 2. How do these factors promote conceptual change? The data were analyzed using a re-imaged multidimensional conceptual change perspective model which

Monday, March 26, 2012

places more emphasis on the social and affective aspects of learning. The analysis showed that there were six dominant social/contextual structures that factor into how students learn in the OST classroom. Comparing pretest and posttest data, students content knowledge and scientific inquiry indicated statistically significant differences. Individual analysis showed that the statistically significant increases in student content knowledge and scientific inquiry described are directly linked to the social/contextual learning environment in which the students participated. This study of a unique and innovative out-of-school-time program addresses the conference theme by re-imaging conceptual change research to present a balanced view of both individual and sociocultural perspectives.

Merging Playfulness with the Formal Science Curriculum in an Outdoor Learning Environment

Nir Orion, Weizmann Institute of Science, nir.orion@weizmann.ac.il

Molly L. Yunker, Weizmann Institute of Science

ABSTRACT: The outdoor environment is not often considered as a legitimate venue for formal learning, yet this unique setting can be integrated more widely due to valuable cognitive and affective aspects. However, the particular ways in which curriculum materials can be designed and developed to provide simultaneously engaging, playful, and educational experiences in the context of learning science have not been fully explored. The study described in this paper involved two stages: 1) the design, development, and enactment of an elementary school curriculum that includes an educational field trip to a prehistoric cave; and 2) data collection and content analysis using a story-writing instrument. Salient findings from students' stories provide a window into the cognitive contribution of a field visit to students' science learning and long-term memory, as well as the role of the field trip in helping students overcome unrealistic and imaginary fears.

The Range of Science Instructional Materials used in a Statewide Afterschool Program

Ruchi T. Bhanot, SRI International, ruchi.bhanot@sri.com

Christopher J. Harris, SRI International

Ann House, SRI International

Carlin Llorente, SRI International

ABSTRACT: Increasing attention has been paid to afterschool programs for their potential to deliver science experiences that are rich and engaging for children. We report on our study that examined the science offerings of a publicly funded statewide afterschool program. The program provides afterschool services at schools and in other community settings. We designed and sent a survey to more than 600 afterschool sites serving elementary-aged children. Of the 416 sites that responded to the survey, 285 reported that they offered science. The majority of afterschool sites offering science activities reported that they used science enrichment materials, such as science activity books and activity descriptions found on the Internet, as their primary source for science. Sixteen percent reported using school-based science materials, such as inquiry-based science units and textbooks. Twenty-two percent reported using science instructional materials expressly designed for afterschool settings. Follow-up observations at a small number of sites as well as interviews with staff at these sites provide a developing portrait of use of science materials in afterschool programs.

Bridging Inquiry across Settings Using Mobile and Curricular Supports

Clara Suzanne Cahill, University of Michigan, claracah@umich.edu

Shannon E. Schmoll, University of Michigan

Ibrahim Delen, University of Michigan

Wan-Tzu Lo, University of Michigan

Alex Kuhn, University of Michigan

Brenna McNally, University of Michigan

Chris Quintana, University of Michigan

Joseph S. Krajcik, University of Michigan

ABSTRACT: Informal settings can be ideal contexts for engaging students in authentic scientific inquiry when supported in making connections between school and informal environments. We developed a set of curricular

Monday, March 26, 2012

and mobile supports to help students engage in nomadic inquiry - project-based inquiry conducted across contexts. Students are introduced to a driving challenge before the visit, and plan an investigation to address the driving challenge in the classroom. The investigation is uploaded to mobile devices, which support learners in actively collecting data to further their investigation in the form of annotated photos, audio notes, and video during their field trip. Students use an online tool to access, organize, analyze, and construct explanations using the data their class collected. In this study, we collected video, audio, and daily student artifacts from 3 diverse middle-school students who used this program to build understandings about energy and electricity by bridging the classroom and a science center. We analyzed student interest, inquiry practices, and conceptual understanding throughout the investigation. Our preliminary case study shows that the driving challenge supports connections across settings, and that the mobile supports encourage content-oriented reflection, and identifies both benefits and challenges of these outcomes.

Strand 7: Pre-service Science Teacher Education

Elementary Science Teacher Preparation II

1:15pm – 2:45pm, Room 306

President: Josephine Shireen Desouza, Ball State University

Preservice Elementary Teachers use of Discourse Moves to Support the Social Construction of Science Concepts

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

Carla Zembal-Saul, Penn State University

ABSTRACT: A central feature of science education is the adoption of the language of science and utilizing public reasoning to make sense of science concepts; without such language events and social processes understanding the practices of science is impossible. Thus preservice teachers must learn how to use the social language and practices of science in order to effectively mediate their students' adoption of scientific language for the purpose of participating in inquiry and the social construction of scientific concepts. This study describes the nature of the science discourse in classrooms where preservice teachers were engaged in their initial science teaching experiences and uses Discourse analysis to understand the language and discourse moves that facilitate the social constitution of science understanding by elementary school students. Such repertoires include revoicing student ideas, small and large group discussion formats, asking for peer assessment of student talk and probing to understand why a student thinks the way he/she does rather than accepting an answer at face value. These techniques are historically difficult for veteran teachers to implement yet this study describes the early adoption of such discourse moves by preservice teachers engaged in their initial science teaching experience.

Re-thinking Early Field Experiences For the Purpose of Preparing Elementary Preservice Teachers Pedagogical Content Knowledge

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Meredith A. Park Rogers, Indiana University

Heidi L. Wiebke, Indiana University, Bloomington

Valarie L. Akerson, Indiana University

ABSTRACT: Often elementary teachers are not specialized in teaching a particular content area and therefore can experience many challenges when teaching densely fact-driven subjects such as science (Appleton, 2006). To help Pre-Service Teachers' (PST) develop this specialized knowledge called Pedagogical Content Knowledge (PCK) we designed a field experience called Iterative Model Building (IMB). This IMB approach gave an opportunity to PSTs to conduct Formative Assessment Interviews with elementary children and then reflect upon students' thinking to inform instruction prior to teaching and to make modifications to implemented lesson plans. This three-fold iterative process of reflection developed PSTs knowledge about student thinking and thus shaped their overall PCK. Through a case study approach we collected data from 24 PSTs over the semester. Data collection included PSTs reflections from FAIs, Lesson Observations, Post Teaching lessons, Blogs and e-portfolios. We present two cases of 6 teachers each demonstrating PSTs understanding about student thinking and how they modified their

Monday, March 26, 2012

lessons based on this understanding. Our findings show that PSTs experiencing the IMB approach may be developing only a surface level of understanding of children’s scientific thinking, but a much deeper understanding of the need to always probe student’s thinking in order to make instructional decisions.

Response-shift Bias of Internal and External Standards in Elementary Science Pre-service Teachers

Tina Cartwright, Marshall University, tina.cartwright@marshall.edu

Jon Atwood, Marshall University

ABSTRACT: Examining pre-service teachers’ response-shift bias can be utilized to measure potential change in baseline perceptions that the teachers may have over the course of programs or methods courses. But do certain types of constructs exhibit more response-shift bias than other constructs? This study will examine the response-shift bias of science teaching efficacy, attitudes toward science, and relevancy of science which have been partitioned into scales that include both internal and external standards. Three surveys were administered to the 36 elementary methods students at the beginning and end of the semester. At the end of the semester, participants were asked to examine their feelings at two time frames – at the beginning of the semester (then) and at the end of the semester (now). Twelve of the 15 scales showed significant response shifts from the pretest to the retrospective pretest, suggesting response-shift bias. These scales shared the characteristic of measuring beliefs the participants had about themselves relating to science. The three scales that did not show any evidence of response shift bias all measured participants’ beliefs in a non-internal concept which includes the science teaching outcome expectancy and two scales that evaluated the value and relevancy of science.

Structured Communities, Science Instruction Development, and the Use Of Digital Media in A Pre-Service Elementary Teacher Education Program

Steven D. Wall, University of North Carolina at Chapel Hill, dodd220@aol.com

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

Julie E. Justice, University of North Carolina at Chapel Hill

Jennifer Jones-Gorham, University of North Carolina at Chapel Hill

Kat Nichols, University of North Carolina at Chapel Hill

Ashley Boyd, University of North Carolina at Chapel Hill

Jonathan Bartels, University of North Carolina at Chapel Hill

ABSTRACT: The use of digital media coupled with the presence of anxiety regarding the teaching of a subject discipline such as science makes the use of structured communities uniquely challenging. The requisite need for beneficial interactions requires confidence and trust that allows for meaningful critique amongst members of the community. The challenge is two-fold: First, members need awareness of practices that lead to growth and development. Second, members need to have a level of competence with science specific subject matter, practices associated with the subject matter, and meaningful instruction. With recognition of the association between trust and subject-based competence, research was conducted with the following question in mind: How does blogging within a structured community of pre-service teachers mediate science instruction development between cohort members in a science methods course?

Strand 8: In-service Science Teacher Education

Models for Promoting Teacher Learning

1:15pm – 2:45pm, Room 105

Presider: Tamara H. Nelson, Washington State University Vancouver

Teacher-learning Processes During Professional Development: Conceptual Change and Metacognitive Analyses

Hedi B. Lauffer, University of Wisconsin-Madison, hfbaxter@wisc.edu

Peter W. Hewson, University of Wisconsin-Madison

ABSTRACT: Professional development that intends to influence teaching practices involves complex interactions among teachers’ conceptions and actions. Understanding the processes involved when teachers change their

Monday, March 26, 2012

conceptions of teaching and pedagogy and how it affects their practices can help those who facilitate teacher learning, policymakers, researchers and teachers to promote effective teacher learning. This design-based study employed three theoretical constructs and multimodal analyses to explain the multifaceted nature of elementary teachers' experiences learning an inquiry-based approach to science teaching. The study presents an emerging theoretical framework for conceptual teacher learning that is synthesized from the complementary relationships found among teachers' commitments to the status of ideas, different types of metacognitive awareness, and contextual concerns. This research also specifically points to the importance of teachers' meta-level awareness of the relationship between teaching and students' learning (identified in this study as consequential metacognition) and calls for its inclusion in further studies.

Perspectives on Teaching and Learning to Teach from Students and Teachers in a Teacher-Developed Situated PD Model

Rachel Ruggirello, Washington University in St. Louis, ruggirello@wustl.edu
 Phyllis Balcerzak, Washington University
 Vicki May, Washington University in St. Louis
 Jill Mcnew, Washington University

ABSTRACT: Professional development accounts for much of the efforts intended to improve science teaching and learning for in-service teachers. However, teacher professional development programs are often too short-lived to foster change in teacher classroom practice. Situated within a Math-Science Partnership Institute, this research focuses on a novel continuation of the Institute initiated by teacher leaders after the third year of the program. We present this model for teacher-led professional development in an informal science program as an effective source of learning and present findings about teacher and student perspectives on indicators of quality science teaching. We use situated learning (Lave & Wenger, 1990) as a framework for looking at the participation of both teachers and students in this professional development model, focusing on collaboration through communities of practice. We follow their development over the course of the summer program, as students engage with the culture and learn about both science and science teaching through authentic science case studies and supervised teaching experiences. Our research focuses on the acquisition of knowledge and pedagogical skills by teachers and students and on the ways in which both construct quality science teaching. Finally, we link the professional development to revisions in instructional planning and implementation of case studies.

Change in Teachers' Instructional Practices Over Time: The Effects of Master's Program on Science Instruction

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 Barbara Hug, University of Illinois at Urbana-Champaign

ABSTRACT: This study examines the impact of a new 2.5 year master's degree program on the instructional practices of K-8 teachers. The master's degree program, designed in collaboration with a partnering school district following an intensive needs assessment, included courses that integrated science and mathematics content knowledge with current pedagogy taught with an inquiry-oriented approach designed specifically for K-8 teachers. Teachers' instructional practices were captured annually through classroom observations, students' reports, and teachers' self-reports. Based on the results of the first two years' implementation of the program, there was a significantly positive change in the extent to which teachers implemented inquiry-based instruction in the classroom. Our results shed light on which instructional practices were more apt or resistant to change. Changes in the quality of the lesson structure and tasks as well as teachers' attention to design and pace of lessons appeared to be sustained over time while changes in the quality of scientific discourse and student engagement were hard to retain. A comparison of different data sources indicated teachers perceived their progress toward inquiry-oriented instruction as far more steady than indicated by outside observers or student reports. Implications for current policies, professional development, and further research are discussed.

Is it Possible to Explicitly Stimulate Pedagogical Discontentment in Science Teachers through a Graduate Course?

Margaret R. Blanchard, North Carolina State University, meg_blanchard@ncsu.edu
 Jason W. Osborne, Old Dominion University

Monday, March 26, 2012

Jennifer L. Albert, North Carolina State University

ABSTRACT: Recent studies suggest that teachers' pedagogical discontentment can be a motivator for changing teaching practices to more reform-based, following teacher professional development. We wondered if teachers who were pedagogically content could be stimulated to be less contented with their practices, given explicit input. This paper reports our quantitative findings of an exploratory, semester-long study of 28 graduate students in a synchronous, online master's level science methods course. We examined the range of teachers' pedagogical discontentment at the start of the course, whether it changed through the semester, and explored what factors are related to change. Participants began the course with a broad range of discontentment, ranging from 1.10 to 3.20 (on a scale of 1.0 to 5.0, average = 1.99, SD= 0.59). A full 44% increased discontentment with their practices, and changes were directly linked to the number of hours spent engaged in the course. Interestingly, 39% of the teachers started more pedagogically discontent, and became less so. We speculate that teachers who became more pedagogically content were further along a developmental curve in examining their practices, and that they were finding their learning from the course to give them pedagogical solutions to issues in their practices.

Strand 8: In-service Science Teacher Education

Teacher Conceptions of Life Science

1:15pm – 2:45pm, Room 106

Presenter: Jan H. Van Driel, Leiden University

In-service Biology Teachers' Perceptions and Adaptation of Evolution Issue into the Curriculum

Yilmaz Kara, Karadeniz Technical University, yilmazkaankara@yahoo.com

ABSTRACT: The work presented here represents a preliminary effort undertaken to address the role of teachers in supporting students' learning about evolution issue by characterizing in-service biology teachers' critique and adaptation of Turkish biology curriculum and identifying factors that serve to mediate this process. The Participants were 32 in-service biology teachers (66% female) enrolled in a month-long in-service teacher education program. The semi constructed interviews were conducted among teachers to explore their views and adaptation skills regarding the issue of evolution at the end of the in-service program. Results indicated that participants perceived a need to address evolution in biology classrooms. Participants had low personal science teaching efficacy beliefs related to teaching about evolution. They perceived the lack of instructional time and the unavailability of relevant materials as the primary obstacles that hindered the teaching of evolution. **Keywords:** Biology education; Evolution; Teacher perceptions; Teaching proficiencies.

The Impact of a Science Teacher Professional Development Program on Evolution Knowledge, Misconceptions, and Acceptance

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Minsu Ha, The Ohio State University

Ross H. Nehm, The Ohio State University

ABSTRACT: Our study investigated the impact of an intensive, two-week professional development program on 28 in-service science teachers' knowledge and acceptance of evolution. The intervention employed key curricular and pedagogical approaches suggested in the literature, including (1) explicit teaching about the nature of science; (2) discussions of the relationships between science and religion; and (3) inquiry-based instruction in evolutionary concepts. We used a pre-post, quantitative methodology to investigate the impact of the intervention on the in-service teachers. We employed a series of published instruments (e.g., Conceptual Inventory of Natural Selection, Measure of the Acceptance of the Theory of Evolution) to measure teachers' evolution content knowledge, misconceptions, and evolutionary acceptance levels. Our results indicated that the intervention was associated with statistically significant increases in teachers' evolutionary knowledge, significant decreases in misconceptions, and a significant increase in teachers' acceptance of evolution. Our work shows that knowledge and acceptance of evolution are strongly associated, and that short-term professional development interventions can influence in-

Monday, March 26, 2012

service teachers' evolutionary knowledge and beliefs. Our delayed post-test will be investigating if these knowledge changes have impacted teachers' classroom actions.

Characteristics of Teachers and Professional Development that Predict Growth in Life Science Content Knowledge

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 Stephanie B. Philipp, University of Louisville
 Sherri L. Brown, University of Louisville

ABSTRACT: Science content knowledge of teachers is an important predictor of student achievement. Many inservice teachers continue to acquire content knowledge through a wide variety of professional development (PD). The literature base on the relationship between individual teacher characteristics and PD characteristics for teacher learning from PD is growing, but additional evidence unpacking unique PD impacts is needed. This study used the [project name blinded] life science measure of pre-PD and post-PD knowledge with a total of 325 teachers distributed across 20 independent PD sites. Taking advantage of the nested nature of the data, an HLM analysis computed the unique contributions of teacher-level and PD-level variables. Results showed that, in addition to pre-PD scores predicting post-PD (as expected), teachers with a high school certification had higher growth, and PD groups composed of more-experienced teachers had higher growth. Interpretations of these results suggest that teachers with a depth of knowledge in at least one domain (rather than broad general knowledge), and teachers with more experience were able to best enhance their science content knowledge growth through PD. Discussion explores potentially fruitful foci effective for increasing teachers' knowledge of life science content.

Strand 10: Curriculum, Evaluation, and Assessment

Construct, Item, and Instrument Validation Studies

1:15pm – 2:45pm, Room 308

President: Cari F. Herrmann Abell, AAAS/Project 2061

Investigating Development on a Force and Motion Learning Progression

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 Gavin W. Fulmer, National Science Foundation
 Ling L. Liang, La Salle University

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

ABSTRACT: Alonzo and Steedle (2009) recently proposed a five-level learning progression (LP) for the concept of force and motion. Employing the Force Concept Inventory (FCI; Hestenes, Wells, & Swackhammer, 1992), we used data from a high school and a physics major freshmen sample to explore their abilities with respect to the force and motion LP. For data analysis, options of each FCI item were assigned a particular LP level. Rating scale Rasch modeling was used for data analyses. The results indicate that (1) the proposed LP is valid for even an inhomogeneous sample as investigated; (2) level thresholds increase as proposed by the LP; (3) on average, physics freshmen achieve higher LP levels than high school students do; and (4) on average, students progress to higher LP levels when achieving physics education over an academic year.

Item Context: How Organisms Used to Frame Natural Selection Items Influence Student Response Choices

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 Erin M. Furtak, University Of Colorado
 Deborah L. Morrison, University of Colorado

ABSTRACT: Natural selection, the mechanism for evolution, is an important unifying concept in the field of biology and is a core concept in the national standards for science education. However, it is also a complex and multifaceted concept that students have many difficulties understanding. This study explored matched pairs of items in an assessment of student understanding of natural selection designed to surface common naïve ideas. In particular, we focused on how the organisms used to frame these items might influence the way students respond

Monday, March 26, 2012

to those items Results indicate that there is a difference in high school students' responses to matched pairs of items featuring different organisms, although the difference diminished after students participated in a unit of instruction on natural selection. The study shows that the organism used in biology items should be considered when creating natural selection diagnostic tools.

The AUI: A Valid Instrument to Measure High School Students' Knowledge of Flu Transmission and Management

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Lloyd H. Barrow, University of Missouri

William R. Folk, University of Missouri

ABSTRACT: We present and describe the development of a valid multiple choice instrument called, "The Assessment of Understanding of Influenza (AUI)," to assess knowledge of influenza in high school students. Items were developed from a review of the literature on flu misconceptions. These were reviewed by a panel of five medical practitioners and researchers to establish content validity, and a panel of five experts on secondary education to establish face validity. A pilot was then tested on 205 students. Through full information factor analysis and Rasch modeling, item characteristics were extracted, including difficulty, goodness of fit with the Rasch model, and common variance with other items. A new, validated version of the assessment was tested on 410 students from five high schools. Through confirmatory factor analysis, the assessment structure was tested against the hypothesized structure derived from the first testing. The final version of the AUI (alpha = 0.819) uses 13 items to measure knowledge of flu transmission (alpha = 0.709) and management (alpha = 0.755). The AUI is meant for use by medical, public health, and education professionals who wish to quickly collect accurate numerical measures of influenza knowledge in high school students.

Utilizing Ordered Multiple Choice Items to Assess Students' Understanding of the Matter Concept

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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 describe students' growth in understanding core concepts of science. Empirical validation of a learning progression usually requires an extensive number of items. Briggs et al. (2006) introduced a new type of item, so called Ordered Multiple Choice (OMC) items, which may facilitate diagnostic assessment of learning progressions. This study aims to investigate to which extent OMC items may be utilized to assess students' level of understanding of the matter concept. We started focusing on students' conceptions of the structure and composition of matter. Ten OMC items and corresponding open-ended versions of these items were administered to a sample of N = 294 students of grade 6 to grade 12. Rasch analysis was used to investigate instrument functioning and to determine linear measures of person abilities and item difficulties. Analysis revealed that item difficulty increased with complexity and person ability increased with students' grade. Overall the answers chosen in the OMC items reflected the level assigned to students' open-ended answers.

Strand 11: Cultural, Social, and Gender Issues

Investigating Women' Identities and Career Trajectories in Science

1:15pm – 2:45pm, Room 107

President: Femi Otulaja, University of Witwatersrand

How Did They Do It? Career and Family Together Among Successful Women Science Educators in Both Formal and Informal Settings

Phyllis Katz, University of Maryland, pkatz15@gmail.com

ABSTRACT: The combined demands of both family and career are cited as one reason that women do not seek career paths in science or science education. There is a demand for this work for the common good. These are also fulfilling careers in which women's perspectives enrich these professions. Simultaneously, biology tells us that

Monday, March 26, 2012

most women want to have children. This study explores the ways in which eight women who have been successful in science education have managed both career and family goals. Success is defined as achieving a doctorate and field recognition through publications, elected or appointed positions, and awards. Prior research among women in science education has focused only on academic careers. This study includes women working in informal science education as well. Life-history interviews provided evidence that suggests that in these women's multiple pathways there were common qualities of determination, flexibility and resilience that led to persistence. These women noted these characteristics in their marriages as well. Future research should investigate how these qualities can be better facilitated in relation to science education and it should explore men's perceptions and expectations of family when their significant others want to contribute to science education.

Exploring the Longitudinal Professional Development of Teachers to Teach for Diversity through Sociotransformative Constructivism (sTc)

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ABSTRACT: This 3-year project investigated the challenges novice teachers encountered as they implemented a sociotransformative constructivist approach to teaching and learning in diverse secondary school settings. The project also documented the novice teachers' successes by using hybrid methodologies. Quantitative data on students' knowledge growth were gathered using semi-structured pre and post unit concept maps. Qualitative data were gathered by following an ethnographic approach (multiple interviews, weekly classroom visits, and field notes). Significant and positive results were found and recommendations are provided to strengthen the connection between teacher preparation programs and everyday school practice.

Female Physicist Doctoral Experiences and Career Choice Factors

Katherine P. Dabney, University Of Virginia, kd3c@virginia.edu

Vanessa Wyss, Ball State University

Robert H. Tai, University of Virginia

ABSTRACT: The underrepresentation of women in physics doctorate programs and in tenured academic positions indicates a need to evaluate what may influence their career choice and persistence. This presentation examines females in physics doctoral programs and professional science positions in order to provide a more insight into understanding why and how women make career choices and persist in doctoral programs based on aspects both inside and outside of school and their subsequent interaction. The analysis was examined through a critical realist (Miles & Huberman, 1994) and emergent coding approach regarding personal life and graduate school experiences. Results are examined through an extensive literature review and point toward further inquiry and evidence that may impact public policy and educational practices and promote ways to strengthen advanced education and career opportunities for women in physics.

African American Female Faculty Members: Factors Influencing their Recruitment, Retention and Promotion at Traditionally White Institutions

Natasha Johnson, The University of Georgia Athens, GA, yjohnson@uga.edu

Mary M. Atwater, The University of Georgia

Malcolm B. Butler, University of South Florida, St Petersburg

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

Tonjua B. Freeman, The University Of Georgia

ABSTRACT: The lack of African American female faculty coupled with the increasing numbers of African American female students in undergraduate programs, makes this a vitally important area of research across all majors, particularly for STEM majors hoping to attract and retain these individuals. This qualitative analysis seeks to find an understanding of what factors contribute to the recruitment, retention, and promotion of African American female faculty members in science education. It compared the trajectories and experiences of 4 African American female faculty members employed at 4 different traditionally White institutions. The African American female faculty members who shared their trajectory into the academy all expressed the development of successful mentoring relationships as being a key component to their success at the undergraduate and graduate levels, as

Monday, March 26, 2012

well as, in their current faculty positions. The African American female faculty members identified support networks as instrumental in their ability to navigate campus politics, the tenure and promotion process, and expectations for community service and committee work.

Strand 12: Educational Technology

Transforming Teaching with Technology

1:15pm – 2:45pm, Room 101

President: Janell Nicole Catlin, Teachers College, Columbia University

The Effect of Using Representations of Reified Objects in a Simulation on Students' Conceptual Understanding

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Zacharias C. Zacharia, University of Cyprus

Ton de Jong, University of Twente

ABSTRACT: This study aimed to identify when complementing representations of concrete objects with representations of reified objects improves students' conceptual understanding as they use a simulation to experiment in the domain of Light and Color. Moreover, we aimed to investigate whether students' prior knowledge is a factor that must be considered in deciding when to use representations of reified objects. A pre-post comparison study design was used, involving 69 participants assigned to two conditions. The first condition involved a simulation with representations of concrete objects, whereas the second condition involved a simulation with representations of both concrete and reified objects. Both conditions used the same curriculum material, consisting of three sections that included physical phenomena with increasingly complex underlying mechanisms. Conceptual tests were administered before, after and during the intervention. Results revealed that the presence of representations of reified objects was helpful for the first two sections, but only for students with low prior knowledge. On the third, most complex section, the students with higher prior knowledge also profited from the presence of reified objects. Overall, it appears that for physical phenomena with lower level of mechanism complexity, the presence of reified objects is not necessary for students with adequate prior knowledge.

Using Technology to Address Non-Traditional Learning Objectives in an Undergraduate General Chemistry Course

Ted M. Clark, The Ohio State University, clark.789@osu.edu

Robert P. Griffiths, The Ohio State University

ABSTRACT: E-learning resources were used in a technology-enhanced introductory undergraduate chemistry classroom. Student gains were apparent in terms of conceptual learning, increased understanding of NOS, and greater awareness of historical experiments. Student gains were not correlated with performance on the traditional algorithmic-based final exam. Findings suggest that e-learning resources, especially interactive simulations, can expand the teaching and learning objectives of general chemistry without affecting traditional measures of student performance in the class.

High School Students' Development of ICT Fluency/Workforce Skills by Designing a Virtual Science Center

Camille Ferguson, EDC's Center for Children and Technology, cferguson@edc.org

Preeti Gupta, New York Hall of Science

ABSTRACT: The skills needed to prepare students for the STEM workforce of the future are increasingly multidisciplinary, varied, and technology oriented. Clearly, our next generation of workers must be information, media, and ICT literate at levels that are not yet supported in traditional educational settings. In this paper we describe how high school students from diverse backgrounds in an urban city develop ICT and workforce skills by learning how to develop STEM interactives in a virtual world for the ultimate purpose of building a sustainable virtual science center. Our overall research question is: how does building a virtual science center mediate development of ICT and workforce skills in a high school student?

Monday, March 26, 2012

Strand 13: History, Philosophy, and Sociology of Science
Standards in the History, Philosophy & Sociology of Science

1:15pm – 2:45pm, Room 102

President: Catherine E. Milne, New York University

Teaching Physics as One of the Humanities the History of Harvard Project Physics, 1962-1970

David Meshoulam, University of Wisconsin-Madison, meshoulam@wisc.edu

ABSTRACT: Although many science education scholars consider the history of science (HOS) to be an invaluable component of the K-12 science curriculum, they disagree over its exact pedagogical role. HOS did not always play such a prominent role in per-collegiate education. In fact, until the publication of the high-school physics curriculum Harvard Project Physics (HPP) in 1970, HOS appeared only sporadically in early 20th-century science textbooks. By the latter-half of the 20th century, educators began to argue for a coherent inclusion of HOS into the science curriculum. Although many scientists objected to the way this history tended to portray science, the promoters held their ground. HPP was the culmination of these efforts. Science education today carries the legacy of these efforts. Unfortunately, the history of HPP has been the subject of only limited scholarly study. By overlooking HPP's influence on the development of the science curriculum, researchers have missed a central component of the history of reforms in American science education. This paper examines the genesis and development of HPP. It provides insight into how curricular reform efforts become negotiated across multiple social, political, and cultural sites, providing scholars with a fuller understanding of science education in America today.

Comprehensiveness and Completeness of Nature of Science in State Standards: Update and Report Card

William F. McComas, University of Arkansas, mcomas@uark.edu

Carole K. Lee, University of Maine Farmington

Sophia J. Sweeney, Northeastern State University

ABSTRACT: Investigators searched for 12 Key Aspects of the Nature of Science in the current science content standards of the 50 states and DC (N=51). This study is based on one conducted in 2009 using the then-current standards and updated here to include 17 new science content documents. Some NOS elements (empiricism, tentativeness in science, cooperation and collaboration in science, the distinction between observations and inferences, and the role of experiments) are consistently included in various state standards. The distinction between law and theory is less likely to be included in state science standards. The empirical requirement in science, the role of cooperation, the distinction between observation and inference, and the distinction between science and technology are likely to be found across grade levels. Creativity, the distinction between theory and law, subjectivity and limits of science are introduced only at the higher grade levels and rarely appear across grades. State standards were ranked for NOS quality using a "report card" format. The top ten states were OH, FL, NH, CO, MO, MI, PA, KY, NY and MA. States with new content standards that have dramatically increased (CO, PA, RI and TX) or decreased (NV, NJ) in their NOS content are discussed.

Is the Integration of Engineering Design Into K-12 Science Curriculum Prudent?

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Norman G. Lederman, Illinois Institute of Technology

ABSTRACT: Currently, a very salient topic is seen in the science education community – the integration of engineering into science education. There're many national and state initiatives, reform documents, STEM education programs and research papers supporting this idea, but there're problems. Most initiatives and reform documents mainly see the importance of a closer relationship between engineering and science education through the economic/political perspectives of ensuring the country's technological/economic growth, and few adopt epistemological/pedagogical perspectives. In those that do include such perspectives, it's mainly argued that the advantage of integrating engineering is engineering design can be used to promote science learning. However, frequently this is just a deduction from the commonsense belief that engineering is applied science; further, it's unclear from these documents that this idea is supported by well-designed empirical studies. Having found these

Monday, March 26, 2012

problems, this paper asks whether the current trend of integrating engineering into science is prudent, and does the following to answer this question: defining and comparing the natures of scientific knowledge and of engineering knowledge, defining and comparing the natures of scientific inquiry and engineering design, critically reviewing empirical studies advocating the trend. Based on this work, some conclusions and implications are developed.

Strand 15: Policy

Curriculum Development

1:15pm – 2:45pm, Room 104

Presider: Michelle P. Cook, Clemson University

Science Teachers' Views of Factors that Affect Urban Physics Accessibility and Participation

Angela M. Kelly, Stony Brook University, angela.kelly@stonybrook.edu

ABSTRACT: A basic question that underlies the push for increased rigor in science and mathematics education is whether the requisite gateway courses in the physical sciences are even options for all students, particularly underrepresented minorities. The availability of physics for high school students is not equitably distributed throughout the U.S., despite the fact that these courses are often considered prerequisites for success in post-secondary STEM study. This study explored urban science teachers' perceptions of the factors influencing physics availability, and their ideas for how accessibility might be improved for urban students. The following research questions were examined: 1) What factors influence the decision of high school administrators as to whether or not physics courses will be offered? 2) How have specific state- and district-level mandates influenced the availability of physics and how it is taught? 3) How might participation in and the quality of physics education be improved in urban schools and/or districts? Qualitative methods were employed with data from focus groups and interviews with teachers in three urban school districts. Teachers expressed the need for greater administrative commitment, cohesive curricular reform efforts, and improved student preparedness. Their suggestions for recruitment and higher standards are discussed.

Consequences of School Improvement: Examination of the Association between School Improvement and Student Science Achievement

Adam V. Maltese, Indiana University, amaltese@indiana.edu

Craig D. Hochbein, University of Louisville

ABSTRACT: For more than half a century concerns about the ability of American students to compete in a global workplace focused policymakers' attention on improving school performance generally, and student achievement in science, technology, engineering and math (STEM) specifically. Using a rich longitudinal dataset, including school and student level achievement, we explore the intersection of school reform and STEM policies by examining the science achievement of students from improving schools. Findings from three consecutive cohorts of high school students who graduated in 2008, 2009 and 2010 indicate that students attending improving schools identified by state administered standardized tests in either reading or math performed no better on a college entrance science test than peers from declining schools.

Challenges in Transition to a Large-Scale Reform in Chemical Education

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Orit Herscovitz, Israel Institute of Technology, Haifa, Israel

Yehudit Judy Dori, Department of Education in Technology and Science

ABSTRACT: Large-scale science education reforms that are accompanied by research are quite rare. We describe a five-year-long implementation study of a large-scale chemistry curriculum reform, which encompassed, about half of the chemistry majors in the country. The research goals were: (a) examining the challenges in transition to a large-scale reform; (b) investigating the effect of the reformed curriculum on students' knowledge and choice of questions in the national matriculation examination. Research tools included teachers' interviews and students'

Monday, March 26, 2012

numbers and scores in the national matriculation examinations. Challenges in up-scaling the reform were classified into teacher-related and system-related. The gradual exposure of the reformed curriculum by the pioneer teachers helped reduce resistance from veteran teachers. During 2007-2010, the number of students studying the reformed curriculum increased while their failure rate decreased. The percentage and average scores of students electing to respond to the Taste of Chemistry question (a new topic taught only in the reformed curriculum) increased. This can be attributed to the students' ability to self-evaluate their knowledge in order to choose questions that they can answer best. Finally, the reform was successful due to the close collaboration between three stakeholders, academic institutions, the Ministry of Education, and the teachers.

Self-Efficacy, Organizational Culture and Change: Engaging Science and Mathematics Faculty in a New Policy-Based Initiative

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Chad Ellett, CDE Research Associates, Inc.

Lisa M. Martin-Hansen, Georgia State University

Judy Awong-Taylor, Georgia Gwinnett College

Nancy Vandergrift, University of Georgia

ABSTRACT: This paper presents the results of a study of linkages between science and mathematics faculty engagement in change processes, self-efficacy beliefs and organizational (department) culture in response to a new policy-based initiative. Three new measures were developed and used to better understand these linkages within the context of a new higher education advocacy policy designed to value and reward faculty work in K-12 schools through the tenure and promotion process. A web-based survey procedure was used to collect data from 113 science and mathematics faculty from 8 universities. Results of reliability analyses for this sample for these new measures were strong and supportive of their use in future research. The results of regressing the measure of change on the measures of self-efficacy and department culture showed that 57% of the variation in faculty engagement in change was explained by four dimensions of self-efficacy related to work with K-12 schools and enhancing the scholarship of teaching and learning. The measure of department (organizational) culture, contrary to prior research results and change literature, did not correlate with the change process measure. Implications of the findings for future research, policy and practice are discussed.

Re-imagining Nature of Science: Implications for Policy and Research

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ABSTRACT: The recently released document, A Framework for K-12 Science Education, provides a vision and a conceptual foundation for the development of new science content standards in the USA. This vision has major policy implications especially with regards to decisions regarding what concepts in and about science are of most worth. These decisions have direct impact on the subsequent development of standards, curricula and assessments. Among the striking differences between the new conceptual framework for science education and those of two decades ago, such as Science for All Americans, is a marked shift from an emphasis on nature of science and technology to an emphasis on scientific and engineering practices. This study reviews a variety of stable and evolving nature of science notions and evaluates the extent to which emergent conceptions could be represented in or subsumed by the notion of scientific practices. The analysis reveals that there is few important emergent nature of science notions that are not explicitly addressed in the new framework. The paper concludes with few implications for policy and research.

Monday, March 26, 2012

Poster Session A

3:15pm – 4:15pm, Griffin Exhibit Hall

Strand 1: Science Learning, Understanding and Conceptual Change

Poster Session A

3:15pm – 4:15pm, Griffin Exhibit Hall

A1. *The Effect of Studying Socio-scientific Issues on Pre-service Teachers' Understanding of the Nature of Science*

Kristin L. Cook, Indiana University, kshockey@indiana.edu

Gayle A. Buck, Indiana University

ABSTRACT: Our study explored the question: In what ways is pre-service teachers' understanding of the nature of science (NOS) linked to perceptions of their experience within a socio-scientific inquiry (SSI)? Insights from this study are 1) the importance of open inquiry and 2) NOS as foundational for including students in the process of SSI investigations. First, PSTs were scaffolded through a more guided approach to inquiry before their development of their open second inquiry project in which they designed, implemented, and analyzed their own investigation; the experience of actually conducting an open inquiry was important in developing students' conceptions of NOS. Many SSI contexts center around research for the development of an argument (Khishfe & Lederman, 2006; Bell & Lederman, 2003; Albe, 2008), rather than engaging students in the process of open inquiry. Second, we came to value NOS as a foundation for including students in the process of science and underscoring their voice in the generation of knowledge in environmental science issues. NOS laid a foundation that led PSTs to understand science as a process not a destination and helped to empower them to understand that everyone, even non-scientists, can make a contribution to science.

A3. *What Can the Matter Be? Introducing Problematizing, a Strategy to Engender Inquiry in Chemistry Learning*

Catherine E. Milne, New York University, cem4@nyu.edu

Jan Plass, New York University

Bruce Homer, Graduate Center, City University of New York

Trace Jordan, New York University

Ruth Schwartz, New York University

Dixie Ching, New York University

Mubina Kahn, New York University

Yolanta Kornack, Graduate Center, City University of New York

Anna G. Brady, New York University

ABSTRACT: Previous studies report that narratives work best to scaffold model-based learning environments when they present familiar everyday phenomenon as an entry point for the content-to-be-learned providing common ground for discussion and engagement. We highlight another essential characteristic of effective narratives: they must generate a motive or a need to know that supports further exploration of explanatory models. In this study we report the use of problematizing, or casting doubt on students' perceptions they already know why a specific, otherwise familiar, phenomenon occur, as a structure for generating motive. Findings from a study conducted in chemistry classrooms in a public school in New York City indicate that the introduction of problematization into a narrative can lead to better learning outcomes and increased interactions with our diffusion simulation, compared with a non-problematizing version. Implications and next steps are discussed.

A5. *Exposing Differences between Korean and American College Students' Evolution Concepts and Attitudes*

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Minsu Ha, The Ohio State University

Heeyoung Cha, Korea National University of Education

ABSTRACT: For the past three decades many studies have investigated both the cultural differences of learning evolution and majors' and non-majors' evolution concepts. The culture (e.g. religions) and knowledge level (e.g. major) are important variables to understand learning evolution; however, previous studies have not tested the

Monday, March 26, 2012

combined effect of both culture and major variables. This study aimed to provide an in-depth understanding of the relationships among culture, major, evolution concept, religiosity, as well as the interest in and acceptance of evolution. Methodologically, we used a large-scale survey method in four Korean universities and one American university. The participants were 141 Korean biology majors, 142 Korean non-majors, 129 American biology majors, and 508 American non-biology majors to whom we administered an evolution concept instrument, religiosity instrument, interest of evolution instrument, and acceptance of evolution instrument. Statistically, we used ANOVA, Two-way ANOVA, and Pearson correlation to obtain Results which showed that the combined effect of major and culture on religious explanation and acceptance of evolution. Regardless of the culture, majors showed higher correlations between knowledge and acceptance of evolution. This study provides in-depth information to understand the effects of both culture and major on learning evolution.

A7. Cognitive Processes Used by High and Low Prior Knowledge Students When Interpreting Graphics

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ABSTRACT: The purpose of this study is to explore: (1) what cognitive processes learners use when viewing and interpreting representations of cell transport and (2) if the cognitive processes used differ for high and low prior knowledge learners. Four cell transport representations, typical of those found in high school biology textbooks, were selected for eye tracking and verbal protocol responses. This research examined the verbal protocol responses of 44 students (21 low prior knowledge and 23 high prior knowledge) to ascertain cognitive processes used. The findings indicate that students, in general, use low-level cognitive processes (reading, paraphrasing, and comprehending) when interpreting graphics. In addition, students with low prior knowledge were less likely to use high-level cognitive processes (making inferences, connecting information, and drawing conclusions) than high prior knowledge students.

A9. Situational Interest and Cognitive Conflict as Factors Influencing Conceptual Change

Lawrence C. Scharmann, Florida State University (USA), lscharmann@fsu.edu

Hunsik Kang, Chuncheon National University of Education (Korea)

Sukjin Kang, Jeonju National University of Education (Korea)

Taehee Noh, Seoul National University (Korea)

ABSTRACT: Relationships among situational interest and cognitive conflict (both induced by a discrepant event), attention and effort allocated to learning, and conceptual change in learning the concept of density were investigated. Seventh graders (N=183) from six middle schools in Seoul, Korea served as subjects. Pretests administered included a: preconception test, test of responses to a discrepant event, and questionnaire measuring situational interest. Students identified as possessing the target misconception received computer-assisted instruction as a conceptual change intervention. A conception test and questionnaires regarding attention and effort were administered as posttests. The conception test was also administered one additional time beyond the posttest as a retention test four weeks later. The results of a path analysis indicated that both situational interest and cognitive conflict (induced respectively by a discrepant event) had indirect effects on students' conceptual understanding (mediated by attention and effort allocated to concept learning). Situational interest, however, was found to exert a much stronger influence on conceptual change than cognitive conflict. In addition, results were obtained indicating that attention (as a variable), either directly or indirectly through effort, influenced students' conceptual understanding.

A11. Analysis of Associations among the Factors Affecting on Secondary School Students' Conception about Evolution

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Minsu Ha, The Ohio State University

Seulae Ku, Korea National University of Education

Heeyoung Cha, Korea National University of Education

Jeong-rae Kim

Eun-young Hwang

Monday, March 26, 2012

ABSTRACT: The understanding of evolution is an important component in biological disciplines playing a crucial role in unifying biological concepts and providing an explanatory framework. This study aims to compare basic knowledge, interest and acceptance of evolution, religiosity and epistemological belief about science according to school levels, and religions, in order to verify properties and correlation among the factors affecting on secondary school students' conception about evolution. 444 secondary school students participated in this research. Multiple choice questions were utilized for the basic knowledge of evolution, while Likert scale questions were employed for religiosity, the interest and the acceptance of evolution and epistemological belief about science. The results indicated that secondary school students were positive in the acceptance of evolution but negative in the interest of evolution. Each area of epistemological belief about science was significantly correlated, however religiosity was negatively correlated with the acceptance of evolution. Non-christians exhibited higher acceptance of evolution and lower religiosity than christians. There was a significant correlation between the interest of evolution and the role of experiment in science. For a better acceptance of evolution, the prejudice that evolution and religion are opposite must be removed and that evolution theory is just one of the biology concepts should be emphasized.

A13. *Impact of Evolution Instruction on Understanding and Acceptance of Evolutionary Theory and the Nature of Relationships among Understanding, Acceptance, and Religiosity*

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Peter G. Schrader, University of Nevada Las Vegas

Joshua Keilty, The Alexander Dawson School Las Vegas

ABSTRACT: Science education researchers have long been interested in exploring the convoluted relationship between understanding and acceptance of evolutionary theory. Some studies reported no relationship between understanding and acceptance, while others reported a positive relationship. Findings of this study indicated that there is no statistically significant relationship between understanding and acceptance of evolutionary theory both before and after instruction on evolution. As a result of instruction on evolution, students' both understanding and acceptance of evolutionary significantly increased. Students' understanding of evolutionary theory was not found to be related to religiosity, but students' acceptance of evolutionary theory negatively correlated with religiosity both at the beginning and at the end of instruction on evolution.

Strand 2: Science Learning: Contexts, Characteristics and Interactions

Poster Session A

3:15pm – 4:15pm, Griffin Exhibit Hall

A15. *Analysis of Inquiry Studies by Using Interactive-Constructive-Active Framework*

Muhsin Menekse, Arizona State University, muhsin@asu.edu

Micheline Chi, Arizona State University

Omid Vasefi, Arizona State University

ABSTRACT: Inquiry is one of the most common and prominent concepts in science education. An enormous number of studies have been published on inquiry during past 50 years. A significant amount of these studies investigated the effectiveness of inquiry based science instruction on student learning. Most of the meta-analyses of inquiry studies provide some level of positive trend favoring inquiry based science instruction over traditional methods. However, some meta-analyses found very little (Lott, 1983) or no relation (Minner et al., 2010) between the inquiry level and the students learning of science concepts. In this study, Chi's (2009) interactive-constructive-active framework was applied to classify inquiry based science instructions/interventions and to measure their relative effectiveness on learning on a finer grain size. We used Chi's framework to clarify the discrepant findings in some inquiry studies. Chi's interactive-constructive-active framework provided a good model to comprehend and interpret the results in inquiry based science education literature. The classification of overt activities and /or interventions based on underlying cognitive principles offered a finer grain size to analyze and understand the contradictory findings in different studies as well.

Monday, March 26, 2012

A17. *Facilitating Student Creativity in Scientific Inquiry: An Exploration of Secondary Chemistry Classrooms*

Allison Antink Meyer, Illinois Institute of Technology, aantink@hawk.iit.edu

Norman G. Lederman, Illinois Institute of Technology

ABSTRACT: The study utilized teachers' instructional materials surrounding inquiry tasks (teacher generated) and student work to characterize scientific creativity in the high school chemistry classroom environment. Ten student groups from five different teachers' classrooms participated in a semester long study of how student creativity is manifested in teacher-generated inquiry activities. Transcripts were analyzed for instances of student talk that reflected the operationalization of scientific creativity: a manifestation of student knowledge in a science context through a process of divergent thinking culminating in convergence on an idea deemed "best". Codes and categories were then developed and interviews were conducted to ensure that findings were valid.

A19. *High School Youths' Reactions to and Perceptions of STEM Project-Based Learning*

Leah A. Bricker, University of Washington, lbricker@u.washington.edu

Katie Van Horne, University of Washington

ABSTRACT: In this interactive poster paper, we highlight high school youths' reactions to and perceptions of science, technology, engineering, and mathematics (STEM) project-based learning (PBL). We do so because the voices of youth are rarely represented in our literatures yet youth are critical educational stakeholders. The research questions that guided this analysis were: (a) What are high school youths' reactions to and perceptions of the STEM PBL experiences in which they are engaged?, and (b) Do high school youth perceive PBL to be a pedagogy that helps them learn and if so, why and how (or why not)? Data sources included audio and videotape of student focus groups and student survey responses. We segmented our findings into three categories: (a) youth perceptions of and reactions to PBL as a learning tool, (b) suggestions youth have for improving PBL experiences, and (c) projects that youth report participating in outside of school and hobbies/interests that they count as related to STEM. We discuss implications for the design of STEM project/problem-based learning environments, a youth voice research agenda, and research that examines science learning and teaching across the boundaries of formal and informal settings.

A21. *Authentic vs. Vicarious: An Analysis of Environmental Education in Different Learning Contexts*

Jeffrey Nordine, Trinity University, jnordine@trinity.edu

Courtney Lambert Crim, Trinity University

ABSTRACT: Many individuals do not perceive an attachment to or a responsibility to protect the environment (Louv, 2005). However, research has demonstrated that perceptions about the environment are learned, not innate (Rickinson, 2001). As educators grapple with diverse populations and exploding urban communities, they are challenged to connect urban students with nature through deliberately integrated educational experiences. Many children in urban areas do not receive their information about nature through direct experiences with nature and learn about the environment through a variety of built experiences. Given the challenge of providing authentic experiences in nature to a rapidly growing number of urban students, the present study explores a university/community collaborative model that offers 7th grade, urban students an opportunity to experience authentic outdoor experiences as they engage in hands-on investigative science - not possible in their urban school settings. This quasi-experimental study explores: (1) If this authentic outdoor model of instruction is an effective approach for urban based middle school students to gain understanding about the environment?, and (2) Is this model more effective than vicarious learning experiences that are typically managed in the traditional classroom context? Specifically, we evaluate students' attitudes, content knowledge, and mental model conceptualization of the environment.

A23. *The Interplay between Student and Material Agency in Ecological Investigations*

Michelle Cotterman, Vanderbilt University, michelle.e.cotterman@vanderbilt.edu

Richard Lehrer, Vanderbilt University

Leona Schauble, Vanderbilt University/Peabody College

Monday, March 26, 2012

ABSTRACT: Although both ecologists and students must struggle to obtain a material grasp on the ecosystems they study, students' practice differs from that of the discipline as much of what they wrestle with, though new to them, has already been harnessed by others. This disciplinary foresight into how ecosystems materially function raises a concern about students' agency in designing ecological investigations: could a research interest in a minor element impede students in developing knowledge of the system as whole? This comparative case study examined to what extent an early focus on critical system elements predicts what middle level students will learn across sustained investigations of aquatic microcosms. Findings indicated that the initial state of students' investigations did not seem to predetermine the complexity of their final system explanations, suggesting that how students begin their investigations might be less decisive than how they refine their practice and accommodate material resistance as these investigations evolve. Two features of students' practice seemed particularly meaningful for the types of system relationships students came to see as they wrestled with the materiality of their aquaria: fluidity in dealing with the emergent nature of research and social interaction within the classroom community.

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

3:15pm – 4:15pm, Griffin Exhibit Hall

A25. Teacher Strategies to Implement the Argument-Based Inquiry Approach

Aeran Choi, Kent State University, aeran-choi@hotmail.com

Vanessa Klein, Kent State University

Susan Hershberger, Miami University

ABSTRACT: This study investigated the challenges the argument-based inquiry approach brought to science classrooms; and instructional strategies that teachers used to aid students to be engaged in the approach. Eighteen grade 3 through 5 teachers from fourteen elementary schools in Northeast Ohio participated in intensive two-week professional development programs with respect to the argument-based inquiry approach, i.e., the SWH approach during summer prior to the semester they implemented the approach. Data analysis indicated that both teachers and students encountered a number of difficulties and challenges as follows: (1) difficulty of writing of students' thoughts and ideas. (2) lack of critical thinking skills. (3) difficulty of constructing a reasonable argument. (4) lack of decision-making ability. (5) struggle with ways to facilitate students to be engaged in authentic inquiry. (6) problem of the limited time. Data analyses revealed that the teachers used a number of pedagogical strategies that aid students be successful in argument-based inquiry approach as follows: (1) Start from one component and extend to the whole process. (2) Use a class discussion. (3) Inform students about scientific norms. (4) Practice organizing and clarifying students' thinking. (5) Revise the writing template based on their students' ability. (6) Connect science into other subjects.

A27. Classroom Perspectives: Observation of the Implementation of a Fourth Grade Immersion Science Inquiry Curriculum

Irene U. Osisoma, California State University Dominguez Hills, Carson California, iosisioma@csudh.edu

Shirley Lal, California State University Dominguez Hills, Carson California

ABSTRACT: Abstract The study sought to discern how well teachers implemented inquiry and to what depth they promoted students' self direction It was a sub-set of a larger randomized field trial professional development and classroom implementation of a fourth grade science inquiry immersion unit based on National Research Council's five EFIs and presents the results of observation data (obtained through mixed methods) from two years of classroom implementation of science inquiry professional development aimed to equip "immersion" teachers with knowledge and skills to implement the full cycle of science inquiry as depicted by the EFI variations and continuum through the use of appropriate scientific language, questioning and students' use of inquiry skills. Findings from the continuous flow narrative depiction of classroom occurrences of inquiry include: The immersion group implemented more inquiry than did the comparison group and there were more incidences of inquiry in Year 2 than in Year 1 for both groups. Incidences of inquiry were more with immersion teachers than comparison

Monday, March 26, 2012

teachers. Both immersion and comparison teachers used scientific language and questioning, with more evidence in the immersion group. There was more evidence of teacher directed inquiry for both groups and little evidence that either immersion or comparison teachers implemented full cycle inquiry.

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

Poster Session A

3:15pm – 4:15pm, Griffin Exhibit Hall

A29. Examining High School Students' Understandings of Molecular Genetics

Amber Todd, Wright State University, rosenberg.5@wright.edu

Lisa Kenyon, Wright State University

ABSTRACT: There has been a large push for increasing scientific literacy, especially in areas rapidly advancing such as molecular genetics. Much research has been done on student understandings of molecular genetics and the consensus is that the concepts are difficult to both learn and teach. Two molecular genetics learning progressions have been published but remain hypothetical. Our study aims to test the upper bounds of the progressions by using 10th graders and supplying their teachers with molecular genetics intervention units, differing from normal classroom instruction by introducing proteins before discussing DNA and targeting instruction to components of the learning progressions. We found that students entered 10th grade with low levels of knowledge about the molecular model of genetics, but were still able to reason in the inheritance and meiotic models. After instruction with the intervention units, the students increased, on average, one level in the Duncan et al. (2009) learning progression. Additionally, some students were able to give level 3 (the highest level in the progression) responses in multiple components of the progression. This study shows that the intervention units helped increase student understanding and provide some curricular support for the progressions, which make them more useful for teachers and researchers.

A31. Exploring CoRes as an Effective Framework for Developing PCK with In-service Science Teachers

Adam Bertram, Monash University, adam.bertram@monash.edu

ABSTRACT: In the science education literature, CoRes (Content Representations) have been reported to be an effective framework for articulating science teachers' pedagogical content knowledge (PCK). This paper reports on a study which explores this claim by exploring how practising science teachers might value CoRes after developing them and using them in their classrooms, and whether the teachers' felt that their professional knowledge and, in particular, their views about teaching and learning had been influenced. The study also explicitly explored how the teachers' PCK might be articulated, revealed or developed as a consequence. In the process of constructing and using CoRes in their classrooms, all six teachers claimed that it was a very effective and useful framework which assisted them to: be able to better articulate their views on teaching and learning; improve their professional knowledge of practice; and, portray instances of their own PCK in ways which meaningfully helped them to form a deeper understanding of the PCK construct, and therefore better understand themselves as teachers. In this way, the framework of CoRes could be suggested as being a valid instrument in developing the PCK of practising science teachers.

A33. Rethinking Expertise in Physics: An Investigation of Expertise in High School Physics Teachers

Kara Krinks, Vanderbilt University, kara.krinks@vanderbilt.edu

Pratim Sengupta, Vanderbilt University

ABSTRACT: Several studies have considered the nature of physics knowledge in novices and experts. However, most of these studies have largely been situated in canonical, textbook-like physics problems involving formal representations where expert thinking is very predictable. Few studies, if any, have considered the nature of expert thinking when reasoning through non-canonical, informal physics phenomena. This study aims to probe the nature of physics expertise in non-canonical situations by examining the reasoning of high school physics teachers

Monday, March 26, 2012

as they think through informal problem representations. We will also investigate teachers' views on the role of these informal representations in their classrooms.

A35. Using PISA 2006 Data to Explore the Relationship between Inquiry Teaching and Student Science Achievement

Feng Jiang, University of Arkansas, fjiang@uark.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. This may be done with PISA data. By analyzing data from 2006, we found that all the four analyzed teaching strategies (applications of scientific knowledge, hands-on activities, student investigations, and classroom interaction) had statistically significant correlation with student science achievement. However, only the use of student investigations had a practically significant correlation with student science achievement. Surprisingly, the correlation between the use of student investigations and student science achievement was negative, which most contradicts science educators' recommendation for its use. It was suggested that more studies must be conducted to explain this finding in the future.

A37. Instructional Strategies for Nano-science and Technology: A Case Study of Three Experienced Teachers

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Huey-Por Chang, National Changhua University of Education, Taiwan

Kuo-Hua Wang, National Changhua University of Education, Taiwan

ABSTRACT: The purpose of this study explored how teachers teach nano-science and technology in high school in terms of knowledge representations and instructional activities. The case study was adopted in this study. Three experienced teachers with biology, chemistry, and physics background respectively were asked to plan and to teach "Science and Scaling" concepts of nano-science and technology within current high school science curriculum in Taiwan. The classes were observed and video-taped. Interviewing with the teachers were recorded and transcribed. Constant comparison and triangulation methods were applied for the analysis of qualitative data. The findings suggested that the teachers with different science backgrounds used dissimilar knowledge representations to help students construct concepts of nano-science and technology based on the nature of domain-specific and the objectives of teaching. In addition, the teachers suggested hand-on and inquiry teaching strategies were important activities to teach nano-science and technology.

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

Poster Session A

3:15pm – 4:15pm, Griffin Exhibit Hall

A39. Anyone Can Draw a Scientist, but How Realistic is this Portrayal? A Study Examining Change in Preservice Students' Conceptions of Scientists Using Multimedia Films

Catherine Koehler, University of New Haven, ckoehler@newhaven.edu

Ian C. Binns, University of North Carolina-Charlotte

Mark Bloom, Texas Christian University

ABSTRACT: Peoples' perceptions of scientists have changed minimally over the past 50 years. It is suggested that peoples' perceptions of scientists may have an impact on their attention toward science (Kahle, 1988; Finson, 2002). When asked to draw-a-scientist (DAST), people resort to the classic white, male wearing a lab coat, having crazy hair and working in a lab (Chambers, 1983). Attempts to change students' perceptions of scientists have been successful and have shown marked improvements on the post-DAST scores (Borhmann & Ackerson, 2001; Finson, Beaver, & Cramond, 1995; Mason, et al., 1991;). In this study, we use an explicit/reflective approach to

Monday, March 26, 2012

demonstrate alternative conceptions of scientists as they are portrayed in the multimedia films, Contact, Twister and SuperSize Me. Preservice music education students were the participants in this study. Using a pre-post design, the students demonstrated statistically significant change in their conceptions of the scientists as measured by the DAST. This study provides more evidence that supports the use of mainstream films along with explicit/reflective instruction to improve students' understandings of the scientific endeavor and the scientist who participates in it.

A41. *Transforming Cambodian University Science from Lecture to Inquiry: Cultural Barriers and Student Responses*

Gail L. Dickinson, Texas State University, San Marcos, dickinson@txstate.edu

Heather C. Galloway, Texas State University, San Marcos

Maureen Lemke, Texas State University, San Marcos

David Ford, Royal University of Phnom Penh

ABSTRACT: After decades of political turmoil and a dismantling of the education system, Cambodia is still in the process of rebuilding. Despite reform efforts, Cambodian instruction remains largely teacher-centered and primarily lectures emphasizing rote learning of concepts unrelated to students' everyday lives. This mixed methods study examines how undergraduate Cambodian college students respond to a two-week, inquiry-based general science course in terms of their willingness to engage in inquiry and their understanding of science. Despite their limited exposure to inquiry, students quickly adapted to the environment. Students' confidence in designing experiments and their understanding that investigations undergird scientific knowledge increased significantly. Students also shifted away from the view that rote memorization is the way to learn science. Four dominant themes emerged from students comments about the course: (a) increased understanding of science concepts, (b) positive reaction to activities, (c) application to real life experiences, and (d) increased knowledge outside students' majors. In addition three minor themes emerged: (a) having to think, (b) increased interest, and (c) increased skills.

A43. *The Focus and Relationships Negotiated During Undergraduate Science Instructor Mentoring*

Cynthia C. Deaton, Clemson University, cdeaton@clemson.edu

Benjamin Deaton, Anderson University

ABSTRACT: This multiple case study examined the use of mentoring to support undergraduate instructors teaching of science in a large Supplemental Instruction (SI) program. The participants were four mentor-protégé pairs with each pair being a separate case study. To support mentoring, experienced undergraduate instructors were paired with new undergraduate instructors to help them quickly gain knowledge of providing collaborative learning opportunities to their fellow undergraduate students. The results indicated that mentors and protégés developed different forms of negotiated relationships that produced both personal and professional benefits for both parties. For mentors, they were afforded their first opportunities to work in a supervisory role and they felt intrinsically rewarded in helping their protégés better themselves as an undergraduate instructor. The protégés noted an increased knowledge of approaches for fostering student engagement, quickly incorporating new learning strategies into their teaching, improving classroom/session management, and becoming better designers of instruction. Finally, the use of mentoring impacted the SI program as a whole in that more students started attending the protégés SI sessions and the training and supporting new undergraduate instructors was enhanced.

A45. *Engaging STEM Students from the Beginning: An Interdisciplinary Approach to Introductory Biology and Chemistry Laboratories*

John R. Geiser, Western Michigan University, john.geiser@wmich.edu

Renee S. Schwartz, Western Michigan University

Leonard Ginsberg, Western Michigan University

Donald Schreiber, Western Michigan University

ABSTRACT: Project Engage is an interdisciplinary team of biology, chemistry and science education faculty that aims to increase progression of undergraduate STEM students towards advanced courses in biology and chemistry by improving instruction in introductory-level chemistry and biology laboratory courses. The project focuses on

Monday, March 26, 2012

designing and pilot testing laboratory investigations and developing instructional expertise (teaching assistants and faculty) that (1) engage students with common, real-world materials and situations relevant to key biological and chemical concepts; (2) demonstrate the interdependence of biology and chemistry disciplines; and (3) promote active learning in an investigative environment. We employ a quasi-experimental approach to test the effects of revised laboratory lessons for both courses that utilize food or food-related exercises as a context for learning core concepts of chemistry and biology. The inquiry-oriented lessons include explicit connections between core concepts and real world applications (i.e. food industry) to improve student awareness of the interdependence of biology and chemistry; thus demonstrating relevance and connections between two introductory level science courses. The project includes professional development for faculty and teaching assistants. Results indicate a positive effect on student conceptual knowledge and attitudes toward STEM majors.

A47. Undergraduate Biology Students' Conceptions of Fungi

Andrea Bierema, Western Michigan University, andrea.m.kryger@wmich.edu

Renee S. Schwartz, Western Michigan University

ABSTRACT: Classification is essential in the understanding of biology, especially ecology and evolution (Cotterill & Foissner, 2010), and students are expected to increase their understanding of organismal classification during their secondary education (AAAS, 2009). Studies have illustrated that students hold several alternative conceptions regarding classification of animals (e.g., Bell, 1981) and plants (e.g., Barman et al., 2006). However, few studies have involved students' conceptions of fungi, even fewer after it was accepted in the scientific community that fungi are more closely related to animals (e.g., Barman et al, 2006). This study was part of a larger project that assessed via survey and then interview upper-level undergraduate biology students' conceptions of organismal diversity. Most participants understood that fungi are not animals, but some participants had the alternative conception that fungi are photosynthetic, and some even classified them as plants. Some participants were able to face this alternative conception and understand that fungi are heterotrophic and more closely related to animals when asked about the preferred environment of fungi.

A49. Learning about Error with a Virtual Laboratory: Evidence from a Biomedical Engineering Course

Eva Erdosne Toth, West Virginia University, eva.toth@mail.wvu.edu

Cerasela-Zoica Dinu, West Virginia University, Department of Chemical Engineering

ABSTRACT: This poster-paper reports new data associated with a series of studies on using virtual laboratories (VRLs) to supplement hands-on laboratories (HOLs) in the college classroom. The current study examined whether working with a VRL can provide a conceptual bridge for students' towards evaluating erroneous data outcome yielded by HOLs. A mixed method data collection approach was used with a pre-post instruction design, to document students' conceptual and procedural knowledge, their evaluations of erroneous data and their reasoning for their data evaluations. The results indicated that students in a biomedical engineering course constructed new conceptual and procedural knowledge with the VRL and were able to use this understanding to formulate data focused evaluations of erroneous outcome. The majority of students' reasons for data evaluation were also content specific and reflected students' conceptual knowledge development. However, intuition and logic focused evaluations and unspecific reasoning continued to exist, suggesting the need to further enhance students' experiences with a variety of VRLs so as to better prepare them for real-world investigations.

A51. Assessment of Argumentation Skills through Individual Written Instruments and Lab Reports in Introductory Biology

Melissa Schen, Wright State University, melissa.schen@wright.edu

ABSTRACT: Little assessment is done in college science majors' regular classroom practice of argumentation skills – explaining data using scientific principles and in lab reports. This descriptive study used Toulmin's argumentation pattern to assess the quality of scientific arguments created by college biology majors enrolled in an Introduction to Biology course. Two versions of a paper and pencil instrument and the discussion section of lab reports were used to identify the quality of argumentation. Similar patterns were seen across the assessments. Students demonstrated an ability to generate simple arguments including a claim backed by evidence. The connection of

Monday, March 26, 2012

that evidence with the claim through biological principles was not as evident, even when directly requested. In addition, unless specifically asked, students generally did not consider alternative claims or explanations. As this study was done at the beginning of the academic year, this implies that biology majors come to the curriculum with very little, if any, understanding on how to best support a scientific claim and may need a more explicit approach to developing arguments early in their major.

A53. Exploring the EEG Dynamic during Physics Problem Solving

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Wen-Chi Chou, Institute of Education, National Chiao Tung University

Tzyy-Ping Jung, Institute of Neurocomputation, University of San Diego, USA

ABSTRACT: This study explores electroencephalographic (EEG) correlates when solving an ill-structured optics problem. Volunteer college students were instructed to construct three solutions to an optical maze under a Web-based learning environment, which required some knowledge of physics and optics. The subjects were instructed to put forth their best effort to minimize the number of convexes and mirrors needed to guide the image of an object from the starting point to the end point. The goal of this study is to examine whether varying demands on the cognitive process of providing solutions would be accompanied by EEG changes in different frequency bands. Results of this investigation showed that the number of convexes and mirrors used by students in general decreased from solutions 1 to 3. Grouping EEG power spectra by task performance demonstrated that the mean EEG power increased as the number of lenses and mirrors in the solutions decreased. Topographically, the theta (θ) activity predominately exerted greater activity at the prefrontal area (F7, F8, Fp1, Fp2), the lower (α 1) and upper (α 2) alpha activity exerted a slightly greater activity at F8, O2, and T4 channels.

A55. College Students' Mental Models and Predictions: An Example of Heat Convection

Guo-Li Chiou, National Chiao Tung University, Taiwan, gc2158@columbia.edu

ABSTRACT: This study investigated thirty college students' mental models of a dynamic natural phenomenon, heat convection, and how they used mental models to generate predictions for related questions. Semi-structured, interview-about-event questions were used to elicit the participants' mental models of the process of heat convection in multiple formats, such as graphic illustrations, oral utterances, and written responses. Then, the constant comparative method was adopted for data analysis, and seven patterns of mental models of heat convection were constructed accordingly. Although the obtained seven mental models of heat convection shared some superficial features, the participants provided sharply different explanations for the mechanisms underlying these mental models, and performed different simulations of the dynamic processes of heat convection. In addition, the results indicated that the participants who possessed a scientifically accepted mental model were more likely to generate a correct prediction for a convection-related phenomenon with sufficient explanation. These findings highlight the merit of investigating the ongoing processes of students' mental models through which predictions and explanations are generated, and affirm the importance of helping students construct a scientifically accepted mental model.

A57. Interviews and Content Representation for Teaching Condensed Matter Bonding: An Affective Component of PCK?

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

Norma A. Ortega-Villar, Universidad Nacional Autonoma de Mexico

ABSTRACT: Pedagogical Content Knowledge (PCK) of four General Chemistry College teachers on the topic of condensed phase substances' bonding models has been documented by Loughran et al. Content Representation (CoRe) and an interview in which some questions related to the affective domain of teaching were included. The central ideas related to the CoRe were discussed with the four teachers arriving to the following consensual ideas: a) Physical properties; b) Bonding parameters (dissociation energy and distance); c) Polarity and intermolecular interaction in covalent bonding; d) Networks (metallic, ionic and covalent). In the General Chemistry course the teacher faces a problem when entering bonding in solid or liquid substances, because there are several bonding models applicable: 1) Covalent molecular bonding. 2) Ionic bonding. 3) Metallic bonding. 4) Multidirectional

Monday, March 26, 2012

covalent bonding. The «network» concept may play a useful proposition to describe the last three bonding models and the teacher can display it pretending students' conceptual comprehension of the topic. It is interesting to say that all of the teachers mentioned ways of achieving motivation and interest related to the specific topic, that is, a new element of PCK of the affective type. Key Words: PCK, solid state bonding models, affective

Strand 6: Science Learning in Informal Contexts

Poster Session A

3:15pm – 4:15pm, Griffin Exhibit Hall

A59. Dealing with Troubles by Pedagogical Repairs in Science Internship

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.

A61. After School Science Club: Learning Science Inside the Box Outside-of-School-Time

Kim Sadler, Middle Tennessee State University, ksadler@mtsu.edu

Leigh Gostowski, Middle Tennessee State University

Linda Gilbert, Murfreesboro City Schools

Emily Newton, Middle Tennessee State University

David Green, Middle Tennessee State University

ABSTRACT: The goal of this project was to improve student content knowledge, attitudes, and engagement in science and mathematics in ways that extend to subsequent education and out-of-school-time (OST) experiences. Multiple partners collaborated in providing meaningful OST experiences for middle school students through twice a week after school club attendance and in the summer with a thematic Science and Mathematics Camp. Schools were selected for this project on the basis of increasing populations of at-risk students and low comprehensive assessment scores in science and mathematics. Quarterly professional development workshops for participating OST teachers, target in-school teachers, and STEM undergraduate facilitators focused on STEM content and pedagogy. Family Science Nights were held bimonthly on site to engage families with their children in science activities. The project utilized a pre/post survey design to evaluate student interest in STEM. To identify gains in achievement, student end-of-course grades in math and science and state comprehensive assessment scores were obtained for analysis. Preliminary analysis of the data from more than 600 participating students suggests questions relating to general interest in STEM show increases after participation in Club Neutron but pursuit of STEM coursework in high school and state science and mathematics assessment scores are inconclusive.

A63. The Relevance of the Science Curriculum: Scientific Concepts in Online Public Discussion Concerning Animal Experimentation

Ayelet Baram-Tsabari, Technion - Israel Institute of Technology, ayelet@technion.ac.il

Esther Laslo, Technion - Israel Institute of Technology

ABSTRACT: One of the goals of education for science literacy is to provide the public with appropriate skills which enable engagement with real-world socio-scientific issues. Therefore, public discourse in authentic online media environments can be used as an indicator of the relevance and applicability of science education. This study analyzed a year worth of online media coverage of animal experimentation (28 articles) and its subsequent reader comments (n = 2,448). It examined the relation between the level of scientific concepts appearing in the article

Monday, March 26, 2012

and in its subsequent reader comments. Distribution of the level of all the scientific concepts used in the course of one year, showed high correlation between the science concepts used in the articles and in reader comments ($r = 0.96$). Only 16% of the comments included scientific content which referred the issue of animal experimentation, but 65% of the scientific concepts used, were in high school or academic level. As science study is elective in high school in Israel, it is likely to assume that only a small part of the public acquired the necessary knowledge needed to engage in debate over this socio scientific issue at school.

A65. What Do Zoological Institution's Websites Communicate to the Public about Education Programs?

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

ABSTRACT: This study is an evaluation of the educational opportunities described on 130 AZA (Association of Zoos and Aquariums) accredited zoos' websites. The zoo websites have been evaluated on the presence/absence of the following educational components: professional development, zoo activities aligned with state/national academic standards, classroom kits aligned with standards, pre/post-visit activities, outreach programs, distance learning programs, staff guided field trip tours, summer/holiday day camps, overnight programs, programs for home-schooled children, teen volunteer programs, an accessible library, private wildlife tours (off-site), internships for high school students, internships for college students, programs for both Boy and Girl Scouts, and the presence of an internet blog. The data shows that AZA accredited zoos on average participate in only 8.8 of the 17 components (range=1-16, median=9, STD=3.04). The most common educational component is the presence of summer/holiday camps (89.23% of institutions participating) and the least common is internships for high school students (6.92%). This study reveals that zoos offer a wide range of programs and there is a great difference in the programs offered. Because the website is a crucial place for teachers, parents, and home-schoolers to learn about educational programs, the website should be a reflection of the zoo's educational programs.

A67. Exploring a Summer Camp Based on Robotics Activities Prepared for Underrepresented Groups: A Pilot Study

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Mehmet Ayar, Texas A&M University

Sencer Corlu, Texas A&M University

Mary M. Capraro, Texas A&M University

Alpaslan Sahin, Texas A&M University

ABSTRACT: In our pilot study, we aimed at exploring a summer camp program allowing students to engage with Robotics systems. Our study participants were thirty-seven 11th grade students (19 male and 18 female) from an inner city charter school. We sought answers to two questions: (a) How does a summer camp program based upon robotics system help students gain 21st century skills? and (b) to what extent can a summer camp program be a vehicle for increasing students' interest towards pursuing a career in STEM related fields? We employed several data collection methods including interviewing, taking field notes, videotaping, and student journal writings. Preliminary findings from our analyses indicated that Robotic activities scaffolded students to have the ability to analyze authentic situations from different perspectives and to generate solutions to problem. Although these activities were well-defined, teacher-oriented tasks, students were more inclined to be interested in Robotics systems. These activities provide them with doors to open up their career choices. We conclude that Robotics activities can be educational tools for students to gain skills essential for their lifelong learning as well as to increase interests toward STEM related fields.

A69. Taiwanese Children's Conceptions and Relations to Nature: Using the Contextual Model of Learning as the Theoretical Framework

Amy H. Dai, University of Maryland, amydai@umd.edu

ABSTRACT: The present study seeks to investigate urban children's conceptions and relations to nature in Taiwan and understand the factors that influenced them. Twelve children ages 5 and 6 were prompted to draw a picture of themselves in nature and interviewed about sources of conceptions about nature, school and out-of-school experiences, and living environment. Eleven photographs of scenery with different degrees of naturalness were shown to them to examine their definition of nature. Furthermore, their parents were asked about related issues

Monday, March 26, 2012

in a survey for investigating the family influence. This study was designed to cover aspects of the personal, sociocultural, and physical contexts that change over time in the Contextual Model of Learning. It is found that children often thought plants are nature, and that humans are usually not thought as part of nature. Nature grows and moves, and it sometimes contains different degrees of natural and artificial elements. Their understanding of nature is learned mainly from family members and their firsthand exposure to those green spaces around the city. It is also found that, most Taiwanese parents in this study are aspired to nature. However, they usually missed those teachable opportunities to make these experiences meaningful. Finally, implications are discussed.

Strand 7: Pre-service Science Teacher Education
Poster Session A

3:15pm – 4:15pm, Griffin Exhibit Hall

A71. Developing Preservice Teachers' Science Teaching in an Elementary Science Methods Course: An Activity-Theoretical Perspective

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

ABSTRACT: Preservice elementary teachers have limited opportunities to observe or practice inquiry-oriented science teaching lessons in their elementary field placements. As a result of these constraints, a team of teacher educators redesigned an elementary science methods course to provide opportunities for preservice teachers to practice teaching science lessons on campus. This paper details those efforts to design a peer-teaching activity that enabled peer teachers to take on the role of a “teacher” and teach investigation-based lessons to their peers who acted as “students”. I use Cultural-historical activity theory to develop a theoretical framework to identify and analyze the tensions that emerged when the peer-teaching activity was introduced into the course. The tensions emerged in the peer-teaching activity, in part, from the re-conceptualization of the methods course as a context where preservice teachers both practiced teaching and received feedback on their teaching. I conclude by raising important questions for teacher educators to consider as we incorporate opportunities for preservice teachers to practice inquiry-oriented science teaching lessons in the context of methods courses.

A73. Subject Matter Equivalencies: Are All Majors Equal?

Beth W. Kubitsky, Eastern Michigan University, mkubitske1@emich.edu

ABSTRACT: A call in teacher preparation is to create programs that expedite the certification process for change in career professionals so that they can get into the classrooms sooner. Colleges of education are being asked to create programs to facilitate this process. One push has been to recruit scientists and engineers to become secondary teachers, with the assumption that they have sufficient, if not superior, subject matter knowledge. However subject matter for teaching is not necessarily the same as that required for science majors and is even less likely to align with the engineering programs. This paper presents an analysis of the engineering programs in 13 public universities in Michigan and compares the required courses with the science competencies identified by the National Science Teacher Association and the Michigan State Content Expectations for physics, physical science and chemistry. The intent of this analysis is to inform the design of the alternative certification programs in planning of supplementing subject matter as well as pedagogy.

A75. Constructing Views of Theory-Practice Relationships in a Content-Specific Methods Course for Prospective Teachers

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Danusa Munford, College of Education - Universidade Federal de Minas Gerais, Brazil

Luciana Moro, Biosciences Institute - Universidade Federal de Minas Gerais, Brazil

Márcia F. Serra, College of Education - Universidade Federal do Rio de Janeiro, Brazil

ABSTRACT: This paper presents initial results of a research that aims to analyze the construction of relationships between theory and practice from the perspective a teacher educator in a Biology Teacher Education program. We investigate social practices based on the analysis of activities in the context of a Pathology Teaching discipline. We

Monday, March 26, 2012

employ a naturalistic design using qualitative research methods. Drawing on an “ethnography in education perspective” we perceive the classroom as a culture, locally constructed by its participants. We identified 4 types of activities in the course. Our results indicate that different types of knowledge were mobilized in the course depending on the type of activity performed. Despite the prevalence of biological knowledge, educational knowledge and knowledge about school played an important role in some activities.

A77. Promoting Science Learning through Reading: Practices in the Classroom of a Prospective Science Teacher

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Danusa Munford, Universidade Federal de Minas Gerais, Brazil

Diego O. Silva, Universidade Federal de Minas Gerais, Brazil

Ana Paula S Souto, Universidade Federal de Minas Gerais, Brazil

ABSTRACT: The present study aimed to investigate reading practices promoted by a prospective science teacher in a Middle School classroom for adult learners. A naturalistic design utilizing qualitative research methods was employed in the present study. During four months, we conducted participant observation with narrative recording in field notes, and video recording. Other data sources were: interviews and informal conversations with the teacher, artifacts produced in the course, and group meetings. The analyses were informed by interactional ethnography and grounded-theory. Results indicated that reading practices for this PST in this classroom involved construction of intertextual relationships in various forms. For him, reading was more than decoding messages expressed in words printed on paper. On the contrary, reading was a complex activity that demands sense making, involving dialogue with multiple texts (written and oral, from different sources and different authorship). This work has implication for teacher education and for the developing of reading practices in science classrooms.

A79. Partners in Denial? A Link Found between Ecological Worldview and Attitudes toward Teaching Evolution

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

ABSTRACT: The purpose of this study was to determine if attitudes towards teaching evolution in public schools correlated with environmental attitudes, and if so, what links might emerge from related qualitative data. Both topics are currently prone to denial in the general public but are critically important in science education: understanding evolution is essential to science literacy, while understanding and adapting to climate change may be the next generation's most important challenge. Over seven terms, preservice science methods teachers (n=265) were given two anonymous surveys, the TEPEs on teaching evolution and the NEP for ecological worldview. Total scores on each were moderately correlated ($r(263)=.376, p<.01$): higher scores on the TEPEs correlated to higher scores on the NEP. The qualitative data, which consisted of open-ended prompts on each survey, was coded for nature of science, ecological facets and world-view. Participant statements provided insight into why the two seemingly unrelated surveys might be correlated, and some of the implications for both evolution and climate change education. The paper/presentation will include details on how other researchers can use each of the surveys to examine their own students.

A81. Are We Failing to Prepare 21st Century Teachers for Diversity Lost?: Climate's Influence on Evolution

Norman Thomson, University of Georgia, nthomson@uga.edu

Deborah Tippins, University of Georgia

Rene Bobe, University of Georgia

Anna Scott, Athens Academy Upper School

Leonard Bloch, University of Georgia

Bahadir Namdar, University of Georgia

Sarah Hakala, University of Georgia

ABSTRACT: Two topics at the science-public interface in which there seems to be knowledge and acceptance gaps are evolution and climate change. We investigated pre-service biology and geology teachers' understandings of these two phenomena as they designed and implemented lessons for high school instruction as a part of a methods/practicum course. Amongst our findings, we found that the pre-service teachers, in their science content preparation courses, are not experiencing interdisciplinary learning that would allow them to effectively include

Monday, March 26, 2012

these related topics in their instruction, In the process of designing and teaching their lessons, the pre-service teachers struggled to create activities and experiences that reflect the most recent scientific understandings of the evolutionary consequences of climate change The pre-service teachers were able to infuse some aspects of argumentation (weighing evidence, evaluating scientific claims) into their lessons but with mixed difficulty, The pre-service teachers entered the 10th grade classroom expecting to encounter some resistance to instructional lessons focused on evolution and climate change. Much to their surprise, they did not encounter the type of resistance that they expected as portrayed in the media. We see new challenges for science educators emerging in the preparation of science teachers for the 21st Century.

A83. *The Influence of Theory and Research on Science Teacher Preparation Program Design*

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

ABSTRACT: Despite our growing understanding of factors that shape the development of teacher knowledge and skills, there has rarely been a successful marriage between this research-based understanding (theory) and practice. In this paper I examine how research informed by two theoretical lenses can converge to strengthen our understanding of the complex nature of science teaching and of teacher development. This understanding can in turn inform the design of programs to provide opportunities that support new teachers and effectively serve the needs of high-poverty schools. The first area explored arises from critical knowledge and skills for teaching and focuses on the development of high-leverage teaching practices. The second arises from sociocultural views of learning and focuses on professional learning communities. We have taken these two bodies of work as foundations to support the design of a new post-baccalaureate certification-induction program with two intentions—the provision of multiple, scaffolded opportunities to acquire the knowledge and skills necessary for effective teaching; and situation of these opportunities in environments which provide maximum learning support. The opportunity to develop such practices while being supported by peers and more experienced others can create a ‘third space’ to support teaching and learning.

Strand 8: In-service Science Teacher Education

Poster Session A

3:15pm – 4:15pm, Griffin Exhibit Hall

A85. *Training Teacher Leaders in Science and Math: The Science and Math Fellows Program*

Andre M. Green, The University of South Alabama, green@usouthal.edu

Andrea M. Kent, The University of South Alabama

Phillip Feldman, The University of South Alabama

James Van Haneghan, The University of South Alabama

Shelly Rider, The University of South Alabama

ABSTRACT: The Science and Math-Fellows program seeks to create a professional development in-service program that prepares and supports science and math Teacher Leaders at the elementary level. The project seeks to study the effect of a professional development teacher leadership training program on the pedagogical and content knowledge improvement of elementary teachers. This program is intended to improve the teaching of science and mathematics by elementary teachers to improve student learning as assessed by student achievement on standardized measures. The result of this effort will be a model that will inform the professional development of elementary school teachers. This project also seeks to investigate and evaluate the extent to which a collaborative relationship between a State Department of Education, a local school system, and a local university education faculty will translate into improved pedagogical methods used by each of these stakeholders in the training of science and math Teacher Leaders in the pursuit of improved student achievement in science and math at the elementary school classroom level.

A87. *Re-Imagining Research Now: A Community Partnership Engaged in Improving Science Education*

Alan B. Sowards, Stephen F. Austin State University, asowards@sfasu.edu

Monday, March 26, 2012

Cheryl T. Boyette, Informal Science Educators Association Boyette Consulting
 Alison Pierce, Humble ISD
 Lisa K. Doughty, Waste Management

ABSTRACT: Re-Imagining Research Now: A Community Partnership Engaged in Improving Science Education In order for school districts to develop high Self-Efficacy and Pedagogical Content Knowledge (PCK) in their teachers, professional development programs must provide opportunities for teachers that will increase science content knowledge and provide experiences to learn and implement best practices in teaching science. Teacher self-efficacy, a teacher's belief in their ability to teach science, determines the teacher's attitude and behavior towards teaching science. Enhanced context strategies, including the use of field trips (placed-based learning) field investigations, using the school garden and community for lessons, are the teaching strategies that have been shown by research to have the greatest positive influence on student's science achievement (Texas Science Initiative, 2004). This research study examines the use of community partnerships and field investigations to introduce place-based learning opportunities during teacher professional development training. Teachers participated in a field investigation to their local sanitary landfill and constructed habitat gardens on their school campus. Subjects in the study were 85 Pre-K through 5th grade teachers. The study employed a mix design including both qualitative and quantitative methodology. Participants were pre and post tested on science content knowledge and teacher attitudes (self-efficacy) for teaching science.

A89. *An Integrated Approach to In-service STEM Education in a Title One Elementary School*

Carolyn A. Parker, The John Hopkins University, carolyn.parker@jhu.edu
 Francine W. Johnson, The John Hopkins University

ABSTRACT: This proposed interactive poster presentation and accompanying paper describes the research on a collaborative effort between a institution of higher education (IHE) and a Title I elementary school. The research describes the change in STEM content and pedagogical content knowledge of eight in-service teachers participating in a comprehensive professional development program in an elementary STEM education program. A mixed methodology study was designed to examine any changes in the eight teachers' integrated STEM content knowledge and pedagogical content knowledge. Quantitative data analysis demonstrates that the teachers' knowledge of the tested integrated STEM content improved. Qualitative data analysis demonstrates that the teachers believe that the professional development would strengthen their implementation into their elementary classroom, but had suggestions on strategies to improve the program. Insights into the relationships between the four STEM disciplines has implications for the science education community in that it will help the science education community better understand the implications of the more transdisciplinary approach to STEM inservice teacher education.

A91. *Unexpected Allies: Advancing Scientific Literacy in an Interdisciplinary Context*

Billy McClune, Queen's University Belfast, w.mcclune@qub.ac.uk
 Ruth Jarman, Queen's University Belfast

ABSTRACT: The presentation of science in the media is one theme in scientific literacy that has attracted interest among science educators. However, science teachers are often as ill at ease with the underlying issues and pedagogies that are familiar to their English teaching colleagues as English teachers are with the content and contexts of the news reports themselves. As concerns regarding the relevance of discrete subject based teaching as a preparation global citizenship and employability rise, 'critical reading' of science based media reports is an authentic context in which to explore the benefits of interdisciplinary learning. This empirical study focused on 90 trainee and experienced teachers of science and English to explore their aptitude and capability for critical reading of science based news reports. Patterns of critical response were observed, in particular fundamental differences between science and English specialists were noted. The study revealed limitations in critical reading that were characteristic of the subject background of the participants. It suggested approaches to teacher education that could provide opportunities for pedagogical synergies that could be beneficial to those interested in promoting critical responses to science-related news media as a means to further aspects of scientific literacy.

Monday, March 26, 2012

A93. High School Chemistry Teachers' Assessment Literacy

Shannon M. Burcks, University of Missouri-Columbia, burckssm@missouri.edu

Marcelle A. Siegel, University of Missouri-Columbia

Kemal Izci, University of Missouri Columbia

Stephen B. Witzig, University of Missouri-Columbia

Steven W. Keller, University of Missouri-Columbia

ABSTRACT: The ability to assess student learning is essential for science teachers however, there is little research on teacher assessment literacy. Our goal is to understand how experienced teachers understand and use assessments to influence student learning. For this study, the overarching research question posed was how to characterize the teachers' knowledge and use of assessment based on the model of assessment literacy. Specifically: 1) How do the teachers understand the five components of assessment literacy? 2) In which areas do teachers request support to improve? We conducted an in depth examination of assessment literacy on three high school chemistry teachers with varying amounts of teaching experience. Multiple data sources included teacher created assessments, surveys, and open-ended questions. Our findings were organized around themes grounded in the assessment literacy framework and suggest that: 1) Teachers' values and principles affected the assessments they chose; 2) Teachers focused assessments on content knowledge and conceptual understanding ; 3) Student motivation and conceptual understanding were teacher's two main purposes for assessment; 4) Teachers utilized multiple assessment strategies; and 5) Teachers requested support to improve the development of assessments that focus on understanding and scoring of those assessments.

A95. Building Middle School Science Teachers' Understanding about Scientific Inquiry Using Secondary Research

Jamie Mikeska, Michigan State University, jamiemik@yahoo.com

Patricia S. Bills, Michigan State University

Kenne Dibner, Michigan State University

Suzanne Wilson, Michigan State University

James Short, American Museum of Natural History

Robyn Carlson, Michigan State University

Suzanne Elgendy, American Museum of Natural History

ABSTRACT: Recent efforts to promote teachers' and students' understanding about scientific inquiry have focused on doing science through direct involvement in data collection. Another form of inquiry, secondary research, which involves examining data previously gathered from other sources and working with large data sets to develop questions and evidence-based explanations, has been under-explored. It is essential that teachers and students alike broaden their knowledge of how science is conducted; otherwise their understanding of science and inquiry more generally is truncated. This study addresses this issue by examining how using secondary data sets and related resources as part of a science-specific professional development program can be used to build middle school science teachers' understanding about scientific inquiry and to impact their teaching practice, and how teachers' developing understanding and practice is enabled by the availability and use of resources. Results indicate that: (1) scientific inquiry understandings are connected to how PD facilitators help teachers engage in secondary research as a type of scientific investigation and (2) teachers' understandings about scientific inquiry are enabled by the use of specific PD resources aimed at using secondary data sets.

Strand 9: Reflective Practice

Poster Session A

3:15pm – 4:15pm, Griffin Exhibit Hall

A97. How Teachers Make Sense of Their Beliefs to Be Congruent with Practice: Sensible System Framework

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Soonhye Park, University Of Iowa

Monday, March 26, 2012

ABSTRACT: This study examined how physics teachers in Thailand make sense of their beliefs in a way that is congruent with their practice related to inquiry-based teaching approach. Employing Leatham’s sensible system framework, it presumes that “individuals develop beliefs into organized systems that make sense to them” (p.93). According to researching on several literatures, it is evident that teacher beliefs in the four areas impact their implementation of inquiry-based teaching approach: a) what inquiry is, b) the effectiveness of inquiry-based approach, c) self-efficacy about teaching science as inquiry, and d) epistemological beliefs. Within this study, the case study was conducted with five Physics teachers. We analyzed Videos to reflect teachers’ practice while the survey and interview were considered as teachers’ beliefs. Through Leatham’s framework, it is believed that teachers’ actions go consistently with their beliefs. Result showed that all participants performed low inquiry implementation even they think they understand the meaning, realize the effectiveness, and be confident in their teaching. In the sensible system framework, people’s belief is to work in the way that makes sense to the individual. In this case, teachers habitually make sense of their beliefs as a system and then their beliefs are represented through their practices.

Strand 10: Curriculum, Evaluation, and Assessment

Poster Session A

3:15pm – 4:15pm, Griffin Exhibit Hall

A99. *Designing Student Assessments for Understanding, Constructing and Critiquing Arguments in Science*

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

Seth Corrigan, Lawrence Hall of Science

Jacqueline Barber, Lawrence Hall of Science

Megan Goss, Lawrence Hall of Science

Amanda M. Knight, Boston College

ABSTRACT: There is growing recognition at a national level that argumentation lies at the heart of practicing and learning science. The educational importance of argumentation is reflected in recent science education research, the new K-12 Science Education Frameworks, and in the English Language Arts common core in the standards for science and technical subjects. In order to change classroom practices, there is a need for comprehensive, effective, and scalable classroom tools and assessments for argumentation. Although there has been important research around measuring students’ argumentation in both writing and talk, the field still lacks valid or reliable instruments to measure student competency. In this paper, we present theoretical models or construct maps for developing assessments for understanding, constructing and critiquing arguments in science. These construct maps are an important first step for future development of assessment items and corresponding teacher instructional responses to better support all students in engaging in scientific argumentation.

A101. *Performance Assessment of Science Competencies That Normally Go Unassessed*

Penny J. Gilmer, Florida State University, gilmer@chem.fsu.edu

Albert Oosterhof, Florida State University

Danielle Sherdan, Florida State University

Adam LaMee, Florida State University

ABSTRACT: When stakes are high, test content significantly influences what is learned. When efficiencies require statewide assessments to limit competencies tested to those that can be measured with multiple-choice tests, this poses a serious problem for science education. Our research is evaluating an alternative strategy. As with the National Assessment of Educational Progress (NAEP), our research utilizes sampling. The strategy includes three components: 1) administer complex assessments to samples of students to estimate group-level competencies unassessed by traditional tests; 2) use teacher-administered assessments to estimate competencies of individual students, utilizing statewide samples and teachers cross-validating each other; and 3) help teachers apply best-practice feedback approaches that facilitate assessments’ formative role. Statewide and teachers’ tests would be based on common specifications. Our project, in its sixth month of a three-year U.S. Department of Education

Monday, March 26, 2012

grant, has identified essential science competencies unassessable by typical statewide tests, established four initial specifications that define sets of complex performance assessments, and trained teachers participating in the project's pilot phase. At the 2012 NARST meeting we will describe project details and present data from this pilot phase. The NARST meeting provides an opportunity to solicit reactions and ideas from science educators, teachers and curriculum specialists.

A103. Translation and Validation of the Reformed Teaching Observation Protocol (RTOP) into Turkish

Mustafa S. Topcu, Mugla University, msamitopcu@gmail.com
 Tugba Temiz, Yuzuncu Yil University

ABSTRACT: The purposes of the study were to validate the Turkish translation of the Reformed Teaching Observation Protocol (RTOP), and to explore preservice science and mathematics teachers' (PSMT) constructivist-based instruction quality with respect to the recent curriculum reforms in Turkey. Totally 114 PSMT from a university in Turkey participated to the study. For the validation of the RTOP, face validity was provided and then construct validity was estimated by exploratory factor analysis. According to the exploratory factor analysis results, three dimensions were identified: lesson design and implementation, content, and classroom culture. The alpha reliability was found to be 0.900 for Factor 1, 0.866 for Factor 2 and 0,915 for Factor 3 suggesting satisfactory reliability. To conclude, this study has provided the Turkish RTOP scale to the field that is both reliable and valid instrument. According to the RTOP scores of the participants, it was claimed that PSMT can instruct science or mathematics topics successfully in light of the constructivist approach.

A105. Assessing Interdisciplinary Understanding in Science: The IT3 Framework

Ji Shen, University of Georgia, jishen@uga.edu
 Shannon Sung, University of Georgia
 Wendell F. Rogers, Jr., University of Georgia

ABSTRACT: Interdisciplinary understanding is critical for science students to solve complex problems. However, it is unclear what "interdisciplinary understanding" means and little research has been conducted on assessing students' interdisciplinary understanding in science. In this paper, we propose a theoretical framework to guide the construction of measures for interdisciplinary understanding in science. Building upon multiple perspectives, our framework consists of four interrelated dimensions: integration, translation, transfer, and transformation. We elaborate on each dimension using examples related to osmosis, a science topic that involves interdisciplinary science knowledge. Educational implications are also discussed.

A107. Developing Computer Model-Based Formative Assessments for High School Chemistry

Xiufeng Liu, State University of New York At Buffalo (SUNY), xliu5@buffalo.edu
 Noemi Waight, University at Buffalo
 Roberto Gregorious, Canisius College
 Erica L. Smith, University of Buffalo

ABSTRACT: This interactive poster reports the process and preliminary 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 levels of 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 most assessment items have good technical quality and the most assessments have adequate construct validity and reliability. Students who used computer model-based formative assessments did statistically significantly better on the state standardized test than students in the comparison classes, although there was no statistically significant difference on a chemistry conceptual test between the two types of classes. Results also suggest specific areas of

Monday, March 26, 2012

improvement for computer models, computer model-based assessments, and integration of the models and assessments in high school chemistry courses.

A109. Leveraging Formative Assessment to Foster Scientific Argumentation among Students in a Middle School Classroom

Gayle A. Buck, Indiana University Bloomington, gabuck@indiana.edu

Amy Trauth-Nare, Indiana University

Jianlan Wang, Indiana University

ABSTRACT: Evidence-based argumentation is a critical aspect of scientific epistemology as well as a genre of discourse central to scientific practice. As in other fields of study, scientific practice requires consideration of competing explanations and claims, deliberations about methods of inquiry, and evaluation of data and its interpretations. If students are to understand the nature of science, argumentation should be an integral part of learning, as it leads to connected understanding rather than rote knowledge. Scaffolding the development of assessment can prompt students to clarify their thinking, generate examples, recognize the need for information, and monitor and repair knowledge gaps. Part of a larger research agenda focused on examining the pedagogical tools and classroom structures necessary to support middle level students' conceptual development in science, our study explored the extent to which formal and informal formative assessment strategies were used to promote scientific argumentation skills among middle school students. Our findings reveal the aspects of formative assessment strategies/documents that successfully foster scientific argumentation for middle level students.

A111. Towards a Measure of Representational Competence (RC) in Science

Christine D. Tippett, University of Victoria, chris.tee@shaw.ca

Sandra Nitz, IPN

ABSTRACT: Science is multimodal; both scientists and students learning science use representations such as text, diagrams, graphs, mathematical formulas, and chemical symbols to construct knowledge, communicate findings, and to persuade people about claims. Therefore representational competence (RC) is an important aspect of science literacy. However, RC is a relatively recent focus in science education research, and there is no widely accepted measure of RC. The two projects described here were designed and implemented in different countries (Germany, Canada), grade levels (Grades 11 and 12, Grades 6 and 7), and dealt with different topics (photosynthesis, general science topics). Yet each project attempted to measure RC by asking students to complete tasks that involved constructing representations, choosing the most appropriate representation of a particular concept, analyzing features of representations, and making connections between representations. Project 1 focused on closed items and a quantitative approach to assess students' RC whereas Project 2 used open items and a qualitative approach; advantages of both approaches should be incorporated in an overall measure of RC. Each project provided insights into students' interpretation, construction, and transformation of representations that provide a foundation for developing a measure of RC that is applicable in different teaching and learning contexts.

Strand 11: Cultural, Social, and Gender Issues

Poster Session A

3:15pm – 4:15pm, Griffin Exhibit Hall

A113. A Call for Environmental Justice Education for Pre-Service and In-Service Teachers

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ABSTRACT: Well before the industrial revolution, environmental racism has occurred in both international and national communities. This form of systemic marginalism is perpetuated by and translates directly into a negative effect on education, teaching and learning. Disproportionate exposure to neurological toxins in minority and marginalized communities of children is affecting learners in dramatic, yet rarely recognized ways. The consequence of lifelong exposure to these toxins in poor and minority populations gives rise to a call for

Monday, March 26, 2012

incorporating “socio-scientific issues” (Sadler 2009), such as Environmental Justice (EJ) education into the scientific literacy model for pre-service and in-service teachers, with purpose of developing a comprehensible connection between science education and sustainable development or redevelopment. This integration “could provide the basis for making science more relevant to learners, as well as better prepare learners for active participation in society” (Onwu & Kyle 2010). Given the severity of these learning discrepancies, coupled with a limited amount of research related to EJ and its effect on learning and school attendance. I emphasize a critical need to integrate pre-service and in-service EJ education into teacher education programs and the Pre-k-12 curriculum

A115. *Becoming an Activist Science Teacher: a Longitudinal Case Study of an Induction Intervention*

Sarah Barrett, York University, sbarrett@edu.yorku.ca

ABSTRACT: The focus of this longitudinal case study is the evolving beliefs of a new science teacher who wishes to teach for social justice by teaching about and through socioscientific issues (SSI). The participant’s espoused beliefs evolved into enacted beliefs unevenly, with the inclusion of SSI as content occurring prior to his having the skills to enact an approach to teaching which optimizes that content. Over time, his ability to talk about his teaching practice as well as his ability to implement his vision became more focused. This study shows an example of a trajectory of beliefs and implies that, for new teachers, the transition from espoused to enacted beliefs follows a developmental trajectory. This recognition has implications for the design of future studies which investigate whether or not preservice teachers retain their reformist views years after they begin teaching. By understanding this trajectory, teacher educators can more effectively intervene in cases where new teachers have the intentions to teach for social change (become activists) but fail to realize those intentions in practice.

A117. *A "B" Isn't Good Enough: Gendered Expectations for ELL Students' Science Achievement and Participation*

Kathyrn Scantlebury, University of Delaware, kscantle@udel.edu

Beth A. Wassell, Rowan University

Sonya N. Martin, Seoul National University

ABSTRACT: This paper examines urban, middle school ELL students’ and their teachers’ gendered attitudes towards science using a mixed methods that included students’ surveys, interviews with students, teachers and parents. Much of the research has failed to examine the gendered educational experiences in science for ELL students. There were no gender differences between students on teacher practices and students’ science attitudes. However, Ethnic Chinese Cambodian and Ethnic Chinese girls reported less support from for their academic work parents/adults compared with African American and Latina girls. The lack of parental support did not deter the girls from being interested in science. Ethnic Chinese Cambodian and Ethnic Chinese boys also reported lower levels of support from parents/adults.

A119. *(Re)Visions of Science and Science Teaching: Students of Color Transforming Their Ideas of Teaching Science in Urban Schools*

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

Ilesha Jackson, Teachers College, Columbia University

ABSTRACT: This study was situated in a preservice elementary science methods course at a large, urban university in the northeastern United States. The methods course was designed to orient preservice teachers to multicultural science education. Five students of color were invited to participate in this study. The experiences of these preservice teachers were analyzed using critical race theory. Notions of becoming a scientist, observing that science is everywhere, and seeing self and science differently as a result of the course structure and discussions were salient themes from an analysis of data collected from the study. Implications of the study are discussed in terms of science methods courses structured to critique dominant discourses of science and science education for teachers of color and the utility of critical race theory in science education to provide deeper theoretical understandings of the experiences of teachers of color in science teacher education.

Monday, March 26, 2012

A121. Narratives and Interactional Self-construction: Why are All the Cree Students Chatting Together About Science?

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

ABSTRACT: The way people come to teach science is shaped by a long trajectory of experiences in science and most importantly by how they make sense of them. This session addresses questions of how Native preservice teachers resolve the tensions between their personal, collective and historical oppressive encounters with science and their future role as science teachers. Discourse analysis of autobiographical narratives and online interactions in a science course for preservice elementary teachers explored the representational as well as the interactional/constructionist functions of language in those discussions. Shared personal and collective experiences with science led to solidarity and co-construction of new selves among the Native students and between Native and non-Native students. Shared historical encounters with science built solidarity among Native students, but interfered with solidarity building between Native and non-Native students. This highlights the vastly different historical understandings of science that shape the figured worlds of Native and non-Native future teachers and the need for this to be addressed in science education. The role of instructor as an active agent in recontextualizing knowledge and providing pedagogical opportunities for self-construction is also highlighted. This session will be of interest to those concerned with social reproduction for many marginalized groups and researchers concerned with operationalizing the constructs of identity and narrativization.

A123. Using the 5R Instructional Model to Develop Content Knowledge and Language in Science for ELLs

Molly H. Weinburgh, Texas Christian University, m.weinburgh@tcu.edu

Cecilia Silva, Texas Christian University

ABSTRACT: Our research focuses on the equity issue of helping English Language Learners (ELL) acquire and modify knowledge, skills, attitudes and behaviors that are needed to be successful in science in U.S. schools. Specifically, we examine the emerging 5R Instructional Model to see what change occurs in student learning. During a 3-week period, instruction ‘...married scientific activities with scientific ways of using words rather than with lifeworlds languages’ (Gee, 2004, p. 25) using the 5R Instructional Model. Thirty-one students participated in the study. All students were recent immigrants and came with various levels of English language proficiency and prior schooling. The data were collect from multiple sources including audio-tapes of student conversations, video-tapes of student activities, pre/post interview, pre/post read aloud, daily written journal entries by students, researcher notes field notes, and student end of course products. A team of researchers coded the transcribed pre/post interview, ‘what I know about wind turbines’ entry in the journal, and ‘book’ page produced at the end of the summer. Comparisons between the first day’s and last day’s oral interview and written description of their knowledge of wind turbines indicate that the students content knowledge and language skills increased.

Strand 12: Educational Technology

Poster Session A

3:15pm – 4:15pm, Griffin Exhibit Hall

A125. Video Games in Middle School Science: Overcoming Spore's Flaws to Promote Conceptual Understanding

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Hasan Deniz, University of Nevada, Las Vegas

Joshua Keilty, The Alexander Dawson School at Rainbow Mountain

ABSTRACT: Researchers’ arguments combined with video games’ widespread popularity and potentially spurious advertising may leave teachers confused or misinformed about games like Spore. Spore was marketed as an experience in biological evolution. However, several scientists have criticized the algorithms and models that form the basis of students’ experience (Bean, Sinatra, & Schrader, 2010; Bohannon, 2008). Based on this, researchers conclude that Spore may promote and induce scientific misconceptions (Bean et al., 2010; Schrader, Lawless, & Deniz, 2010). Fortunately, there is ample evidence that critique of models and simulations may also provide opportunities for meaningful learning (Jonassen, 2006). As a result, this research explores the possibility of

Monday, March 26, 2012

leveraging Spore in as a forum for discussion and criticism to target misconceptions and promote understanding. Specifically, this study reports findings associated with 56 middle school students who were randomly assigned to a task involving Spore. Students who examined the algorithms and mechanisms of Spore performed significantly better on a test associated with conceptual understanding of natural selection than students who engaged in an analogous task.

A127. *From Tree to Map: Using Digital Tools to Update Metaphors for Evolution*

Sonia H. Stephens, University of Central Florida, sonias@knights.ucf.edu

ABSTRACT: Metaphors like the evolutionary “tree of life” are crucial tools for evolution education, and are designed to overcome barriers to understanding and provide a phylogenetic framework for thinking about evolutionary pattern and process. Like any other metaphor, however, there is not a one-to-one mapping between the tree metaphor and our understanding of evolutionary processes and patterns. Misunderstandings may arise from how we depict the tree of life itself. This study asks how we can mobilize digital media to address some of the conceptual limitations of the tree of life as a visual metaphor for evolution. It draws from three research traditions: new media theory, cognitive science, and information visualization, to explore the ways digital media tools can extend the types of visual metaphors used for communicating about evolution. Finally, it proposes a new metaphor for evolution, an interactive visualization called a “dynamic evolutionary map.” This visualization combines a non-traditional map metaphor with two types of user interaction: temporal interaction emphasizing lineage splitting and change, and exploration of evidence for evolution and key phylogenetic concepts. Digital tools have promise for transforming science communication and education, and this study is an example of using these tools to rethink a traditional education challenge.

A129. *Enhancing Lifelong Learning among STEM Graduate Students via Distance Learning*

Rania Hussein-Farraj, Technion-Israel Institute of Technology, rania1r2@technion.ac.il

Miri Barak, Technion, Israel Institute of Technology

Yehudit Judy Dori, Israel Institute of Technology, Haifa, Israel

ABSTRACT: Enhancing Lifelong Learning among STEM Graduate Students via Distance Learning This paper presents a study that examined the development of two distance learning (DL) courses and their effect on students' learning perceptions. Our study included 105 STEM graduate students divided into two research groups: face-to-face (F2F) on-campus students (N=70), and DL – online students (N=35). Data was collected through an online questionnaire, consisting of both open-ended and close-ended questions. The 'mixed methods' model was then used in analysis and interpretation of the data. Students of the DL group, those studying from distance, were found to be more satisfied from their learning compared to the F2F students. Female students of the DL group were found to be more confident about their ability to communicate with their classmates and lecturers, in comparison to males of that group. We also found that young students (in their mid-twenties), in comparison to the older students, hold higher positive opinions about the quality of the DL courses and the support received from the lecturer and teaching assistants. In order to succeed in distance learning, students are to adopt self-regulated learning, show responsibility, and plan their time efficiently. Learning about students' opinions and experience in DL may assist in developing the next generation of online courses in higher education.

A131. *How Wetlab and Database-Centered Research Experiences Influence High School Students' Perceptions of Authentic Scientific Practice*

Maureen Munn, University of Washington, mmunn@uw.edu

Randy Knuth, Knuth Research Inc.

Katie Van Horne, University Of Washington

Hiroki Oura, University Of Washington

Andrew W. Shouse, University of Washington

ABSTRACT: This study examines how two kinds of authentic research experiences—genotyping human DNA and utilizing a database to test hypotheses about factors that affect smoking behavior—influence students' perceptions and understanding of scientific research. A fundamental question we are exploring is the extent to

Monday, March 26, 2012

which doing research with a database affects student learning and interest in STEM and careers compared to a wetlab experience. This study used a focus group protocol to compare students who conducted the research experiences in one of two sequences: genotyping before database, and database before genotyping. Data was gathered from 205 students, including 101 who had completed the database research and 104 who had completed genotyping. Students completed a Focus Group Worksheet, followed by a facilitated discussion. The students in this study were more likely to rate the genotyping experiment to be more like real science than the database research experience, in spite of the fact that they associated more scientific tasks with the database experience than the genotyping experiment. This result suggests that students retain their beliefs that science is primarily concerned with manipulation of equipment and materials rather than analysis of data and ideas, even when their own experience is to the contrary.

A133. *Developing Technological Pedagogical Content Knowledge in an Experiential Environmental Science Course Using Geospatial Technologies*

Rita Hagevik, The University of North Carolina at Pembroke, rita.hagevik@uncp.edu

Patty Stinger-Barnes, The University of Tennessee

Jessica Horton, The University of Tennessee

ABSTRACT: This study describes how geospatial technologies (GT) were used to enhance developing technological pedagogical content knowledge (TPACK) in preservice and inservice teachers. Twelve preservice elementary, three preservice secondary science, and five inservice secondary science teachers participated in an experiential course called Ossabaw Island: Ocean Beach & Estuarine Ecology Education for the past two summers. The course involved a four-day camping trip on a remote island off the coast of Georgia. The teachers used the Mapping Our School Site (MOSS) GT program, GT maps of the island and global positioning systems (GPS) to create a Google Earth tour of their experiences for use as an instructional tool. Data was collected pre and post using an Environmental Attitudes Survey, TPACK instrument, and participant interviews. Analysis of the survey showed overall positive environmental attitudes with no change over time and a slight positive change in environmental behaviors. A significant increase was found in technological knowledge and geospatial knowledge with no pre to inservice teacher group differences. Pedagogical content knowledge and technological pedagogical content knowledge were higher in inservice teachers as compared to the preservice teachers. Analysis of participants' interviews revealed the following three themes: (1) new ways to use technology, (2) an interest in gaining more practice regarding how to use these new technologies, and (3) knowledge of ways to use the natural environment as a teaching tool. Though the course was a brief although intense experience in nature, participants described how they had used or planned to use the environment in teaching.

Strand 13: History, Philosophy, and Sociology of Science

Poster Session A

3:15pm – 4:15pm, Griffin Exhibit Hall

A135. *Science Teachers' Views about Teaching Socioscientific Issues: Understandings, Experiences and Suggestions*

Ahmet Kilinc, ahmet_tr@yahoo.com

Dilber Bahceci

Umit Demiral

Nagihan Tanik

Baris Eroglu

Kasim Yildirim

Ozkan Gorgulu

Ozlem Afacan

Mutlu Pinar Demirci Guler

Arzu Sonmez

Monday, March 26, 2012

ABSTRACT: Current science teachers perceive a need to address Socio-Scientific Issues (SSI) positively. However, only a minority of them deals with these issues in their classrooms and not even they address SSI in any systematic manner. However, several case studies in which teachers were supported by an intensive in-service education displayed very satisfying results. At this point, we consider that determining current teachers' understandings, experiences, and suggestions about teaching of SSI should be the first step towards creating productive in-service and/or preservice education opportunities. This paper addresses this issue. Fifty seven Turkish science teachers constituted the sample. Semi-structured interviews were conducted. In data analysis, Creswell's content analysis approach was adopted. The results showed that most of the teachers believed SSI to be current and intriguing. However, they mostly used SSI in unplanned teaching activities perhaps because they did not possess knowledge as to how to teach these issues. We believe that macro changes are needed to provide them with the opportunities to enhance their professional development. Even though providing comprehensive in-service education seems an effective solution, deep problems stemming from educational policies, as in Turkish context, restrict science teachers' understandings and experiences about teaching of SSI.

A137. *Understanding Research Paradigms: Trends in Science Education Research*

Sebastian P. Szyjka, sp-szyjka@wiu.edu

ABSTRACT: This essay offers several insights regarding the principles of qualitative and quantitative methods, defining how they shape the empirical process as well as knowledge acquisition in social science research. A comprehensive discussion includes comparing the assumptions and techniques of each paradigm, as well as a description of their respective strengths and weaknesses in research. These paradigms are examined in terms of past trends in science education research, indicating that over the last several decades a shift in approach from the quantitative to qualitative has occurred. The central thesis of the essay contends that methodological decisions should be based in pragmatism, rather than a pre-existent set of philosophies or beliefs irrespective of context. Implications for research are discussed in terms of the findings of several science education content analysis studies, conveying that research methods often coincide with the collective interest of the masses, policy, educational reform or program developments.

A139. *(Re)Examining Standards: Challenging Epistemological Assumptions of the National Education Science Standards*

Jesse T. Bazzul, OISE University of Toronto, jesse.bazzul@utoronto.ca

ABSTRACT: This paper attempts to turn a Foucauldian archaeological lens on the National Science Education Standards (NSES) (1996) and Benchmarks for Scientific Literacy (Benchmarks) (1993, 2009), specifically statements explicitly concerning history and nature of science. The broad research question at the heart of this analysis being: How does the discourse concerning the history and nature of science in the NSES characterize the basic epistemological underpinnings of science? A secondary aim of this paper is to challenge the views of the history and nature of science in these policy documents put forth by Good & Shymansky (2001). This work follows the general methodology spirit of Michel Foucault's *Archaeology* to help flesh out the particular epistemological and historical views of science contained within the standards. This short analysis of the NSES and Benchmarks reveals a firm realist view of science, singular and unproblematic views of the history of science, and a demarcation of science from 'other' sociocultural views of the world.

A141. *What Can We Learn About the Public's Understanding of the Nature of Science from a Popular, Open-access 'AskScience' Website?*

Leigh S. Arino De La Rubia, Tennessee State University, leigh.arinodelarubia@gmail.com

ABSTRACT: This research study highlights the ways in which an informal science education website called AskScience can be used to study the public's understanding of the nature of science. The audience for this online informal educational tool is a diverse group of international individuals, primarily anonymous in nature, who are interested in asking or answering scientific questions on the larger Reddit.com site. A series of three questions about the nature of science were posed to this online community, each as an open-ended query taken from the Views on the Nature of Science instrument (Lederman, et al., 2002). The responses to these and other questions

Monday, March 26, 2012

posed by other users in the areas of philosophy of science will be coded in accordance with both the VNOS instrument procedures and considering the unique nature of the website. Investigating the Reddit community's views of the nature of science (and even epistemology) without the lens of ethnicity and race, but within the context of science field of study/formal training is a key goal of this research. The anonymous nature of Reddit becomes an advantage in this research study, removing one of the lenses that can unintentionally color data analysis and interpretation of results.

A143. *What Makes Chemistry Unique? An Exploratory Study of Graduate Students' Conceptions*

Paulo A. Porto, Instituto de Química - Universidade de São Paulo (Brasil), palporto@iq.usp.br

Anielli F. G. Lemes, Instituto de Química - Universidade de São Paulo (Brasil)

ABSTRACT: The aim of this work is to investigate the conceptions of ten chemistry graduate students about aspects of the philosophy of chemistry. In particular, we are interested in what the students characterize as peculiar to chemistry (in comparison with physics or biology), and in their position towards reductionism. In this qualitative research, graduate students from the five traditional areas of chemistry answered to a semi-structured interview. Results show that graduate students emphasized the macroscopic aspects of chemistry, without neglecting their relation with microscopic explanations. However, the precise nature of the processes that link the two "levels" of chemical knowledge was not clearly expressed by the interviewees. As to reductionism, different opinions were observed: some chemists agreed that chemistry can be reduced to physics, some rejected reduction arguing in terms of different ontologies, and some associated reductionist claims with the defense of interdisciplinary approaches in science. These preliminary results suggest that the inclusion of philosophy of chemistry discussions in undergraduate and graduate courses could help chemists to develop more elaborate views about crucial aspects of that science.

Strand 14: Environmental Education

Poster Session A

3:15pm – 4:15pm, Griffin Exhibit Hall

A145. *Perceptions of Animals in Primary School Children*

Clara Vasconcelos, Faculdade de Ciências da Universidade do Porto, csvascon@fc.up.pt

António Almeida, Centro de Geologia da Universidade do Porto, Portugal

ABSTRACT: This study aimed to verify the perceptions of animals in 88 children, aged between 8 and 10, attending the 3rd and 4th years in primary school. To this end, a questionnaire was applied, with a seven point like/dislike scale for twenty five animals also inquiring about the reasons for the ranking attributed. The dog, the horse, the tortoise, the sparrow and the butterfly received the best rankings places; the cockroach, the mosquito, the snake, the mouse and the bee got the worst ones. More opposite opinions were expressed about the bat, the mouse, the boar, the wolf and the shark. Because the reasons given by children frequently reflect the lack of knowledge about certain behaviours of the animals and of their ecological role, some suggestions are made to change some of the bad perceptions that children have about the animals with the lowest ranking.

A147. *High School Students' Understanding of Global Climate Change*

Natalie N. Torres, California State University, Long Beach, price.torres@gmail.com

James F. Kisiel, California State University, Long Beach

ABSTRACT: A study was conducted to explore secondary students' understanding of global climate change, specifically targeting student understanding of the causes and mechanism of climate change. Student misconceptions and sources of student understanding were also investigated. A five-item questionnaire collected both qualitative and quantitative data from 168 ninth-grade students in biology courses. Results suggest that students are generally aware of different aspects of climate change, but generally do not possess any depth of understanding relating to the causes or mechanism. Student-identified sources of information regarding climate

Monday, March 26, 2012

change included school, the Internet, documentary movies and documentary or news television—this despite the fact that this important topic was not introduced to students in a school setting prior to taking the survey.

A149. Preservice Elementary Science Teachers' Conceptions of Sustainability: A Phenomenographic Approach

Rita Hagevik, The University of North Carolina at Pembroke, rita.hagevik@uncp.edu

Jessica Horton, The University of Tennessee

Dorothy Blanks, The University of Tennessee

ABSTRACT: If we strive for citizens who have sustainable lifestyles, then education for sustainable development (ESD) plays an important role. But the concept of sustainable development (SD) has evolved independently and with little input from educators. Understanding how teachers view sustainability is the first step in the process of ESD. In this study, 29 preservice elementary teachers enrolled in a semester long science methods course were asked to draw an environmental steward and to explain their drawing and then to draw sustainable development and to explain their drawing. This was done before and after the course. A phenomenographic approach was used to compare the pre to post drawings and explanations and to analyze the preservice teachers' descriptions of stewardship and sustainability. The results showed that the preservice teachers had a variety of ideas about SD that could be categorized as varied but narrow. The preservice teachers thought of SD as the environment (recycling, planting trees, etc.) and energy but lacked a broader understanding that would have included technology, society, economy and politics. There was little change from before to after the course, even though sustainability was discussed as a topic.

Strand 15: Policy

Poster Session A

3:15pm – 4:15pm, Griffin Exhibit Hall

A153. Estimating the Influence of Course-Taking Patterns and English Language Proficiency on Science Achievement

Zoe E. Buck, University of California, Santa Cruz, zbuck@ucsc.edu

Saul Maldonado, University Of California, Santa Cruz

Edward G. Lyon, University Of California, Santa Cruz

Eduardo Mosqueda, University Of California, Santa Cruz

ABSTRACT: As the United States competes in the global economy, politicians and educators place more emphasis on standardized tests, and the demographics of public schools change rapidly, disparities in STEM achievement between native English speakers and English learners (ELs) are becoming more apparent. Drawing on an opportunity to learn (OTL) theoretical framework, we examine factors that could influence ELs' science achievement using data gathered from the second wave of the National Education Longitudinal Study (NELS:90). Differences in tenth-grade science achievement between ELs and non ELs as well as differences in science course-taking patterns led us to estimate the influence of course taking patterns using Hierarchical Linear Modeling (HLM) to account for the clustering of students within schools. We found that taking college preparatory science courses has a powerful effect on science achievement. Test scores of college preparatory students were substantial higher by 0.5 of a standard deviation than scores of general track students on the NELS assessment. English proficiency was also an important predictor of science achievement. The results from this study can inform policy by emphasizing the importance of EL access to college-track science courses, which could ultimately give them opportunities to learn and demonstrate learning in science.

Monday, March 26, 2012

Poster Session B

4:15pm – 5:15pm, Griffin Exhibit Hall

Strand 1: Science Learning, Understanding and Conceptual Change

Poster Session B

4:15pm – 5:15pm, Griffin Exhibit Hall

B2. Using Visualizations to Help Younger Student Understand Inheritance

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

Michelle Williams, Michigan State University

ABSTRACT: Technology-enhanced learning instruction has tremendous potential for promoting student learning around complex and abstract science topics such as genetics (Roseman, Linn, & Koppal, 2008). This study explores fifth grade students' understanding of biological inheritance in relationship to two visualizations specifically developed to help students to differentiate inherited and acquired traits during the WISE Case of Audrey module. One teacher and his 106 fifth-grade students at an upper-elementary school located in a Midwestern suburban school district participated in the study. Identical content assessments comprised of 23 items were administered to all fifth-grade students before and after instruction. Overall, students participating in the fifth grade heredity curriculum experienced large and significant learning gains from pretest to posttest. Further qualitative analyses of students' understanding are being conducted with embedded assessment items that capture students' knowledge of inherited and acquired traits, prior to and after experiencing the visualizations. Preliminary data analysis indicates that prior to experiencing the visualizations, most students were unable to distinguish between inherited and acquired traits, but were able to do so afterwards.

B4. A Model Centric Ontology for Physics

Eric Brewe, Florida International University, ebrewe@fiu.edu

ABSTRACT: This paper will argue that models are one of the subcategories within the ontological category of things, and that attending to both epistemology and ontology in any learning environment is essential. Accordingly the poster we propose will describe the role of Modeling Instruction in introductory university physics classes and provide a description of instruction which has been designed to attend to ontology and epistemology and the affordances gained by including the focus on models and modeling.

B6. Children Learning to Explain Astronomy across Moving Frames of Reference: Kinesthetic and Visualization Strategies

Julia D. Plummer, Pennsylvania State University, jdp17@psu.edu

Alicia Kocareli, Arcadia University

Cynthia Slagle, Colonial School District

ABSTRACT: A quasi-experimental approach was used to investigate the role of instruction in supporting students' development of explanations for the daily patterns of apparent motion of the sun, moon, and stars and the lunar phases. Pre/post-instructional interviews were conducted with third grade students who participated in four instructional conditions (N=99). These instructional conditions included: the district's traditional curriculum, a kinesthetic planetarium program, revised district curriculum (with greater emphasis on moving between frames of reference), and a condition that combined the planetarium and revised curriculum. Analysis supports our hypothesis; students showed significantly greater improvement in their daily celestial motion mental models after instruction that supported their ability to a) visualize celestial motion through earth-based observational simulations and b) explain through the use of hands-on and kinesthetic strategies. Children in the traditional curriculum showed no improvement in their descriptions from an earth-based perspective while the experimental conditions showed significant improvement. Significant improvement was seen in students' explanations for the phases of moon in both conditions though the limited level of improvement leads us to conclude that additional time spent reflecting on the explanation is needed for most children.

Monday, March 26, 2012

B8. How to Assess Modeling Ability? A Comparison of Different Concept Mapping Practices at Primary School

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Cornelia Sommer, IPN, Kiel Germany

Ute Harms, IPN, Kiel Germany

Jörg Großschedl, IPN, Kiel Germany

ABSTRACT: Previous studies have shown that modeling facilitates students' understanding of scientific phenomena. Concept maps are considered as suitable method to assess modeling abilities. However, there is lack of evidence which concept mapping practice captures modeling abilities most validly. This study targets on the validity of three different concept mapping practices characterized by the medium and the directedness according modeling abilities. Modeling abilities of 4th graders and 8th graders were evaluated in a pre-post-test intervention design. Results provide empirical evidence on the effects of the CM practice on students' concept mapping performance. According to the medium, Students who constructed computer maps performed best concerning proposition score. Furthermore, there is no influence of the medium on the concept mapping validity concerning modeling abilities. According to the directedness, it seems that high-directed CM practices capture modeling abilities more validly than low-directed CM practices. However, our results provide indication for assessing modeling ability of 8th graders validly through high-directed computer based CM practice which is particularly interesting concerning the emerging computer automation in classrooms.

B10. Immersive Visual Learning of Moon Phases and Seasons in a Planetarium Setting

Thomas R. Tretter, University of Louisville, tom.tretter@louisville.edu

E. Scott Ingle, University of Louisville

ABSTRACT: Engaging elementary students (grades 1-3) in visually rich instruction in a planetarium setting may offer a venue for them to enhance understanding of complex 3-D spatial phenomena such as moon phases and seasons. This study explored content understandings and growth (pre-post) in those understandings due to a 90-minute planetarium experience targeting moon phases (n=413) and seasons (n=535). The planetarium instruction was designed to facilitate conceptual change by engaging students' prior understandings, and supporting their growth toward revised understandings (as needed) by being able to virtually fly through Earth-Moon-Sun data. Results from this quasi-experimental study suggest that visually rich instruction was effective in enabling young female students to catch up to their male peers on conceptualizing several spatially-dependent concepts. Evidence for which particular supporting concepts for the target ideas of moon phases and seasons were most readily learned by which age of learner suggests developmental stages at which various learners may be ready to integrate different spatially-rich understandings. Implications for curriculum sequencing and the potential learning affordances of visually immersive interaction with spatially complex phenomena for young elementary students are explored.

B12. Learners' Strategies for Size Estimation

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

Hye Sun You, The University of Texas at Austin

ABSTRACT: An understanding of size and scale is important for science learning. Scale is a unifying concept that pervades science and can be used to unify student learning across disciplines, topics, and grades. Constructivist learning theory posits that learners learn by building on their prior knowledge, so science education researchers and practitioners must be aware of how students currently think about scientific phenomena and concepts. This study investigated the strategies that learners from grade 6-expert use for four "aspects" of size and scale: to estimate relative scale (how many times bigger one object is compared to another) and absolute size, and to order and group by size. Objects to be estimated included scientifically-important objects from the atom to the earth. We found that some strategies reported in the literature for estimation of the length of everyday objects or printed lines were not used, showing that strategies are context-dependent. We also identified many novel strategies. For each aspect, strategies include recall, single-aspect strategies, and strategies that rely on the logical connection across aspects. These connections may not be clear to students. Uncertainty with calculation of inverse

Monday, March 26, 2012

of numbers and with numbers smaller than 1 also challenged some students. Recommendations for practice are included.

B14. *Student Views of Formative Assessment in High School Chemistry*

Rachelle A. Haroldson, University of Minnesota, haro0032@umn.edu

ABSTRACT: Current research about formative assessment or assessment for learning in science classrooms focuses on achievement and student learning and teacher experiences with formative assessment. Although there has been some research on empowering students and students' role in formative assessment, minimal research has been done on student perceptions in the ways they use and experience formative assessment. Students play an important role in formative assessment and their views are important in understanding the effectiveness of formative assessment. This study focused on student uses and perceptions of formative assessment through short-videotaped vignettes during each unit. Their responses provide insight into how formative assessment plays a role in student learning from the student perspective.

Strand 2: Science Learning: Contexts, Characteristics and Interactions

Poster Session B

4:15pm – 5:15pm, Griffin Exhibit Hall

B16. *Using Second Life in a Formal STEM Classroom to Learn how to Represent Annotated Genomes and Develop a Sense of Community*

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Kristy L. Halverson, University of Southern Mississippi

Sandra Bohn, University of Southern Mississippi

Robin Heyden, Educational Consultant

ABSTRACT: Effective student learning in science, technology, and mathematics requires immersion in content so that it is interesting and accessible to the learner. Our project used an interdisciplinary approach integrating computer science and biology to explore the use of emerging technology in the classroom. Specifically, virtual reality technology, such as Second Life, presents alternative ways to represent science concepts. We designed our study to assess the impact of a Second Life educational intervention on college student learning and engagement. We found that by interacting in Second Life, students learned how to represent annotated genome accurately. Additionally, students were able to interact with scientists from across the globe with ease. This platform helped develop a sense of community and engaged students in science content.

B18. *Comparing Epistemic Features of Student and Teacher Talk during Argument-based Instruction*

Andri Christodoulou, King's College London, andri.christodoulou@kcl.ac.uk

Jonathan F. Osborne, School of Education, Stanford University

ABSTRACT: Science education reform efforts in the United States and Europe acknowledge the need of teaching the content and methods of science, as well as promoting an understanding of the nature of scientific practices and knowledge. Thus, science educators also need to address the epistemic practices of science. A way to present to students the epistemic practices of science is through the teaching of science as argument. During argumentation-based instruction, students use evidence to support their claims and evaluate other individuals' claims and in this way they engage in 'epistemic discourse', which is argued as essential for the development of students' understanding of the nature of scientific practices and knowledge. This study, through a qualitative case study design, compared the discursive practices of a science teacher and a group of Grade 8 students, observed over 6 argument-based lessons. The classroom talk was analyzed based on a framework of 'epistemic operations'. The results indicate that the student talk modelled the teacher talk for the epistemic aspects of justification and evaluation of knowledge claims. Implications for specific discursive actions science teachers should focus on, and attempt to promote in their classrooms, as well as the context these discursive actions are presented in, are discussed.

Monday, March 26, 2012

B20. *The Language of Science Teaching in High School Students' Internship*

Pei-Ling Hsu, University of Texas at El Paso, phsu3@utep.edu

ABSTRACT: It is often assumed that teachers draw on scientific language in its pure state to teach students, who arrive in classes with their vernacular language. However, how can students understand and learn in a new language that they do not already know? This study investigates how science was taught in a high school students' internship situated in a university laboratory. The analysis identifies three important language mechanisms that allow teaching and learning to occur during the internship—deictic reference, vernacular translation, and situated derivation. The findings suggest that science teaching and learning are heterogeneous processes that not only draw on science but also non-science language.

B22. *Relations between Epistemological Beliefs and Science Learning Abilities in Korean Sixth Grade Elementary School Students*

Jeong Ae Won, Daejon Sunam Elementary School, jeongaewon@gmail.com

Seounghye Paik, Korea National University of Education

ABSTRACT: Research on epistemological beliefs is a growing and interesting area for psychologists and educators. The aim of this study is to investigate the characteristics of epistemological beliefs in science held by Korean 6th grade students and identify the relations between the students' epistemological beliefs and their science learning abilities, especially academic achievement and science process skills. The participants were 265 sixth grade students. And data were collected from the following three sources: (1) a written questionnaire to assess epistemological beliefs, (2) all students' science subject achievement scores, and (3) the 'Test of science process skills (TSPS)' to investigate students' science inquiry abilities. The results of this study revealed that students hold beliefs that are closer to modern and sophisticated epistemological beliefs with regard to the 'nature of science knowledge'. And students with more modern epistemological beliefs in science showed higher achievement in science subject achievement and science process skills. It is suggested that the elementary students' epistemological beliefs in science should be studied as a significant construct that influences science learning and future studies with a larger scope regarding science learning need to be undertaken.

B24. *Characteristics of Real Life Contexts and their Influence on Student Interest in Learning Chemistry*

Helena Van Vorst, helena.vanvorst@uni-due.de

Sabine Fechner

Elke Sumfleth

ABSTRACT: Over the last thirty years, an increasing number of approaches for the development and implementation of context-based curricula has arisen all over the world. Their aim is to raise student interest in science by pointing out their relevance and application outside school. Although different studies have shown a positive effect on student interest and motivation if real life contexts are integrated, a more differentiated look at results shows that they vary significantly depending on the chosen context. Based on this background, the presented study analyzes the influence of context characteristics on student interest in learning chemistry. After the characteristics have been elaborated, defined and substantiated by a rating and a student inquiry, student interest in contexts with specific characteristics will be identified. First results of the rating serve as a basis for the construction of a questionnaire to validate the constructed contexts and to select contexts for the interest investigation.

B26. *Review of Research on Inquiry-Based Laboratory Activities in Science Education in the Last Decade*

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

ABSTRACT: The era we live in demands more scientific knowledge and skills to make sensible decisions so science teaching and learning are much more critical than ever. Therefore, the ultimate goal of science education is to raise a scientifically literate society in all over the world. To achieve it, reforms have been established in science education. Inquiry-based laboratory is suggested to be implemented in science teaching by reform documents. Because research on it has been so popular especially in the last decade, we need to learn details regarding course of research on teaching science through it. Therefore, the purpose of the study was to examine recent research

Monday, March 26, 2012

published in the last decade, regarding participants, types of the study, subject area and constructs studied, and what they have told us about inquiry-based laboratory teaching. To get related research on inquiry-based laboratory activities in science education, ERIC database was searched by the use of ‘science laboratories’ and ‘inquiry’ key words. Research showed that inquiry-based laboratory activities motivate students, increase their self-efficacy in laboratory, help them learn science content, develop better understanding of NOS and metacognitive skills, ask more questions, and actively engage to activities. Suggestions for further research and implications were offered.

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

4:15pm – 5:15pm, Griffin Exhibit Hall

B28. Elementary Human Health and Biology

Ann W. Wright, Professor of Biology Canisius College, wrighta@canisius.edu

Sue D. Tunnicliffe, Institute of Education, University of London

ABSTRACT: Eight activities have been developed to address two issues. One problem is the lack of integrated human biology curricula and the second problem is health advocacy, including first aid and health. Each activity includes first, subject knowledge, which comes from the basic science facts in the main body of the lesson, second, inquiry acquisition, asking questions, analyzing a situation or finding out what problems there are, thirdly, subject related communication, this will be communicating with others. The topics present the context in language appropriate for the student. The assessments include a diagnostic assessments which determine the students prior knowledge, formative assessments that determine what the students are learning as they work through the activity, and a summative assessment. The study has led to insights in particular practices of instruction using activities that not only teach human biology (Connolly, 1998; Onwuegbuzie & Leech, 2004) but also teach health and first aid in addition to inquiry skills, and process skills. As observed by Nastasi and Schensul (2005), qualitative research is essential for providing the initial evidence necessary for application of connection to real-life situations and for identifying core components which are related to required outcomes.

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

4:15pm – 5:15pm, Griffin Exhibit Hall

B30. Beyond Classrooms: Mediating Consequential Science during Dam Removal and Habitat Restoration

Timothy K. O'Mahony, University of Washington, tko2@u.washington.edu

ABSTRACT: Middle school science courses are often constrained by prescribed kits (e.g., FOSS) or teacher generated curricula that are formalized to meet state and high stakes testing standards. This research implemented a design-based intervention to measure the learning outcomes of teaching and organizational process in a blended environment, informal and formal. This research relates to young people’s choosing and valuing within a complex learning scenario that involved technology and collaboration. An earlier pilot study in middle school science and mathematics (O’Mahony et al., 2010) drew attention to positive effects on student performance due to differentiated mediation techniques in blended environments. In this second phase of research, learning scientists, classroom teachers, and outdoor educators collaboratively designed and implemented a quasi-experimental study that compared two approaches to facilitating and delivering an outdoor science course that stemmed from the dam removal and habitat restoration project that is ongoing in their school hinterlands. In this research study, participants conceptualized their science work as either a traditional PowerPoint production; or as an experimental videography production. Results show that student agency (over choice of problem and presentation method) was significant in terms of engagement and learning with understanding.

Monday, March 26, 2012

B32. Earth Science Teachers' Knowledge of the Water System and Its Reflections in Their Lesson Plans

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Gillian Roehrig, University of Minnesota

Fred N. Finley, University of Minnesota

ABSTRACT: This study presents an analytical framework, Earth System Knowledge Framework (ESKF), to assess teachers' conceptual understanding of water in earth systems. By utilizing the framework, this study investigates five secondary earth science teachers' conceptual understandings of water in earth system and how the teachers' conceptual understandings of water in earth system affects their selection and organization of the content knowledge for lesson planning. Through intensive interviews with the teachers, this study employs multiple case studies using inductive and qualitative analysis methods. The findings of this study demonstrate that the teachers' conceptual understandings of water in earth system are highly related to their Earth System Knowledge (ESK). Furthermore, the science teachers' conceptual understanding of water in earth system directly affects the topic choices and content knowledge used for teaching the concept of water. This study implies that the teachers not only need to possess knowledge of physical earth systems but also knowledge of earth's biosphere and ecosystems to understand earth as a system. This study also suggests a need to reform teacher preparation in a way that the teachers could gain basic and fundamental knowledge of earth system and elaborate their skills to apply earth system knowledge for teaching.

B34. Changing NOS Views of a Preservice Teacher after being Actively Involved in a Research Study

Huseyin Colak, Northeastern Illinois University, h-colak@neiu.edu

Evert Cuesta, Northeastern Illinois University

ABSTRACT: This case study focused on a pre-service high school teacher's efforts to understand nature of science (NOS) concepts and his emphasis on teaching these concepts throughout a method class and while acting as a co-investigator on a research study. This study examined the change in his views of all seven concepts: tentativeness, subjectivity, creativity and imagination, empirical, observations vs. inferences, difference between theories and laws, and social and cultural embeddedness. In addition, this study also explored the participant's willingness to teach NOS concepts. In his involvement in a research study, he collected, transcribed and sorted data, conducted interviews, and scored responses to student's VNOS-C surveys. Data sources included three VNOS-C surveys conducted prior to and after SCED-303 Methods in Teaching Secondary Biology and following participation in a NOS research study, a semi-structured interview and notes taken during the discussion of the research study. Data were analyzed to determine the change in the participant's views of NOS and his changing attitudes towards teaching these concepts. The study concluded that despite a short intervention period, his views shifted towards more informed views both after an explicit/reflective instructional approach and after being actively involved in a research study.

B36. Making Connections: Comparison Tasks and Analogical Mapping as a Scaffold for Argumentation

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

Scott P. McDonald, Pennsylvania State University

ABSTRACT: Over a seven-week period 56 preservice elementary teachers in three classes were given analogical-mapping-based comparison tasks and provided training on analogical mapping with an eye toward scaffolding argumentation that leads to learning. The course, which was designed to help preservice elementary teachers learn content through inquiry, reflect on their learning experiences, and design similar types of learning experiences, included content on simple machines in which this research took place. In the research students were given seven comparative tasks in which they were asked whether a new concept (i.e., new simple machine) was more like one of two possible simple machines they had already studied. And, they were instructed to use analogical mapping - a process in which relationships between elements of one simple machine are sought within other simple machines. From over 48 hours of video from 16 groups of 4 students, 24 hours of transcripts were made. From these, reasoning sequences lasting from a few to several dozen utterances were found in which students made one correspondence on the heels of another. This is important because student argumentation is

Monday, March 26, 2012

able to proceed as students make further correspondences (i.e., claims) on the heels of prior ones. Argumentation on new content is thus scaffolded.

B38. *Understanding the PCK and Practices of Early Career Science Teachers in Diverse Settings: A Longitudinal Multiple Case Study*

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

Julie A. Luft, The University of Georgia

ABSTRACT: This research project presents the longitudinal development of PCK and practices of six early career teachers who taught different percentages of English Language learners (ELLs), and who participated in a science-specific induction program during the initial two years of teaching. The data collected encompassed years 1, 3, and 5 of the participants' inservice years. Among the data collected were: interviews about practice, observations of practice, a pedagogical content knowledge interview and a general interview. Finding indicated that participants who taught high percentages of ELLs and who received curriculum maps, professional development and who worked with their mentors, implemented inquiry lessons that integrated language domains and inquiry. Contrastingly, contextual factors such as the school culture and added responsibilities played a negative role on the teachers' implementation of inquiry.

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

Poster Session B

4:15pm – 5:15pm, Griffin Exhibit Hall

B40. *Model-Based Inquiry Instruction: Promoting Knowledge Generation in Biology*

Vivien M. Chabalengula, Southern Illinois University, mweene@siu.edu

Frackson Mumba, Southern Illinois University

ABSTRACT: This study examined the impact of a Model-Based Inquiry Instruction (MBII) using a human leg model, on 20 pre-service elementary teachers' knowledge generation and understanding of how a human leg functions when one is walking. Data was collected using the pre-and post-model drawings of a human leg which required students to show and label the eight parts (upper leg, lower leg, knee joint, foot, ankle joint, muscles, tendons and ligaments. Note: these parts were the foci because the model represented these parts); knowledge tests based on these parts; and perception questionnaire which required students to indicate how the model helped them to generate knowledge. Two major findings were revealed: First, with respect to biological understanding, students gained better conceptual understanding of how a human leg functions and achieved higher test scores. Second, with respect to students' perceptions about the human leg model, nearly all students thought that the model helped them understand the location of parts in the leg, and enabled them to see how these parts function when the model is manipulated. Implications for MBII in pre-service teacher education are discussed. Keywords: human leg, model, knowledge generation, inquiry

B42. *Does BEMA Actually Measure Anything? Searching for the Construct of Brief Electricity and Magnetism Assessment*

Lin Ding, School of Teaching and Learning, The Ohio State University, ding.65@osu.edu

Hui Jin, The Ohio State University

ABSTRACT: Brief Electricity and Magnetism Assessment (BEMA) is a 30-item multiple-choice test, designed to measure student understanding of basic E&M (electricity and magnetism) topics at introductory physics level. Although this assessment has been broadly adopted to gauge student conceptual learning and/or instruction effectiveness of physics classes, previous studies have not yet established empirical evidence to support the claim regarding what it purports to measure. Without this constructed-related information, the application and interpretation of the assessment remains moot. Following the Standards for Educational and Psychological Testing, we used Rasch modeling and factor analysis to investigate the construct validity of BEMA. Specifically, we examined Rasch estimated item difficulty, person-item map, and fit statistics of the BEMA items. Results show that

Monday, March 26, 2012

BEMA items, albeit testing a variety of topics, form a cohesive construct. This finding is further confirmed by a factor analysis.

B44. *Mass Media as a Pedagogical Tool to Increase Awareness of Nutrition in Advertising*

Penny Shumaker Jeffrey, NC State University, penny_jeffrey@ncsu.edu

Gail M. Jones, North Carolina State University

ABSTRACT: This study examined the effects of using of print and television mass media as a pedagogical tool to increase students' awareness of nutrition in advertising. Participants (n=59) were community college health science students enrolled in a nutrition course. Students received either traditional instruction (control) or instruction that engaged students in viewing mass media (treatment). Participants in both groups completed pre and post surveys containing questions related to the awareness of nutritional food-related advertisements in mass media (print and television). Participants also completed a written media interpretation exercise in which they commented about select advertisements. Fifteen participants total from both the control and treatment groups (n = 15) were interviewed about their awareness of nutritional messages in food-related advertisements. Survey results showed that there were no differences in awareness of food related advertisements seen in television or print for students in the control group as compared to students who received mass media (television and print) as an instructional tool. The media interpretation exercise indicated limited differences in awareness about content (nutrition and non-nutrition) of nutrition-related advertisements for participants who received mass media (television and print) as an instructional tool as compared to those in the control group post-course. Interviews found that students in both groups reported that they were more aware at the end of the course of advertisement content including message, nutrition, visual and emotional emphases. However, a tally of the number of student comments in the treatment group about the coded themes indicated that the treatment group had an overall decrease in the number of students that commented about the message, nutrition, visual or emotional aspect of the advertisements while the control group had an increase in the number of student comments.

B46. *Assessing the Impact of a Values Affirmation Task across Biology, Biochemistry, and Physics*

Jennifer L. Momsen, North Dakota State University, Jennifer.Momsen@ndsu.edu

Erika Offerdahl, North Dakota State University

Warren Christensen, North Dakota State University

Shanda Lauer, North Dakota State University

Lisa Montplaisir, North Dakota State University

Mila Kryjevskaja, North Dakota State University

ABSTRACT: Research has documented a pervasive and persistent gender achievement gap in STEM disciplines, especially in math and physics. Instructional efforts to reduce the gender achievement gap in STEM disciplines have yet to yield much success. Recent research has documented a profound effect of a non-instructional intervention. Student participation in a values-affirmation writing task significantly reduced the gender achievement gap in an introductory calculus-based physics course, especially for women who identified with a negative gender stereotype. Although this intervention holds promise for reducing or eliminating the gender gap, further testing with diverse populations of students is needed before the results can be considered robust. We administered the values-affirmation writing task to four STEM courses, including two calculus based physics courses, introductory biology, and biochemistry. Our analysis includes identifying whether a gender achievement gap exists in these four STEM courses using valid and reliable concept tests appropriate to each discipline. Further, we quantified the impact of the values-affirming writing task on any gender achievement gap. Results from this research will contribute to a national dialogue on women in STEM disciplines.

B48. *Illinois Researchers in Partnership with Science Educators (iRISE): A New Model for Training Science and Engineering Graduate Students in Education and Outreach*

Sharlene M. Denos, University of Illinois, Urbana-Champaign, denos@illinois.edu

Tang Wee Teo, National Institute of Education

Monday, March 26, 2012

ABSTRACT: This paper describes a program, Illinois Researchers in Partnership with Science Educators, iRISE, that represents a new model for training science and engineering PhD students in science education and outreach. iRISE is centered around a course which provides instruction in pedagogy, lesson development, assessment, diversity and other broad issues in K-12 education. The practicum part of the course involves teaching a one-hour lesson to underprivileged middle school students at a local community center. At the end of the semester, revised lessons are made available to educators via the program website and four lessons are disseminated to teachers during a summer workshop taught by a subset of graduate students from the course. We present findings from our evaluation of this program related to the impact on graduate student and middle school student participants. Our data indicates the program positively impacted graduate students' communication skills and middle school students' attitudes about science and engineering. We find that offering a graduate level course from within a scientific discipline provides a sufficient reward for a relatively short and unambiguous time commitment from time-strapped graduate students. In addition, the course provides a continuous source of mind and manpower for K-12 outreach and teacher professional development.

B50. *Analysis of Students' Argumentation*

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Y. Kirk Lin, National Taiwan University

ABSTRACT: The objectives of this study are to examine the components and quality of students' argumentation and to compare the differences between their argumentation for varied topics. We examined the components of argumentation based on Toulmin's model of five essential components of argument: claim, data, warrant, backing, and rebuttal. The five-level coding system examining the quality of argumentation was inspired and modified based on Erduran, Simon, and Osborne's study. A total of 251 students' argumentation were read independently by two authors, and then we worked together to compare the analysis and resolve difference in interpretation. Three topics were analyzed: wildlife management, nonnative species, and industry development. The results showed that only a small minority of arguments made by students did not attempt to offer a rationale or some grounds for their claims. The majority of arguments contained data, warrants, backings or rebuttals to substantiate its claims. Still some students presented brief reasoning and grounds without elaboration, and some failed to provide rebuttals. The statistics analyses (Chi-square tests of homogeneity) showed that there are significant differences of the quality of students' argumentation between pairs of different topics. The curricula and pedagogical implication are also discussed in the paper.

B52. *Validation of Science Motivation Questionnaires with Korean Collage Students*

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Sung-Youn Choi, Ewha Womans University

Sung-Won Kim, Ewha Womans University

ABSTRACT: This study examined how Korean college students, who enrolled in a general education science course, conceptualized their motivation to learn science. The 509 Korean college students completed the Science Motivation Questionnaires (SMQ, Glynn & Koballa, 2006). We also conducted deeply interview with 7 students. In order to exam construct validity, exploratory factor analysis (EFA) was performed. The result of EFA revealed that the students' conceptualization of their motivation to learn science in five dimensions: intrinsic motivation, personal relevance and career motivation, self-efficacy and self-determination, assessment anxiety, and interest grade motivation. There are gender differences within the two sub dimensions: self-determination and self-efficacy, assessment anxiety. The interview data presented examples of construct and relations between each dimensions of SMQ. Based on the findings, we discussed follow-up research and collage general science course development. Glynn, S. M., Koballa, T. R., Jr. (2006). Motivation to learn college science. In Jouel. Mintzes and William H. Leonard (Eds.) Handbook of College Science Teaching (pp.25-32). Arlington, VA: National Science Teachers Association Press.

Monday, March 26, 2012

B54. Exploring Students' Model Building Practices while Solving Representational Translation Tasks in Organic Chemistry

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 Bonnie L. Dixon, University of Maryland, College Park

ABSTRACT: Representations are used extensively in chemistry to convey information about the micromolecular world. This demand requires that novices and experts alike possess a working knowledge of how to understand, interpret, and manipulate such representations when solving hypothetical problems within the domain. Research suggests that while experts are adept at employing these skills—what is more broadly referred to as metarepresentational competence—novices typically rely on memorized heuristics or supports, such as physical models, to perform similar tasks correctly. The present study expounds upon this argument by exploring whether or not simply providing students with access to modeling kits results in improved performance on representational tasks and by examining how students work with the models themselves. Preliminary evidence suggests that >95% of students (n= 36) in the model building group elected not to construct models despite the fact that, when asked, almost all (n= 30) were capable of building them correctly. Student scores were not significant in comparison to the control (p= 0.721). While this result is not surprising given the above data, it does suggest that devoting time to teaching students how to work with models may lead to increased performance on representational tasks and in problem-solving within the domain.

B56. Engaging Undergraduates in the Scientific Enterprise through a Summer Research Experience

Parker E. Stuart, University of Missouri-Columbia, pes4kc@mail.missouri.edu
 Stephen B. Witzig, University of Missouri-Columbia
 Deanna Lankford, University Of Missouri - Columbia
 Christopher D. Murakami, University of Missouri-Columbia
 Anna M. Waldron, University of Missouri-Columbia

ABSTRACT: In the last decades we have seen a decline in the amount of students enrolling in post-secondary science classes. Another problem we face is the retention of students in science, technology, engineering and mathematic (STEM) fields, especially female and minorities. This study investigates students' scientific attitudes during an eight week summer research experience. The participants included a unique group of high school students earning their associates of science and high school diploma simultaneously. Data collection methods included a pre/post survey of undergraduate research (SURE), the undergraduate research student self-assessment (URSSA) survey, two semi-structured interviews, reflective writing, observations, and artifacts collected throughout the summer research experience. Data analysis began during the data collection period and each data source informed each other. Two major trends emerged from our findings: 1) Students who engaged in undergraduate research were more likely to continue on in STEM fields and seek more research opportunities, 2) The students' scientific attitudes changed from a more novice understanding to a more expert-like. This supports the notion that if students are placed early in a research experience, they will be more likely to continue on in their field and seek graduate degree in a STEM field. Furthermore this study shows that if female students are given the same opportunities as male, they will be just as likely to enter a STEM field.

Strand 6: Science Learning in Informal Contexts

Poster Session B

4:15pm – 5:15pm, Griffin Exhibit Hall

B58. Holding a Science Fair on the Web: Epistemological & Ethical Considerations

G. Michael Bowen, Mount Saint Vincent University, gmbowen@yahoo.com
 John L. Bencze, University of Toronto
 Susan Jagger, University of Toronto

ABSTRACT: Students have been competing for awards at science fairs for many decades. Nevertheless, there is a relative paucity of published research in this area. To contribute to the literature about science fairs, we conducted

Monday, March 26, 2012

an analysis of the documents and videos provided online as part of a major internet company's on-line ('virtual') science fair. Findings highlight issues regarding some aspects of practices in the sciences, particularly with regards to the Internal Sociology of Science (Ziman, 1984). Science through this online science fair structure seems to be portrayed as highly rational and isolated from fields of technology and societies. We were left wondering how science fair organizers and science educators might respond to dilemmas we noted.

B60. Children in Science Fairs: Interviews with Parents

G. Michael Bowen, Mount Saint Vincent University, gmbowen@yahoo.com

John L. Bencze, University of Toronto

Dianne Fraser, Mount Saint Vincent University

ABSTRACT: Considering the number of students who participate in them each year, science fairs are an under-researched area of science education. As part of a broader research agenda examining and conceptualizing science fairs, in this study we conducted survey questionnaires and then interviews with parents who had had children participate in science fairs. In these, we had parents discuss their role in working with their children, what understandings of science were held and were developed through these activities, and how the parent perceived the overall science fair experience that their child (or children) had. Insights from these interviews that may be useful for schools and science fair organizers/judges are discussed at the end.

B62. Leveraging Out of School Learning Opportunities: A Visit to the Jet Propulsion Laboratory

Athena R. Ganchorre, University of Arizona, athenag@u.arizona.edu

ABSTRACT: This study was designed to investigate teacher expectations and preparation for a school tour to the Jet Propulsion Laboratory a National Atmospheric Science Administration (NASA) research center. The school in which participant teachers teach at, are part of NASA's Explore School Team program. They teach at school that enroll a high proportion of students eligible for free or reduce price lunch. Participant teachers averaged between 10 – 15 years of teaching experience. The study revealed participant teachers' expectations were primarily affective in nature. Expected outcomes for students' after a visit to JPL were: (1) An excitement about science, (2) a motivation to learn science, and (3) an understanding of the nature of science. Teachers accessed JPL online mission resources in preparation for their class trip to JPL, however resources accessed were not translated into student engaged activities prior to their visit. Participant teachers did not take advantage of other online resources available to them that are specific to JPL, such as the JPL virtual tour. Although affective learning goals are important to participants, to what end and to what extent do participant teachers develop and support these goals is not yet clear.

B64. Working on the Public's Perception and Understanding of Science and Scientists through a Popular, Open-access 'AskScience' Website

Leigh S. Arino De La Rubia, Tennessee State University, leigh.arinodelarubia@gmail.com

Tobias Landberg, Murray State University

Eric Ray, Corpus Christi Museum of Science and History

Alex Shaver, Iowa State University

Alexander Blake, University of Arizona

Bradley Biladeau, University of Idaho

Alexander Klotz, McGill University

Andreas Lundberg,

ABSTRACT: National surveys, such as the General Social Survey (National Data Program for the Sciences, 2008) or the report on the Pew Research Center for People and the Press survey of both scientists and non-scientists (Pew Research Center, 2008) provide a portrait of the opinion and knowledge of the public-at-large on a regular basis. These findings show a lack of understanding but high interest level in scientific concepts such as physics and quantum mechanics, and biology/health and evolution. Our tool for addressing the scientific knowledge needs of the public is a pseudonymous, internet-based forum, /r/AskScience. This diverse group of over 50,000 subscribers (primarily from Western countries; North America, Europe, and Australia/New Zealand) forms a community of

Monday, March 26, 2012

scientists and readers who want to educate themselves through asking and answering scientific questions. AskScience features a "panel" of ~850 experts, who are self-described as being knowledgeable in a field of science. These panelists and others within the community field approximately 200 questions per day on the AskScience site and provide a diverse view of science, scientific fields, and approaches to education/teaching. This presentation outlines the design, purpose, challenges, and opportunities presented by this online endeavor to educate the public in matters scientific.

B66. *Talking About Science: The Discursive Experiences of Science Center Staff*

Andrea M. Motto, Virginia Tech, ammotto@vt.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.

Strand 7: Pre-service Science Teacher Education

Poster Session B

4:15pm – 5:15pm, Griffin Exhibit Hall

B68. *Breaking Tradition: The Impact of Community Based Learning Courses on Teacher Preparation*

Eunmi O. Yang, Stonehill College, emyangk@hotmail.com

Briana K. Burke, Stonehill College

ABSTRACT: Community based learning (CBL) has been widely accredited with preparing teachers for STEM education (Wallace, 2010) and diverse classrooms in an increasingly complex society (Billig & Welch, 2004). A CBL STEM education course was created in collaboration with a low-income housing complex in an urban community in Northeastern U.S. Seven preservice teachers worked closely with twelve students from the urban community and taught sound concepts in an informal setting utilizing inquiry and play like activities. Each preservice teacher recorded her students' progress through written reflections and assessments. Other written assignments included a comprehensive paper describing interactions, a response to the documentary *The Boys of Baraka*, and a funding proposal for a future playground. Pre and post results of the STEBI-B survey reveal improvement in science teaching efficacy for most of the preservice teachers. The informal setting of the learning experience proved successful when integrated with play like and inquiry based activities. Furthermore, close relationships with students encouraged the preservice teachers to reexamine their personal biases and stereotypes and to observe students with open minds. The CBL course also enabled the preservice teachers to see the challenges facing many communities and offered them the chance to be involved in civic action.

B70. *Differences between Intensified, Non-Intensified, and Non-Educational Student Teachers' Professional Knowledge in Chemistry*

Stefan Mutke, University of Duisburg-Essen, Germany, stefan.mutke@uni-due.de

Oliver Tepner, University of Duisburg-Essen, Germany

ABSTRACT: Teachers' professional knowledge serves as a necessary precondition for successfully inducing students' learning processes. To prepare student teachers adequately for their future careers, university has to provide and foster in them a profound knowledge base. To date, an information gap exists concerning the influence of different educational backgrounds on the content knowledge and pedagogical content knowledge that beginning student teachers of chemistry start their traineeships with. Thus, we have measured the content knowledge and pedagogical content knowledge of 108 intensified, non-intensified and non-educational student

Monday, March 26, 2012

teachers by using a paper/pencil test. While intensified students teachers work at the grammar school level, non-intensified student teachers work at the basic secondary school level and have passed the first education phase for becoming a teacher. Non-educational student teachers work at both levels, but did not go through any pedagogical studies. Results show significant differences in content knowledge between intensified/non-educational and non-intensified student teachers. In pedagogical content knowledge, intensified/non-intensified score better than non-educational student teachers. No significant differences in pedagogical content knowledge between non-intensified and intensified student teachers can be reported. Our results will be discussed to shed some more light on the identification for teacher education concerning the relevance of several educational backgrounds.

B72. *Simulated Interaction Model (SIM): An Innovative Approach for Preparing and Researching Preservice Science Teachers*

Jeffrey J. Rozelle, Syracuse University, jrozelle@syr.edu
 Benjamin H. Dotger, Syracuse University
 Sharon Dotger, Syracuse University
 Joanna O. Masingila, Syracuse University

ABSTRACT: Teacher education scholars continue to seek innovative approaches that challenge novice teachers to enact and apply their professional knowledge and skills in authentic situations. Utilizing a pedagogy common to medical education, the authors are currently designing a series of simulated interactions, where preservice science and mathematics teachers engage in live, one-to-one simulations with standardized individuals to address content-specific problems of practice. This paper outlines 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 eight mathematics and science simulations, and the resulting products (i.e., the simulations themselves).

B74. *Implementing a Residency-model for Science Teacher Preparation*

Nanette I. Dietrich, Millersville University, ndietrich@millersville.edu
 Oliver Dreon, Millersville University

ABSTRACT: Improving Science, Technology, Engineering, and Math (STEM) education is a national priority. The United States routinely performs in the “middle of the pack” in Science (PISA, 2009) and on our own national exams, The National Assessment of Educational Progress, less than one-third of eight graders were deemed proficient in math and science (NAEP, 2009). Addressing this challenge is multifaceted but there has been an increasing focus on the preparation and retention of excellent STEM teachers. The first step towards this goal is the critical examination of the current models of STEM teacher preparation. The goal of this study is to investigate the first-year implementation of a Secondary Science Professional Development School (PDS) implemented at a mid-size, public funded, 4 year institution with a large school of education. The PDS model that was employed in this study involved a restructuring of the undergraduate science teacher program where science content courses are taken in years 1-3 along with foundational education courses. The fourth year of the program is reserved for a full-year teacher residency program that is supported by pedagogical coursework. This study focuses on mentor-teachers’ reflections on the success of the PDS model.

B76. *Multidisciplinary Methods: Inquiry into Science and Art*

Michelle A. Fleming, University of Wisconsin Oshkosh, flemingm@uwosh.edu

ABSTRACT: Science and art have been intertwined throughout history. Leading educational organizations and researchers support interdisciplinary connections to maximize teaching scope and effectiveness. Preservice elementary teachers face unique challenges in developing appropriate pedagogical content knowledge in a variety of disciplines, including science and art. This multi-method, case study investigated the relationship between science and art as an example of two disciplines that seem disparate but actually have strong similarities. Attitudes and perceptions towards science and art, and the teaching of science and art were studied with a cohort of twenty-six preservice elementary teachers at a large, Midwestern university. Data was generated from pre- and

Monday, March 26, 2012

post- tests, interviews, and observations in the elementary science and art methods courses. Interests and attitudes towards teaching science increased, and participants came to perceive science as a more creative and imaginative endeavor. Attitudes towards art did not change. Qualitative results suggested inadequate and naïve views of science and art at the beginning and more developed views of science and art by the end of the coursework. Creativity and imagination in scientific and artistic inquiry was a pervading theme in the post-course data. Implications are discussed for elementary teacher education and further research in this area.

B78. Pre-service Teachers Perceptions of Rural and Urban Students and Schools

Helen M. Meyer, University of Cincinnati, helen.meyer@uc.edu

Anna E. Hutchinson, University Of Cincinnati

ABSTRACT: The research reported here addresses pre-service science teachers perceptions of rural and urban schools and students. This research is part of a larger research and evaluation initiative to understand our preparation programs' ability to support individual mathematics and science pre-service teachers' development along an array of factors. The particular study reported here discusses baseline data for pre-service science teachers in the three science licensing programs offered at our university-- a traditional undergraduate licensing, a masters plus licensing program, and an accelerated, grant funded licensing program-- focused on their willingness to work in high needs settings. In order to understand the impact of the preparation programs on willingness to work in high needs school, we needed to know the pre-service teachers' entry perceptions of "high needs" students and schools.

B80. Prospective Elementary Teachers' Reflections on Learning-To-Teach Science Experiences

Lucy Avraamidou, University of Nicosia, avraamidou.l@unic.ac.cy

ABSTRACT: A large body of literature illustrates that many elementary teachers are reluctant to teach science and confess a lack of confidence to teach it. Nevertheless, a review of the literature indicates a few cases of elementary teachers who do well in science and offers rare examples of enthusiast elementary teachers. The question then becomes how those cases came to be? The purpose of this study is to document three such cases of prospective elementary teachers, two of which are females. The study was designed upon a narrative inquiry approach focusing on the collection of personal stories. Multiple sources of data were used in order to examine the participants' orientations to science teaching and the kinds of experiences that influenced their development: drawings, interviews, reflective assignments, and others. The analysis of the data was grounded within the Three-Dimensional Space Narrative Structure (Clandinin & Connelly, 2000). Analysis of the data illustrated that the participants perceived certain experiences they had during their university coursework as critical to shaping their orientations to science and science teaching: inquiry-based investigations, contemporary theoretical discussions, outdoors field study, friendly and fun classroom environment and the personality and characteristics of their instructors.

Strand 8: In-service Science Teacher Education

Poster Session B

4:15pm – 5:15pm, Griffin Exhibit Hall

B82. An Examination of Beginning Science Teacher Identity Constructions through an Online Mentoring Program: A Two-Year Qualitative Study

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Julie A. Luft, The University of Georgia

ABSTRACT: This two-year qualitative study examined identities of a beginning secondary science teacher, and how these identity constructions evolved in relation to the existing power structure. The data came from an online mentoring program called e-mentoring for Student Success (eMSS). First-year science teacher Beth, and her first and second year mentors, Emily and Eric, were chosen from 25 pairs due to their active involvements and notable relationship growth over the two years. The qualitative analysis revealed that this study found six identity codes –

Monday, March 26, 2012

Copycat, Fledgling, Inferior, Explorer, Defender and Customer. Based upon the locations of the power between the teacher and the external world, the first three identities were tipped to the external world (school system) whereas the last three related primarily to the self. From these results, we suggest that e-mentoring programs are effective dialogical tools for identity constructions, and create a community of learning.

B84. *Characterizing District-wide Teachers' Science Learning Networks: Silos and Barriers to Change and Innovation*
 Fouad Abd-El-Khalick, University of Illinois at Urbana-Champaign, foudad@illinois.edu

Caroline Haythornthwaite, University of British Columbia

Kirstin Phelps, University of Illinois at Urbana-Champaign

Anita M. Martin, University of Illinois at Urbana-Champaign

ABSTRACT: Despite continued and substantial reform efforts, effecting change and innovation in K-12 science teaching and learning has been, and continues to be, a major challenge. Research on 'resistance' to reform and innovation among science teachers has mostly focused on the dissonance between teachers' knowledge, attitudes, beliefs, and practices and those entailed by reforms. In comparison, this study adopted a social network perspective on learning to understand how innovation (i.e., collective learning across a community of practice) is 'taken up' by a school building or district. Thus, the study aimed to characterize the nature of extant science teacher learning networks within whole school districts. Instructional and administrative staff in two school districts completed a survey, which asked them to identify other individuals across the district from whom they learn in relation to science teaching and three other categories of 'learning.' Participants also indicated the strength and frequency of their relations with those from whom they learn. Results show that science teachers' learning networks were mostly siloed within buildings with few cross-grade, cross-level, and cross-building relations. Additionally, teacher networks related to science teaching and learning were less elaborate when compared to other networks, such as those related to learning about classroom management.

B86. *Physics Teachers' Collective Agency: A Case in Curriculum Reform*

Guopeng Fu, University of British Columbia, fgpubc@interchange.ubc.ca

Samson Madera Nashon, University of British Columbia

ABSTRACT: Collective efficacy, as the most important property of collective agency, was often associated with social changes. This study provided a case study of how collective agency helped physics teachers adopt and adapt to the on-going curriculum reform in an East Asia country. The study employed an ethnographic approach. Three high schools participated in the research. Data were collected from physics teachers and school administrators. The results indicated that collective agency offered a forum for pedagogy and physics curriculum discussion. Through group work, teachers reduced the uncertainties of the reform. The reform mandates eliminating power hierarchies between veteran and novice teachers. Teachers' voices were collected and amplified through collective work and in turn, shaped the reform implementation. The three major factors that influenced successful collective agency were teachers' desire to improve student achievement, teachers' beliefs on the reform and school administration. This study explored the mechanism between individual agency and collective agency, and also examined the interdependent relations between collective efficacy at individual schools and the social-structure within which they were embedded. These findings stimulate a conversation between individuals, communities, and the world. Key words: Collective agency, curriculum reform, ethnographic approach, case study

B88. *Committed to Teaching: Beliefs of Persisting Beginning Secondary Science Teachers*

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Irasema B. Ortega, University of Alaska Anchorage

Jonah B. Firestone, Arizona State University

Krista Adams, University of Nebraska-Lincoln

Julie A. Luft, The University of Georgia

ABSTRACT: Three beginning secondary science teachers were followed through their first five years in practice to explore their beliefs, as well as why they selected and remained in teaching. These case studies focused on whether teacher beliefs and experiences influenced their decision to persist. Qualitative analysis revealed similar

Monday, March 26, 2012

beliefs about teaching, learning and students amongst the participants. Reasons for remaining in teaching include a desire to work with students, aspiration to increase scientific literacy, and commitment to the profession. By understanding the development of teacher beliefs, and what influences teachers to remain in the field, researchers and teacher educators may gain insight into how to prepare and support beginning science teachers in order to increase teacher persistence.

B90. *Exploring Teachers' Epistemological Belief in Relation to Their Practice and Students' Critical Thinking Skills*
 Niphon Chanlen, University of Iowa, niphon-chanlen@uiowa.edu

ABSTRACT: This study is a multiple case study aiming to explore teachers' epistemological beliefs in relation to their practice of three in-service science teachers when trying to implement a new approach. Three middle school teachers who participated in the SWH professional development program during summer 2010 were purposefully selected by convenient sampling technique. Semi-structured interviews, classroom observations, and artifacts were collected throughout school year. Qualitative data from multiple sources were analyzed by constant comparative method. The Cornell Critical Thinking Test was administered at the beginning and the end of school year as the pre and post test. The gain score were observed as an achievement measure. The results showed that teachers held different personal epistemological beliefs about science teaching and learning. And these individual belief systems affected teachers' understanding about the new approach. Teachers also adapted and implemented the new approach to fit their existing beliefs system. Relationship among teachers' beliefs, practice, and students' critical thinking test gain score is observed.

B92. *Assessing Changes in Understandings of Scientific Inquiry and Teaching Across Three Research Experiences for Teachers*

Sanlyn R. Buxner, University of Arizona, buxner@email.arizona.edu

ABSTRACT: Research experiences for teachers are opportunities to help teachers update their current understanding of STEM fields, help teachers experience firsthand how research is conducted, and encourage them to use more inquiry-based methods with their students. Despite the large investment of resources to implement these programs, a full-understanding of their impact on teachers' knowledge and teaching practice remains incomplete. This qualitative study investigated changes in teachers' understandings about scientific inquiry and science teaching as a result of participation in one of three summer science research programs. Each program included research experiences alongside professional researchers as well as activities and discussions to increase student engagement in inquiry-based science. Data were collected through open-ended surveys, semi-structured interviews and focus groups, program observation and artifact analysis. Participation in these programs led to small changes in teachers' understandings of scientific inquiry. Participants also changed their descriptions teaching to include more affective goals for their students, the use of more student-centered activities, and the importance of engaging students in research. Once teachers returned to their classrooms, they reported engaging students in more active roles in their classrooms. Several teachers described implementing student research projects modeled on their own research experiences.

Strand 9: Reflective Practice

Poster Session B

4:15pm – 5:15pm, Griffin Exhibit Hall

B94. *A Three Part Reflective Exercise for Generating Concept Specific Instructional Ideas*

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ABSTRACT: In this paper we share a three part reflective exercise for science teachers. The exercise was driven by three levels of concern. First, there is the desire to move teachers from teacher centered instruction characterized by teacher transmission of information to student centered instruction characterized by deep student understanding. However, we are also concerned that such a goal – or rather the characterization of the goals as focused on students – does not go far enough. A shift to focus on student performance can still keep intact

Monday, March 26, 2012

traditional and/or superficial manifestations of the content itself. Therefore, we also take as a goal significant reconsideration by teachers of the conceptual content as well. Finally, while the focus on students has merit, we find it can leave teachers aspirational rather than intentional in their plans for the classroom. Ultimately, while maintaining the focus on student understanding, teachers must come back to considering what they will do in the classrooms to effect student activity. Our assignment has teachers write about, in turn, content, then student understanding, and finally teacher action. We will share representational examples of both teacher work and instructor prompts.

B96. *Confronting Myths of the Science Teacher Educator: Becoming a "Facilitator" Instead of "Expert"*

Nicole Beeman-Cadwallader, Indiana University, nbeeman@umail.iu.edu

Gayle A. Buck, Indiana University

Amy Trauth-Nare, Indiana University

ABSTRACT: Louie, Stackman, Drevdahl, and Purdy (2002) identified three "myths" about teaching in higher education and the construct of the professor. One major myth is the image of the professor as the "primary, if not sole, expert in the classroom" (p. 200). I wondered, what happens when the professor makes deliberate attempts to not be the sole expert in the classroom? This is what I sought to understand in my self-study as a teacher educator in an undergraduate general science course. I reflected and monitored my attempts to delegate control and shed the label of "expert," which I believe contrasts with the goals of scientific literacy. I collected four forms of data: 1) reflective journals, 2) field notes, 3) student reflections, and 4) student work, and performed a critical events analysis (Webster & Mertova, 2007). Counterintuitively, when students took the most control over their learning, I started out as "expert." In my future teaching, I may begin as an "expert" and shift to facilitator. Examining the nuances in how much, the nature of, and in which contexts beginning as "expert" encourages student control will be crucial. Further, interrogating these "myths" may lead to reconciliation between goals and reality in my teaching.

Strand 10: Curriculum, Evaluation, and Assessment

Poster Session B

4:15pm – 5:15pm, Griffin Exhibit Hall

B98. *The Inclusion of Key Nature of Science Concepts in Saudi 10th Grade Biology Textbooks*

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Fahad S. Alshaya, King Saud University, Saudi Arabia

Saeed M. Alshamrani, King Saud University, Saudi Arabia

ABSTRACT: The purpose of this study is to identify the status of the inclusion of NOS key concepts in Saudi tenth grade biology textbook. The focus was on identifying the included concepts and how this inclusion distributed through the two parts of the textbook, chapters, and types of contexts used in the textbook. The study adopted an instrument developed in a previous study to analyze science textbooks based on their inclusion of NOS. This instrument includes 12 NOS key concepts that should be taught to K-12 students. The translation of the instrument and its validity to be used to analyze Arabic textbooks were assured through experts' review. However, the reliability was assured through the inter-rater and rate-rater reliability (0.90 and 0.77 respectively). The sample was the whole content of the textbook. The findings revealed that the textbook includes all concepts of NOS with unbalance inclusion among them. The most included concepts are "the empirical basis of the scientific knowledge"; and the least included concepts are "the subjectivity" and "sociocultural embeddedness of the scientific knowledge". This study also found unbalance inclusion of the NOS elements through the two parts, chapters, and types of context in the textbooks.

B100. *The Psychometric Properties of the Refined Materials Concept Inventory (MCI)*

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Monday, March 26, 2012

ABSTRACT: The purpose of this study was to evaluate the psychometric properties of the Materials Concept Inventory (MCI) and then recommend revisions. The MCI was administered to a sample of 303 undergraduate engineering students enrolled in a materials engineering course. The MCI demonstrated adequate reliability (Cronbach's alpha was .73) and strong discriminatory power (Ferguson's delta was 0.96). A MCI was given only two days into the course and was able to predict the final course grade ($r = .30$, $p < .001$). Convergent validity was also established by significantly correlating the post-MCI with the final course grade ($r = .50$, $p < .001$). Nineteen of the thirty items on the MCI met the criterion for index of item congruency, demonstrating somewhat mixed reviews by content experts. A confirmatory factor analysis conducted on the initial MCI structure failed to support a six-factor model. Revisions were made to the structure of the MCI, whereby an exploratory and subsequent confirmatory factor analysis yielded a refined six-factor structure that did provide a strong fit by the empirical data. The Cronbach's alpha of the refined-MCI was 0.75, suggesting 'good' reliability. The resulting psychometrics of the refined version of the Materials Concept Inventory are promising.

B102. Science and Social Exclusion: Exploring the Promise of Pedagogy

Anastasios Siatras, School of Education, Aristotle University of Thessaloniki, Greece, asiatras@auth.gr

ABSTRACT: This paper tries to illustrate the relation of science with social exclusion. Research in the field of science curricula has shown that curriculum development based on either educational practices which have nothing to do with the daily experience of children or teaching science without any theoretical background, leads to a "guided" education and tends to develop easily manipulated citizens. Moreover, in our time the restructuring of capitalism creates new conditions which encourage the exclusion of children from education generally and from science education in particular. A number of scientists argue that modern capitalism is completely different from what we have known it to be so far. The principles of traditional employment, the purchasing of goods and property ownership have been replaced by newly formed, more important standards such as access to services (e.g. education). Therefore, teaching students 'pure' science and lab-oriented knowledge can be seen as an action of denying them access to the scientific knowledge which is important for their future life. This paper presents a pedagogical model which has been developed in order to analyze science curricula as well as highlight the links of science with social exclusion.

B104. Middle-schoolers' Science Learning Measured by Close and Proximal Assessments Based on the Framework for K-12 Science Education: Implications for Standards-based Accountability and Teacher Performance Evaluations
 Kathryn F. Drago, University of Michigan, kdrago@umich.edu

ABSTRACT: Utilizing the Framework for K-12 Science Education to improve the quality of teaching and learning requires the development of next generation assessments. This paper reports the initial steps toward developing such assessments using data from six 8th graders participating in a project-based middle school chemistry unit. To assess their learning, I created a core science idea map, a visual display of the interconnected concepts from the Framework addressed by the unit. I then annotated this map for each student using responses from a proximal pre/posttest or close semi-structured, repeated interviews. After evaluating these annotated maps using the levels from a carbon-cycle learning progression, I found that according to both assessment types students could formulate macroscopic explanations of how food provides organisms with energy, but did not consistently relate this process to cellular respiration by the end of the unit. The close, interviews captured a more complex learning arc that may better represent students' developmental trajectory in project-based learning environments. Additionally, it uncovered previously unreported misconceptions. However, the proximal pre/post tests, because they utilized previous misconceptions research, were sensitive enough to provide evidence of student learning and may be well-suited to be a component of teacher performance evaluations.

B106. Evaluating the Assessment of Student Learning related to Novel Instructional Materials

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J. Steve Oliver, The University of Georgia

Kyung-a Kwon, The University of Georgia

Al Cohen, The University of Georgia

Monday, March 26, 2012

B.J. Wimpey, The University of Georgia
 Tom Robertson, The University of Georgia
 Jim Moore, The University of Georgia
 Jared Jackson, The University of Georgia

ABSTRACT: This study investigated the varying ways that students displayed knowledge gains during inquiry based interactive case studies developed by a collaborative team of scientists, science educators, and computer animators. The interactive case studies were developed to teach dimensions of osmosis and diffusion as well as the practices that scientists use to form hypothesis, construct arguments, and interpret data. High school students (n=28) in eleventh and twelfth grade participated in the study that included pretests, three interactive case studies, embedded assessment, posttests, as well as a culminating focus group. The intervention resulted in improved scores on the posttests. The researchers then utilized grounded theory methods to examine the embedded short answer responses constructed while students were involved in the case study. Thematic analysis of these responses highlighted the vast differences in understanding displayed by students when compared to the responses on the multiple-choice questions. This poster session will highlight the methods used to analyze the data set as well as the revisions made to multiple-choice items in response.

B108. *Development of the Critical Engineering Literacy Test (CELT)*

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 Michael Fosmire, Purdue University
 Ruth E.H. Wertz, Purdue University

ABSTRACT: This paper presents psychometric results of a multiple choice instrument designed to measure undergraduate students' scientific and information literacy skills. We developed an instrument, Critical Engineering Literacy Test (CELT), which requires students to first read a technical memo and, based on the memo's arguments, answer eight multiple choice and six open-ended response questions. We collected data from 143 first-year engineering students and conducted an item analysis. The KR-20 reliability of the instrument was .39. Item difficulties ranged between .17 to .83. The results indicate low reliability index but acceptable levels of item difficulties and item discrimination indices. Students were most challenged when answering items measuring scientific and mathematical literacy (i.e., identifying incorrect information).

B110. *Alignment between Standards and Alternative Assessment Based TIMSS-07 Questions: A Comparison among California State (US), Turkey, and Singapore*

Yilmaz Kara, Karadeniz Technical University, karayilmaz@hotmail.com
 Salih Cepini, Karadeniz Technical University

ABSTRACT: This study presents findings retrieved from an analysis of American, Turkish, and Singaporean curriculum guidelines and the TIMSS-07 questions. The analysis was performed in multiple dimensions: content areas, learning outcomes in terms of biology objectives provided under the curriculum standards. Webb's (2007) alignment criteria were used to investigate the relationship between curriculum standards and TIMSS assessment framework. In this process, the alternative assessment type biology questions asked in the TIMSS-07 were examined in detail by 17 reviewers during the web based alternative assessment in-service course. Although alignment consistency was high according to categorical concurrence criterion, the TIMSS biology questions and curriculum outcomes were not fully aligned considering the low consistency of the depth-of-knowledge, range of knowledge, and balance of representation criterions.

Strand 11: Cultural, Social, and Gender Issues

Poster Session B

4:15pm – 5:15pm, Griffin Exhibit Hall

B112. *Children of Elite Advocating for Disadvantaged Others: Factors Influencing their Actions on Socioscientific Issues*

Monday, March 26, 2012

John L. Bencze, OISE, University of Toronto, larry.bencze@utoronto.ca
 Nathalie Lemelin, Lower Canada College, Montreal

ABSTRACT: Given the potential seriousness of socioscientific issues, such as potential climate change, many jurisdictions have urged educators to engage students in decision making regarding such issues. Scholars and others argue, however, that students also need to take sociopolitical actions — such as lobbying of power-brokers — to address issues. In the study reported here, we concluded — based on constant comparative analyses of qualitative data — that sixth grade children in an elite private school developed significant motivation to enact social change for the common good and that their orientations seemed influenced myriad factors, including: the school’s community service orientation, the teacher’s social justice leanings, a situated apprenticeship for research-informed activism and student-led findings with regards to socioscientific issues of their choice.

B114. Sociocultural Predictors of Girls' Intention to Pursue STEM Careers

Theresa A. Cullen, University of Oklahoma, tacullen@ou.edu
 H. Michael Crowson, University Of Oklahoma

ABSTRACT: Studies show that girls often lose their interest in STEM (Science Technology Engineering and Math) subjects in middle school. Researchers have tried to identify what happens at this age. We have been working for three years developing an instrument based on the theoretical framework of the Theory of Planned Behavior to predict girls’ intention to pursue STEM careers to examine if sociocultural factors including their attitude toward STEM and careers, how they perceive others view STEM careers, and if they feel they can choose to pursue STEM study and careers. Development of two different instruments will be discussed, results from both administrations, and other variables that we are exploring to predict girls’ interest in pursuing STEM careers. We will discuss that our findings stress the importance of creating a culture that fosters positive attitudes toward STEM careers and implications for teacher training.

B116. Journeys of Black Scholars in the Academy: Re-Imaging Research and Teaching

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 Tonjua B. Freeman, University of Georgia

Malcolm B. Butler, University of South Florida Eileen C. Parsons, University of North Carolina-Chapel Hill

ABSTRACT: This qualitative case study investigates the teaching and research challenges of 1 male and 1 female Black associate professor of science education. It also explores how they met their challenges. Data included information from demographic forms, interview transcripts, and one survey (Cross Social Attitude Scale). It was found that the participants were both successful in meeting many of their challenges; however, they focused on different challenge areas. The information they shared can be helpful for the career development of other scholars and can be used to guide higher education policies and practices so that Black faculty members are members of the academy to enhance science education teaching and research.

B118. Enhancing Urban Students' Theories of Intelligence as Part of Positive Identity Development

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 Sylvester McKay, Morgan State University
 Avis D. Jackson, Morgan State University
 Mercy Wangu Ndege, Morgan State University
 Samantha L. Strachan, Morgan State University
 Nicola Norman, Morgan State University

ABSTRACT: The study objective is to explore the Theories of Intelligence (TOI) Profiles of urban students. Research shows that students’ theories of intelligence as measured by the TOI instrument are a crucial part of positive identity development in youth and enhances academic achievement, specifically in science and mathematics. According to this motivational model, beliefs about the nature of intelligence result in students responding in different ways to the inevitable challenges and drawbacks attendant on learning. Upon the analysis of our TOI scale we found that only 50% of our students held incremental beliefs about intelligence and 50% held entity beliefs. Given the high correlation of incremental beliefs with enhanced academic achievement and resilience,

Monday, March 26, 2012

there is clearly a need for interventions for classrooms to incorporate aspects of social and emotional learning (SEL) aimed at developing incremental approaches to intelligence in students. Our results show that persistence and ethical behavior in an academic context are also clearly indicated as areas in need of intervention. We report on our empirical findings in the context of the pressing issues in minority education. It would appear that addressing student motivation is a fruitful area for research aimed at understanding and addressing the ethnic test score gap.

B120. *The Roles of Epistemology and Positionality in Teaching Assistants' Development of Inquiry Teaching Practices*

Cara L. Gormally, Georgia Tech, cara.gormally@biology.gatech.edu
 Angela Johnson, St. Mary's College of Maryland
 Jaweer Brown, EngenderHealth

ABSTRACT: Survey data indicate inquiry-based pedagogies have been widely adopted in university biology laboratory classes, in response to continuing calls for reform. Two goals drive STEM education reform: increasing scientific literacy and participation in STEM, for all students. Evidence supporting the shift to student-centered constructivist pedagogies is well documented: increases in student engagement, learning gains, conceptual understanding, and interest in science. However, the potential to support all students' learning continues to be under-realized. Inquiry-based learning's success hinges on instructors' abilities to facilitate group discussion and dynamics. One factor impeding real change in classroom practices is that few opportunities exist for teaching assistants' (TAs) pedagogical development who typically teach laboratory courses. This TA preparation program focused on reflective practice, considering personal epistemology, and examining positionality in the classroom. Triangulating data from TAs' reflections, teaching "confessionals," and interviews, we studied skill development, in particular, TAs' ability to facilitate group dialogue in the classroom, and to identify and challenge assumptions about teaching and learning. We report findings about how ongoing reflection on epistemology and positionality influence TAs' ability to enact inquiry teaching practices. TA support for learning to facilitate group interactions so that all students have a voice is critical for effective inquiry practices.

B122. *Fukushima Disaster: Online Debate and its Implication in Socio-Scientific Argumentation*

Bahadir Namdar, University of Georgia, baha@uga.edu
 Ji Shen, University Of Georgia

ABSTRACT: Social scientific issues (SSI) can serve as great science educational tools. Web2.0 makes public argumentation on SSI more diverse and active than ever. Students face great challenges in sorting out useful information from new media. In this study we investigated the general public's argumentation on the Fukushima nuclear disaster in Japan. We analyzed a total of 178 relevant comments from four websites (two content-oriented and two news-oriented). We examined the ways in which people use language, the quality of individual arguments, and the social connectedness of argumentation in these online platforms. Our analyses revealed the following points within our data set: (1) there are more argumentative ways than instrumental ways of using language when commenting on SSI online; (2) People use very limited types of connections between statements within individual arguments; (3) Content-oriented website users present more relevant connections within their arguments, and make references more frequently to each other's comments; (4) While linking to others' comments, people mainly elaborate on an element of others' comments or provide an example but rarely provide a source for justification. We then discuss the implications of these findings in science education.

B124. *Single-sex Physics Instruction: One Way to Foster Girls' and Boys' Interest?*

Knut Neumann, Leibniz Institute for Science Education (IPN) Kiel, neumann@ipn.uni-kiel.de
 Andreas Borowski, University Duisburg-Essen

ABSTRACT: Research has revealed that students interest in science declines in the middle years of high school and that this decline is considerably higher for girls than for boys. Along with these findings comes a decrease in the number of girls pursuing science related subjects in higher grades. Given the importance of scientific literacy for all students as well as the need for talented science scholars in our technology based world, this gives rise for

Monday, March 26, 2012

particular concern. The question is: What can be done about the decline in girls' interest? In this study, we evaluate a newly introduced single-sex physics instruction program at a middle-sized, urban high school. Results show that the decline in girls' interest could be stabilized, while the number of girls and boys intending to take physics classes in higher grades of high school increased. We moreover found instructional quality to change to the better, in the view of both, boys and girls. Our findings suggest that single-sex physics instruction may be a suitable measure to establish equity in the number of boys and girls in physics classes up to the final year of high school.

Strand 12: Educational Technology

Poster Session B

4:15pm – 5:15pm, Griffin Exhibit Hall

B126. *Designing an Effective Science Education Computer Game through the Light of Commercial Computer Game Design Principles*

Elif Ozturk, Texas A&M University, elifo@tamu.edu

Gokhan Ozturk, Texas A&M University

ABSTRACT: Today, the youth is used to be entertained all the time through computer games and most of their time is spend to improve themselves in the play. Therefore, computer games have been introduced in fields of education including science education as an alternative way of teaching. Science education promotes students involve in scientific activities as real scientist do such as data collection, laboratory experiments, analyzing the data and use it in meaningful ways. Since games have the potential to create an authentic and diverse environment for science education and students are highly motivated for playing computer games, integrating science education and computer games has become a popular issue. However, the problem is that the many games made for educational purposes may be poor quality because of lack of design and fun elements. Computer games with educational context must combine the fun of the game play with the learning elements of the educational part. In this study, we will outline design components for an educational science game by interpreting commercial fun computer games' design principles. We will also define how these elements contribute to create computer games for science education within giving examples from "Rigglefish" which is a Virtual Environment for Learning.

B128. *Relating Student Actions to Learning Gains: Using Immersive Virtual Worlds to Support Understanding of Ecological Systems*

Amy M. Kamarainen, University of Wisconsin, amkamarainen@gmail.com

Shari Jackson Metcalf, Harvard University

Shane Tutwiler, Harvard University

Tina Grotzer, Harvard University

Chris Dede, Harvard University

ABSTRACT: It is important that students gain the basic skills to understand the complexities in coupled social-ecological systems. EcoMUVE is a 3D multi-user virtual environment (MUVE) and associated curriculum designed to help middle-school students understand ecosystem science content in the context of complex causal relationships. MUVEs and similar web-based multi-media learning tools have the potential to offer new and rich insights into the relationship between student actions and learning outcomes; as students interact with digital objects, virtual tools, and classmates, information about their actions are recorded in a time-stamped log file. We asked: what is the relationship between virtual tool use and ecosystem content knowledge in middle school students using a multi-user virtual environment? We will present findings from an implementation conducted in 2011 with 11 teachers (25 classes) from 4 school districts. In the preliminary analysis of the pilot results, students who achieved higher gains in ecosystem science understanding used the chat function with greater frequency. We will show the results from detailed analyses of the relationship between student tool use and associated assessment items that target specific understanding goals. Findings provide insight into how student interactions with immersive media should be designed to best support inquiry-driven collaborative learning.

Monday, March 26, 2012

B130. Investigating Students' Patterns of Use of Supports in an Electronic Science Inquiry Unit

Kasey McCall, University of Michigan, kaseyl@umich.edu

LeeAnn M. Sutherland, University of Michigan

Namsoo Shin, University of Michigan

ABSTRACT: To address students' various learning needs in inquiry-based science, we created an electronic version of a paper-based inquiry science unit that incorporates Universal Design for Learning (UDL) principles (Rose and Meyer, 2002; Rose, Meyer and Hitchcock, 2005). This paper presents quantitative and qualitative data from two studies that examined student use of support features in the e-curriculum. In the pilot study, three teachers implemented the e-curriculum with sixth grade students in authentic classroom settings (n=165 students). Quantitative analysis of posttest data and logfile data, which records student use of supports, indicate students who access more supports perform higher on the posttest. In Study 2, we explored students' use of supports in more detail, conducting a summer enactment for sixth grade students (n=11), whose teachers indicated they would benefit from a summer program before entering seventh grade. Here, we present qualitative findings based on logfile data and daily classroom observations that indicate students choose to use different supports, depending on their needs, to create individualized learning environments to help them make sense of science. Based on this data, we suggest that inquiry science curricula develop supports that address various students learning needs and maximize student choice.

B132. Exploring Student-created Animations to Show Level of Understanding on the Nature of Matter Learning Progression

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: Computers are becoming ubiquitous in society and in secondary science classrooms. Yet assessment that incorporates these advances is lagging. Teachers need a new way to assess the products of learning in a digital age. One promising new arena is the scientific visualization (Sci Vis) course, which incorporates conceptual understanding with computer visualization. Little is known about how students learn science concepts through digital animation creation. In this study, 62 students in six Sci Vis classes of two instructors created a visualization about water boiling. Students in two introductory courses created animations with pre-existing images; students in four advanced courses created animations from scratch, two classes of which also had an additional day working in groups. These results support Van Meter and Garner's (2005) Generative Theory of Drawing Construction in terms of drawing quality and demonstrate differences among student animations that can be documented using the learning progression based rubric. This implies the potential of computer animations in assisting students to demonstrate their understanding of certain science concepts.

B134. Teachers' Implementation of a Game-Based Biotechnology Curriculum

Jennifer L. Eastwood, Oakland University, eastwood@oakland.edu

Troy D. Sadler, University of Missouri

ABSTRACT: Computer games offer students situated learning experiences and foster participation in scientific discourse, inquiry, and content learning. However, there is little research that describes how teachers perceive and incorporate games into their instruction. Here we explore cases of three teachers who implemented the game-based curriculum, [xxx] in their high school biology classes. [xxx] is a curriculum unit providing a narrative context for biotechnology concepts, processes, and exposure to careers in biotechnology. It incorporates a computer game and supporting curriculum of classroom learning activities. We used a case study methodology where classroom observations and interviews from each teacher composed individual cases. We found that all teachers were able to successfully adapt the curriculum to their different classroom variables. The ability to customize the curriculum from high quality resources and provide students with experiences normally unavailable in the classroom were of primary importance to teachers. Teachers differed in their degrees of student interaction, integration among curricular components, and integration with biology content in general. Teachers believed that students effectively

Monday, March 26, 2012

learned biotechnology content and processes, but many students failed to engage with the narrative of the game and connect it to course content. We will discuss implications of these findings.

Strand 13: History, Philosophy, and Sociology of Science

Poster Session B

4:15pm – 5:15pm, Griffin Exhibit Hall

B138. *How Views of a Nobel Laureate can Influence In-service Teachers' Understanding of Nature of Science?*

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ABSTRACT: Research in science education has recognized the importance of nature of science (NOS) for understanding science. Leon Cooper (Nobel-laureate, physics, 1972), has presented a framework based on history and philosophy of science (HPS) to facilitate a better appreciation of the dynamics of scientific progress. Objective of this study is to evaluate how the views of Cooper can influence in-service teachers' understanding of NOS based on a reflective and interactive approach. This study is based on 20 participants who had registered for an introductory course as part of their doctoral program. Besides other material, framework developed by Cooper was required reading. Importance of understanding experiments (oil drop, cathode rays, alpha particles, photoelectric, etc.) within a HPS perspective was explicitly discussed in class. At the end of the course all participants were evaluated on a 5-item questionnaire, based on assertions derived from Cooper's framework. Results obtained show that on four (1, 3, 4, and 5) assertions, most participants (60-80%) had an informed view of NOS. It is concluded that views of a Nobel-laureate (HPS perspective), can facilitate in-service teachers' understanding of NOS.

B140. *Consistency of Practical and Formal Epistemologies of Science Held by Participants of a Research Apprenticeship*

Stephen R. Burgin, University of Florida, sburgin@ufl.edu

Troy D. Sadler, University of Missouri

ABSTRACT: The purpose of this report is to examine the consistency between student practical and formal understandings of scientific epistemologies (also known as Nature of Science (NOS) understandings) in the context of a research apprenticeship program. Six high school student participants of a residential summer research apprenticeship program at a major university in the southeastern United States were interviewed twice during their experience to elicit their perspectives regarding their practical epistemologies. A phenomenological approach was used to analyze these interviews. These students held practical epistemological understandings of scientific knowledge as being developmental, valuable, formulaic and authoritative. A survey administered at the end of the

Monday, March 26, 2012

program was used to reveal students' formal epistemologies of science. These practical and formal epistemologies were described in terms of Sandoval's (2005) epistemological themes and then compared for all participants. Findings revealed that for most students at least some level of consistency was present between their formal and practical epistemological understandings of each theme. In fact for only one student for one theme was no consistency evident. These results hold implications for the teaching, learning and assessment of NOS understandings in these contexts as well as for the design of apprenticeship learning experiences in science.

B142. *Science Teacher Practice and the Development of Student Scientific Creativity*

Allison Antink Meyer, Illinois Institute of Technology, aantink@hawk.iit.edu

Norman G. Lederman, Illinois Institute of Technology

ABSTRACT: Although consensus exists among educators that facilitating student creativity in the science classroom is desirable, Baer (1993) points out that classrooms generally do not adequately identify or develop creativity among students. What is needed is a shift in instructional design and pedagogy through which the development of creativity becomes explicitly addressed within the routines of instruction. Such a shift necessitates that an

understanding of the relationship between teacher practice, student experience and the development of scientific creativity is understood. This study explored those relationships among forty high school chemistry classrooms using an existing measure of scientific creativity and an analysis of teaching and learning materials coupled with classroom observations. Findings, implications and future research will be discussed as well.

Strand 14: Environmental Education

Poster Session B

4:15pm – 5:15pm, Griffin Exhibit Hall

B144. *Building Bridges between Science Classrooms and Working Landscapes through Collaborative Environmental Education Research*

Heidi Ballard, University of California Davis, hballard@ucdavis.edu

Erin Hardie, University of California, Davis

Mary Kimball, Center for Land-Based Learning

ABSTRACT: Environmental action in combination with reflection about relevant scientific concepts has the potential develop students' "action-competence" for environmental problem-solving. Using quantitative and qualitative methods, we investigated the impacts of students' completing science writing prompts before and after each of 5 watershed restoration field days. We found that while understanding of ecological concepts improved only marginally according to quantitative assessments of their writing, qualitative analysis and interviews revealed that preparatory writing prompts improved their understanding and confidence about the science content. Most importantly, students' stewardship attitudes were significantly impacted from pre to post- field day writing responses and over the course of the 5 field days, indicating that combined restoration experiences and reflective writing about science may improve students' action-competence.

B146. *A Climate Change Education Partnership's Efforts to Research and Improve Coastal Regions Climate Change Education*

Benjamin C. Herman, University of South Florida, bcherman@usf.edu

Allan Feldman, University of South Florida

Vanessa Vernaza-Hernández, University of South Florida

Larry Plank, Hillsborough County Public Schools

ABSTRACT: Reported here are the activities and findings of the NSF funded Coastal Areas Climate Change Education Partnership (CACCE). CACCE focuses on helping partners, educators, students, and the general public gain a working understanding of the interrelation among the natural environment, built environment, and social aspects in the context of climate change in coastal regions. To this end, CACCE's objectives include defining the current state of awareness, perceptions, and literacy about the impacts of climate change and how climate change

Monday, March 26, 2012

science works. This objective is met in part by CACCE's 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 these important themes. Presented here are results from these surveys and how deficiencies present in contemporary science education largely facilitates climate change illiteracy. Also discussed here is how CACCE strives to promote wide spread climate change literacy among all members of the public through their initiatives. Those who may be interested in this presentation include environmental educators, science teacher educators, and those wishing to know more about successful multi-disciplinary partnership development and research in an NSF funded climate change education project.

B148. *Urban Students' Perceptions of Scientists, Stewards, & the Environment*

Stephanie Hathcock, Old Dominion University, shath005@odu.edu

Daniel L. Dickerson, Old Dominion University

ABSTRACT: The purpose of this study was to determine student perceptions of environmental scientists, stewards, and their environment. Student participants were urban fifth grade students involved in an Environmental

Education (EE) Summer Academy that focused heavily on STEM (science, technology, engineering, and mathematics) concepts. Student perceptions were measured by the Draw an Environmental Scientist Test (DAEST) and the Draw and Environmental Caretaker Test (DAECT) as well as an open-ended questionnaire. Findings include some traditional stereotypes of scientists, interesting ideas related to caretakers, and the possibility of understanding the relationship between the environment and jobs that aren't traditionally associated with environmental studies.

B150. Are Middle Level Students able to Name an Organism when Provided with Characteristics and Habitat?

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

ABSTRACT: The USA National Science Education Standards require that students know the characteristics of organisms and their habitats. Therefore, it is imperative that educators have a clear understanding of students' knowledge of plants and animals. This study initiates a look at the baseline knowledge of middle level students. One hundred sixty-nine middle level students, ages 11-14 years, have been asked to free-list plants and animals. Additionally, students have been asked, when provided with specific habitats or characteristics, to name plants and animals they believe are found in the habitat or possess the characteristic. The results show that middle level students are most familiar with endemic animals, name mammals most often, and name home most often as the place they learn about animals. Similarly, middle level students name domestic plants most often, name dicots most often, and name home most often as the place they learn about animals. This study supports previous research that students do have some knowledge of organisms and do not believe school to be a place to come in contact with plants and animals.

Strand 15: Policy

Poster Session B

4:15pm – 5:15pm, Griffin Exhibit Hall

B152. Policy Implications of Teacher STEM Grant Proposals

Mary W. Stroud, University of Cincinnati, stroudmw@mail.uc.edu

Maya Israel, University of Cincinnati

Helen M. Meyer, University of Cincinnati

ABSTRACT: This study involved the analysis of proposals for the Innovations in STEM: Teaching & Learning Grant, 2010. The intent of ISTL grant funding was to encourage the development of small scale, innovative teaching and learning activities which engaged students in interdisciplinary STEM experiences at any grade level, kindergarten through Grade 12. Using a mixed methods approach, all proposals submitted for the grant were coded and subsequently evaluated using SPSS analysis to examine trends in STEM innovation and expectations. Analysis revealed that proposed initiatives varied in their characterization of STEM. The potential influence of observed

Monday, March 26, 2012

trends on the proposed direction of twenty-first century STEM education, research and policy will be discussed.

Key Words: STEM policy, STEM initiatives, STEM definitions

Membership and Elections Committee Sponsored Session

Graduate Student Forum

5:30pm – 7:00pm, Room 101

Presiders:

Jomo Mutegi, Indiana University - Purdue University Indianapolis, jmutegi@iupui.edu

Kathryn F. Drago, University of Michigan

Eileen C. Parsons, The University of North Carolina

ABSTRACT: The Graduate Student Forum aims to provide beginning researchers with a support network for addressing uncertainties and creating opportunities for a successful science education career. The Forum will start with attendees speaking to several experienced colleagues representative of the demographic and career diversity

of NARST members. These initial discussions will occur through a series of short round tables, allowing the participants to intimately network with mentors and peers. During these round tables, the Forum organizers will collect pressing and unaddressed questions. Then, the Forum will transition into a fishbowl discussion in which a moderator facilitates conversation between the mentors about these questions. Discussion about all matters of academic interest are welcome.

Tuesday, March 27, 2012

Program Committee Sponsored Session

Virtual Pilot Session

8:30am – 10:00am, Room 105

Presiders:

Sharon Lynch, George Washington University

Anita Welch, North Dakota State University

Multiple Intelligences Profile of Nigerian Science Students: Implications for Teaching and Learning

Immaculata Egerue, Lagos State University, Nigeria, pokebukola@gmail.com

Peter Okebukola, Lagos State University, Nigeria

Tunde Owolabi, Lagos State University, Nigeria

ABSTRACT: In the last ten years, there has been a heightened concern regarding students' underachievement in science. Unfortunately, little research attention has been invested in a potentially contributory variable- the match between multiple intelligences endowment and science learning. Using the Multiple Intelligences Questionnaire (MIQ), this study assessed the multiple intelligences profile of Nigerian science students and determined the appropriate response of the teacher to such profiles in order to ensure that learning prevails in the science class. The sample was 248 senior secondary class 2 science students. The results showed that 84% of the students exhibited visual-spatial intelligence, while 7.5% showed greatest strength in logical-mathematical intelligence. Other profiles include: musical (10.5%); linguistic (12.5%); kinesthetic (11.5%); and intrapersonal (6%). Extensive suggestions are made as to how the science teacher can take advantage of the diverse intelligences profile of students to achieve meaningful learning of science concepts and skills. As an example, since over three-quarters of the sampled science students showed promise in visual-spatial intelligence, the science teacher can harness this intelligence to good use by deploying methodology involving the use of charts, diagrams, and maps with appropriate science content. Recommendations for science teacher professional development and for further research are made.

Effects of Computer Simulations on Undergraduate Science Students Physics Achievement

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Bereket Gebre, Arba Minch University, Ethiopia

Melak Mesfin Ayenaw, Arba Minch University, Ethiopia

Tesfay Medhin Teamir, Arba Minch University, Ethiopia

ABSTRACT: The effect of using computer simulations on third world undergraduate science students' physics achievement was studied by comparing results obtained from simulation supported lessons with results from traditional lessons. Seventy-seven freshman Physics majoring and eighty-one freshman Chemistry majoring students were participated in the quantitative quasi experimental research that employed a switching replicates design. The course 'Electricity and Magnetism' was provided to the experimental group students of the study through the aid of computer simulations obtained from PhET group of Colorado and to the comparison group students through traditional instructional methods. The findings of the study reveal that experimental group students of both departmental students had a statistically significant difference from their counter parts in their mean achievements over the tests administered. Averaging over the effect sizes of the two posttest results used in the study shows that Physics majoring students had an average effect size of 0.86 and Chemistry majoring students had an average effect size of 0.74. It is concluded that computer simulation assisted instructions were more effective than traditional instructional methods in enhancing the achievement of both Physics majoring and Chemistry majoring students in the course 'Electricity and Magnetism'.

Talking Science in the Mother Tongue: Possibilities and Challenges for Substantive Learner Engagement

Audrey Msimanga, University of the Witwatersrand, Johannesburg, South Africa

ABSTRACT: School instruction in South Africa is in the local language for the first three years and thereafter in English or Afrikaans. However, many South Africans are not proficient in any of the languages of instruction and current debates on language policy therefore, centre around this issue. Meanwhile, many teachers and learners

Tuesday, March 27, 2012

are using their local languages in the science classroom, even at high school and this is what triggered my interest in the dynamics of home language use to make sense of science. The data analysed for this paper comes from a larger study that investigated teacher uptake of dialogic pedagogical strategies. I present only those episodes during small group discussions in which learners used their local languages. I used argumentation theories to characterise learner engagement and I found evidence of co-construction of arguments as learners negotiated their understandings and tried to persuade each other. All groups used the vernacular extensively and all successfully solved their problems. Chemical substances were first named in the vernacular before translation to English. Implications for science learning and teacher education are discussed. I argue that it is important to open up classroom interaction spaces in order to facilitate science learning in these contexts.

Strand 1: Science Learning, Understanding and Conceptual Change

Strand Sponsored Session - How Best Can Multiple External Representations be Harnessed for Improving Learning in Biology?

8:30am – 10:00am, Room 310

Presider: David F. Treagust, Curtin University, Australia

Presenters:

Chi-Yan Tsui, Curtin University, Australia

Anat Yarden, Weizmann Institute of Science, Israel

Phyllis Griffard, Weill Cornell Medical College in Qatar, Qatar

Kristy L. Halverson, University of Southern Mississippi, USA

Konrad Shoenborn, Linköping University, Sweden

Renee S. Schwartz, Western Michigan University, USA

Siu Ling Wong, University of Hong Kong, Hong Kong

Barbara C. Buckley, WestEd, USA

Kai Niebert, Leibniz University Hannover, Germany

ABSTRACT: In this symposium, an international panel of experienced biology educators and biology education researchers - chapter authors of the book *Multiple Representations in Biological Education* - will discuss a common theme of how multiple external representations (MERs) in biology are being used most effectively for improving biological education. To address this theme, the participants will consider how the use of MERs improves teaching and learning in their own area of teaching and research, including genetics, experts' views of the knowledge structure of biology, biotechnological methods, complex process diagrams, development of representational competence, cell division, climate change, photosynthesis, cellular respiration, and biology teachers' professional development. Drawing on the pedagogical functions of MERs, the symposium will address the perennial critique of the deficit in the interconnectedness of knowledge in biology curricula and the shortfalls in the systemic transfer of information across multiple levels of biological organization. The symposium aims at harnessing MERs for developing deep understandings of the complexity of biological knowledge and their applications to reasoning and problem-solving in real-life situations. Such aim is in keeping with systems-level understanding of biology and the ubiquity of the increasingly powerful ICT and other learning technologies in schools and homes.

Strand 2: Science Learning: Contexts, Characteristics and Interactions

Related Paper Set - Understanding the Role of Context and Activity in Students' Argumentation Practice

8:30am – 10:00am, Room 302

Presider: Leema Berland, University of Texas, Austin

ABSTRACT: The authors in this related paper set take the perspective that the design of context and activity are likely to be central to students' development and refinement of argumentation practice and seek to understand how the conditions of students' activity can be shaped to render scientific argumentation sensible. In addition to exploring different factors that influence students' interpretations of argumentation, the papers as a set consider a diverse range of supports for argumentation—including content-based supports, the design of activity, and explicit

Tuesday, March 27, 2012

discussion—and present a range of methods for assessing students’ arguments and change over time—including examining explicit norms, the basis of critique, and written products. Together, they suggest the utility of a wider lens on argumentation practice, one that encompasses the design of the entire learning environment. Important aspects of the learning environment discussed include the resources students bring with them, the activity they are engaged in, the community built in the classroom, and the content that is the target of argumentation.

Variation in how Individuals Argue about Scientific and Socioscientific Questions

Sarah Rogers, University of Texas, Austin, sarahjaner@utexas.edu

Kirstin C. Busch, University of Texas, Austin

Leema Berland, University of Texas, Austin

Learning to Argue and Arguing to Learn: A Longitudinal Study of the Impact of Argument-based Instruction on Undergraduate Chemistry Students' Written Arguments

Joi P. Walker, Florida State University, walkerj@tcc.fl.edu

Victor D. Sampson, Florida State University

Engaging Students in Developing the Means of Knowing through Argument

Eve I. Manz, Vanderbilt University, eve.i.manz@vanderbilt.edu

Coordination of Discursive Practice and Material Resources: Leveraging Students to Engage in Epistemic Discussions

Suna Ryu, UCLA, sunaryu@ucla.edu

William A. Sandoval, University of California, Los Angeles

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

Building Scientific Explanations

8:30am – 10:00am, Room 301

President: Felicia M. Mensah, Teachers College, Columbia University

Supporting Elementary Students in Making and Recording Scientific Observations

Anna Maria Arias, University of Michigan, aarias@umich.edu

Elizabeth A. Davis, University of Michigan

Annemarie S. Palincsar, University of Michigan

ABSTRACT: Making and recording observations are key aspects in the process of generating and evaluating scientific evidence and explanations, which are identified goals for K-8 science education. While elementary students have been shown to be capable of participating in this process, we know little about how elementary teachers support the scientific practice of observations and with what outcomes. To fill this gap, we investigated how two fourth grade teachers used a reform-based, inquiry curriculum to facilitate participation in this practice. Additionally, we analyzed the characteristics of the records of their students’ observations while investigating model ecosystem. Analysis of the quality and content of the drawn and written records of the observations provided evidence that the students were capable of this scientific practice but also struggled in certain areas. The study characterized the opportunities and support provided to the students to make, record, and use observations as evidence in making scientific explanations and, then, connected these to strengths and weaknesses found in the students’ written and drawn work. The study has implications for curriculum developers and teacher educators to enhance supports for elementary teachers and students engaging in the scientific practice of observation.

The Establishment of Whole-class Dialogue Patterns by one Experienced Teacher using Argument-based Inquiry (ABI)

Matthew J. Benus, Indiana University Northwest, mbenus@iun.edu

Tuesday, March 27, 2012

ABSTRACT: The purpose of this study was to examine the patterns of dialogue that were established and emerged in one experienced fifth grade science teacher's classroom that used the argument-based inquiry (ABI). The quality of dialogue is understood to be an important link in support of student learning. Few studies have examined the ways in which a teacher develops whole-class dialogue over time and the ways in which patterns of dialogue shift over time. The teacher in this study used the Science Writing Heuristic (SWH) approach to ABI with students who had no previous experience engaging in ABI. The results showed that the teacher principally engaged in three forms of whole-class dialogue with students; talking to, talking with, and thinking through ideas with students. As time went on, the teacher's interactions in whole-class dialogue became increasingly focused on thinking through ideas with students, while at the same time students also dialogued more as each unit progressed. The findings also have informed theory and practice about science argumentation, the teacher's ability to follow and develop students' ideas, the importance of prolonged and persistent engagement with ABI in classroom practice.

Supporting Fourth Graders' Ability to Interpret Graphs through Real-time Graphing Technology: An Exploratory Study

Mehmet F. Dulger, UNLV, dulgerm@unlv.nevada.edu
 Hasan Deniz, UNLV

ABSTRACT: This study examined to what extent inquiry-based instruction supported with real-time graphing technology improves fourth grader's ability to interpret graphs as representations of physical science concepts such as motion and temperature. This study also examined whether there is any difference between inquiry-based instruction supported with real-time graphing software and inquiry-based instruction supported with traditional laboratory equipment in terms of improving fourth graders' ability to interpret motion and temperature graphs. Results of this study showed that there is a significant advantage in using real-time graphing technology to support fourth graders' ability to interpret graphs.

Exploring Scientific Explanations: Promoting Students' Sense-making in Elementary Classrooms

Mandy Biggers, University of Iowa, mandy-biggers@uiowa.edu
 Laura Zangori, University of Iowa
 Cory T. Forbes, University of Iowa

ABSTRACT: The scientific practices articulated in the National Research Council's ([NRC] 2000) essential features of giving priority to evidence, formulating evidence-based explanations, and comparing and evaluating explanations are critical components of students' meaningful knowledge construction and sense-making components of an inquiry investigation. However, little research has been carried out on elementary teachers' curricular adaptations and use of these sense-making components in elementary (K-6) classrooms. The purpose of this mixed-method study was to investigate if and why elementary teachers adapt existing science curriculum materials to engage students in critical sense-making practices. We used the Practices of Science Observation Protocol (P-SOP) to score both lesson plans (n=124) and enacted videos (n=121) of the teachers. We used qualitative case-study teacher data to investigate the characteristics of teaching practices. Our findings show how elementary teachers' conceptions of evidence and explanation are often misaligned with the descriptions of these essential sense-making components and, therefore, very few lessons consisted of student construction of evidence-based explanations. Of those that did include explanation construction, we rarely observed evaluating or comparing explanations. Further, we found that the teachers do not adapt curriculum materials to engage students in these sense-making practices.

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

Enhancing Scientific Literacy

8:30am – 10:00am, Room 304

President: Eva Erdosne Toth, West Virginia University

Fostering Scientific Literacy in Bioengineering Hybrid Courses

Tuesday, March 27, 2012

Yehudit Judy Dori, Israel Institute of Technology, yjdori@technion.ac.il

Hagit Yarden, Technion, Israel Institute of Technology

Amira Allouche, Technion, Israel Institute of Technology

ABSTRACT: The study focuses on fostering scientific literacy in hybrid undergraduate/graduate courses within biomedical engineering programs. Our research goal was to investigate the effect of hybrid courses and reading articles on scientific literacy of bio-medical engineering students. About 100 undergraduate and graduate students participated in one or two of the courses titled From Cell to Tissue and Tissue Engineering during the academic year 2010-2011. The courses required active participation in the face-to-face lectures as well as weekly participation in asynchronous forum discussions of state-of-the-art scientific articles conducted via the course website. Research tools included pre- and post-questionnaires based on adapted scientific articles. The questionnaires included three open-ended questions focusing on question posing, identifying the article structure, and experiment design skills. Students' scientific literacy average gain was positive, indicating that these hybrid courses have increased the students' question posing, identifying article structure, and experiment design skills. Moreover, taking the two courses in sequence yielded the best results in post average scores for the three skills examined, pointing to the need for on-going practicing of these skills. This study sheds light on the importance of practicing scientific literacy in higher education via the integration of face-to-face sessions and on-line discussions of scientific articles.

The Effect of Plain-English Instruction on Student Achievement and Classroom Culture in College Science Instruction

Emily G. Richter, emily-richter@uiowa.edu

ABSTRACT: This study examined the effect of the translation of traditional scientific vocabulary into plain English on student achievement in college science instruction. The study took place in the context of an introductory microbiology course. Data were collected from course sections instructed with traditional microbiology vocabulary as well as sections instructed with plain-English equivalent terms. Both treatment groups followed the same inquiry-based curriculum. Data collected included written and practical exam scores as well as pre and post-course surveys on subject knowledge and impressions of biology, science and the course. Students subjected to plain-English instruction performed significantly better on written exams that assessed higher-order abilities to apply and analyze knowledge from the course. They gained similar amounts of lower-order knowledge during the course when compared to peers instructed with standard vocabulary. Results supported the hypothesis that improved achievement in the plain-English treatment was caused by students' ability to utilize extant neural networks to ground new learning.

Impact of Social Media as an Instructional Component on Content Knowledge, Attitudes, and Public Engagement Related to Global Climate Change

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

ABSTRACT: The impact of an integrated Social Media (SM) component on student content knowledge, attitudes toward global climate change, and indicators of public engagement was studied. Public engagement and social network theories were used to examine SM as an engagement mechanism among community college students learning to make connections between science, social responsibility, and sustainability. A pretest-posttest, non-randomized comparison group design was used with a treatment and comparison section. The treatment group utilized SM as a required means of communication and engagement for half of a semester and an optional component in the second half of the semester. The comparison group used traditional communication methods and an optional SM component. The SM impact was measured in three areas: content knowledge, attitudes, and indicators of public engagement. Data were collected using: content knowledge test, final examinations, climate change attitude survey, student SM posts, self-report data, and interviews. Results show an increase in content knowledge for both treatment and comparison groups. Attitudes toward global climate change did not show significant variation across the semester. However, both treatment and comparison groups showed increased tendency toward public engagement actions. Participants in the treatment group show increased gains in indicators of public engagement.

Tuesday, March 27, 2012

Rhetorical Moves as a Basis for Teaching Undergraduate Life Science Students to read Primary Literature

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Edwin B. Van Lacum, University of Groningen, The Netherlands

Martin J. Goedhart, University of Groningen, The Netherlands

ABSTRACT: Scientific literacy, regarded as an important educational goal, consists of 3 components: scientific terminology and concepts, scientific enquiry and practice and the interaction of science, technology and society. Reading primary literature can make students familiar with the first two components. The structure of a research article consists of different sections, each containing moves, which in genre analysis, can be defined as a textual element with a specific purpose. The goal of this study is to elucidate if moves can be a basis of teaching undergraduate life science students to read primary literature. Students wrote down which move they address to text fragments of an introduction section of a research article. Second, students identified two moves of the discussion section, and list which additional moves can be present. Our data suggest students are not familiar with all moves presented in the different sections of a research article. But, with the instruction given, students were able to find the moves important for weighing evidence and evaluate the outcome of the study (gap of knowledge, limitation), items important to become scientific literate. Thus, genre analysis might be a powerful tool for teaching students how to read a research article.

Strand 6: Science Learning in Informal Contexts

Developing Interests and Identities towards Science Outside of School

8:30am – 10:00am, Room 305

Presenter: Kathleen A. Fadigan, Pennsylvania State University

Identity Development of Middle School Students as Learners of Science during Learning Conversations at an Informal Science Education Camp

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ABSTRACT: This study investigated middle school students' identity development as learners of science during learning conversations at an informal science education camp. The central research question was: What is the role of conversation in influencing science learner identity development during an informal science education camp? Identity in this study was viewed as becoming and being recognized as a certain type of person. This study focused particularly on discursive identity, defined as individual traits recognized through discourse with others. The study used an exploratory case study. Data collection included videotaped observations, field notes, interviews and participants' reflective journal entries. I used qualitative methods to analyze the data including discourse analysis and the constant comparison method. From the findings of this study, I theorized that learning conversations played a role in developing participants' identities as learners of science. Participants used language to make sense of science content, for positioning, to align their discourse with science, to communicate with others, to negotiate power dynamics, and to see others in new ways. The findings of this research support and extend the research literature on identity, learning conversations and science camp programs. This study has implications for those involved with informal education program and exhibit development.

The Influence of Science Summer Camps on STEM Career Interest among Sixth-Eighth Graders

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Robert H. Tai, University of Virginia

ABSTRACT: This study addresses the association between students' reported participation in science summer programs and their reported expectation of a career in the science and engineering field in the subsequent year. We collected data on 1580 students from eight middle schools in five states applying an accelerated longitudinal design. Two consecutive cohorts were sampled over a two-year period time, with four waves of data collected from each cohort. Results indicated that students who participated in science summer camps in the initial year had significantly greater odds in reporting to choose science and engineering as their future career in the subsequent year than students who did not, while accounting for differences in their initial career interest and gender as well

Tuesday, March 27, 2012

as other demographic characters. It appears that science summer camps or programs serve students who later on are more likely to report career expectations in science and engineering.

The Impact of Summer Research-Based Program on Students' Attitudes and Interests in STEM Related Disciplines

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 Andreas Gebauer, California State University, Bakersfield
 Palmira Hernandez, California State University, Bakersfield
 Mark Vizcarra, California State University, Bakersfield

ABSTRACT: Student's experiences both in within and out-of-school settings are widely believed to influence students' academic performance and future studies. This paper examined the effects of a summer research-based program on outcomes related to science learning and students' interests in pursuing advanced studies and careers in science, technology, engineering, and mathematics (STEM) disciplines. Using data collected from two studies—one using quasi-experimental design (N = 54) and the other an experimental design (N = 63)—the samples consisted of 117 students enrolled in grades 9th through 12th from a rural community in the western U.S. Results from the experimental study showed that after controlling for student characteristics, no statistical associations were found between Summer Program participation and outcome measures such as intrinsic motivation, extrinsic motivation, task value, control beliefs, self-efficacy, and test anxiety. Students who participated in Summer Program reported less likely to pursue future studies and careers in mathematics, engineering and technology. Results from the experimental study indicated no significant differences between students assigned to the control and treatment groups on various outcome measures. These findings revealed conflicting results regarding the effectiveness of the summer research-based program in enhancing students' skills and intentions to pursue future studies and careers in STEM disciplines.

The Effect Out-of-School-Time Programs on Career Choices in STEM

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 Gerhard Sonnert, Harvard University
 Katherine P. Dabney, University of Virginia
 Philip M. Sadler, Harvard University

ABSTRACT: The imminent need for a more diverse and skilled STEM workforce has propelled educators and policy makers to look at various ways to attract a more varied population to pursue STEM careers. It has been suggested that involvement with Out-of-School-Time Activities may be a valuable method of inspiring and encouraging traditionally underserved populations in STEM and guiding them toward STEM careers. This paper examines the effects that Out-of-School-Time activities have on students' self-declared likelihood of pursuing four areas of STEM: life science, engineering/technology, physical science and mathematics. We use data from the Project PRiSE survey, which has a nationally representative sample of higher education students. We examine differences that emerge between STEM fields and interactions between various OST activities and gender and race. We find that the probability profile for each STEM field is very different from the others and make suggestions both detailing why this may be and what educators and policy makers may do to attract a more diverse population to each field.

Strand 7: Pre-service Science Teacher Education

Symposium - A Retrospective and Prospective View of Two Studies on Science Teacher Education From 1993-2011: SALISH and IMPPACT

8:30am – 10:00am, Room 306

Discussant:

Robert E. Yager, University of Iowa

Presenters:

Patricia Simmons, North Carolina State University, patricia_simmons@ncsu.edu
 John Tillotson, Syracuse University
 Monica Young, Syracuse University

Tuesday, March 27, 2012

Deborah Barry, Syracuse University
 Lauren Jetty, Syracuse University
 Glenn Dolphin, Syracuse University

ABSTRACT: The goal of this session is to facilitate discussions about how the science education research community can move toward building a 'progress model' for science teacher education research. Participants will engage in small and large group discussions with opportunities to review and critique research hypotheses and questions and data from two science teacher education research projects—Salish and IMPACT, provide input into areas of needed research, and extrapolate how the research community can lead more systematic, scientific research and respond to instructional needs, practices, and policies for science teacher education. The focus of this interactive symposium will be a discussion of the results from the Salish I project (1993-96) and the IMPACT project (2005-2010), as we compare and contrast two national studies on science teacher education over the past fifteen years—a retrospective and prospective analysis of similar investigations about science teacher education. By the conclusion of the session, participants will have examined, critiqued, and synthesized sample research questions and hypotheses, examined data trends, and provided input into critical next steps of the process of assembling a larger research enterprise outline to guide our thinking on science teacher education.

Strand 7: Pre-service Science Teacher Education

Topic Specific Content Knowledge and Laboratory Experiences

8:30am – 10:00am, Room 309

Presider: Marissa S. Rollnick, Wits University

An Exploration of Preservice Science Teachers' Written Argumentation in Science Laboratory Work

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Mustafa S. Topcu, yuzuncu yil university

ABSTRACT: The aim of the present study was twofold. First aim is to explore the preservice science teachers (PST) written argumentation in science laboratory work. The second aim is to explore types of argumentation patterns presented by PST in response to different context of the experiments. The participants were 44 PST (%30 female) enrolled in "elementary science laboratory" course (Fall,2010)from the department of elementary science education at a large eastern university in Turkey.During the laboratory works,there were four different science experiment contexts (magnetic field force, gas expansion, bouyancy, atmospheric pressure)that were experienced by PST in order to write scientetific argumentation papers. Each PST wrote a scientific argumentation papers for each experiment. These papers were used as data source to explore PSTs' nature of written argumentation. Results of the present study indicate that students have no difficulty in developing claims and supporting those claims with appropriate data. On the contrary, students have difficulty in making counter claim, and using rebuttals to refute counter claims. Meanwhile,among the argumentation patterns, the CDR (Claim,Data,Rebuttal) and the CDWR(Claim,Data,Warrant,Rebuttal) patterns were considerably minimum observed across all experiment contexts since PST rarely used rebuttal in their written argumentation papers. Key Words: Preservice Science Teachers, Science Laboratory WorkWritten Argumentation

Development of Pre-service Science Teachers' Metacognition in an Inquiry Based Laboratory Course

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Hamide Ertepinar, Middle East Technical University

Ozgul Yilmaz-Tuzun, Middle East Technical University

ABSTRACT: Metacognition role in learning is crucial since it contributes to academic achievement. Students' success is partly related to teacher. Therefore, teacher characteristics are important in learning environment. When the metacognition and teacher roles are thought together, teachers' metacognition is critically important in learning environment. The aim of this study was to investigate the role of metacognitive prompts in the development of preservice science teachers (PSTs) metacognition in an inquiry based laboratory course. The data were collected from 28 Pre service science teachers (PSTs) who attended the science laboratory course in a large

Tuesday, March 27, 2012

public university. The enhancement of PSTs' metacognition was supported by the prompts which were inserted into the laboratory manual. Mixed research method approach was used to collect and analyze the data. To collect in dept data, interviews were conducted with 4 PSTs. The results of quantitative and qualitative data supported each other. Both the quantitative data and qualitative data analysis showed that the course with metacognitive prompts supported PSTs' metacognitive development and an improvement in their metacognition was found. This study supported that metacognitive prompts can be inserted into science content and activities to help learners to better learn the scientific content and process by using their metacognition.

A Study of Secondary Science Student Teachers' Conceptions of Heat Transfer

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David Wojnowski, University of North Texas

Pamela Harrell, University of North Texas

ABSTRACT: The purpose of this study was to investigate secondary science student teachers' conceptions of heat transfer. This qualitative study used Vygotsky's (1987) theory of concept formation as a theoretical framework. Specifically, this framework has constructs suited to understand the differences in nature of the concepts constructed during K-12 science learning experiences and the socially sanctioned scientific knowledge. Data for the study included concepts maps, observation notes and transcriptions of participants conducting an experiment on transfer of heat, written lesson plans, drawings, and transcribed interviews. Analysis of data revealed that participants' explanations for transfer of heat were basically a mix of complexes, pseudoconcepts and spontaneous concepts. Implications include (1) the need to plan and implement purposefully selected science learning experiences for the topic transfer of heat to help inservice and future science teachers construct teaching strategies that will alleviate complexes, pseudoconcepts and spontaneous concepts prevalent in students' thinking about transfer of heat, and (2) the need to not only identify transfer of heat concepts as misconceptions and/or alternative conceptions but also to view misconceptions and alternative conceptions as complex manifestations like spontaneous concepts, complexes and pseudoconcepts which are part of the complex path towards concept formation.

Strand 8: In-service Science Teacher Education

Various Representations of Science in the Classroom

8:30am – 10:00am, Room 313

Presder: Wayne Breslyn, University of Maryland

Critical Analysis of a Science-IKS Classroom Discourse Relative to the Production of an African Staple Food

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Meshach B. Ogunniyi, University of the Western Cape

ABSTRACT: While several studies worldwide have shown that learners encounter great difficulties with many scientific concepts, only a few have been concerned with helping teachers to develop instructional approaches that can ameliorate such difficulties e.g. through co-constructing such concepts with their learners. In response to Learning Outcome 3 of the new South African curriculum calling for the integration of science and indigenous knowledge, the Science and Indigenous Knowledge Systems Project (SIKSP) at our University mounted a series of argumentation-based workshops to help teachers implement the new inclusive curriculum. This paper focuses specifically on how the workshops were used to assist 12 science teachers develop an understanding of how a staple African food known as gari (cassava) is prepared and produced. The workshops involved training in argumentation, collaborative laboratory activities and discussions in the co-construction of knowledge. The findings based on an analysis of the data derived from completed worksheets and audio/video recordings showed that the teachers found the new instructional approach to be informative and useful on how science and indigenous knowledge can be integrated in the preparation, production and preservation of gari. The implications of the findings for instructional practice are highlighted in the paper.

Tuesday, March 27, 2012

A Case-to-case Synthesis of a Longitudinal Project Exploring Language Strategies in Middle School Science

Christine D. Tippet, chris.tee@shaw.ca

Larry D. Yore, University of Victoria

ABSTRACT: Shifting perspectives towards science learning with texts as opposed to learning science from texts has necessitated the exploration of students' construction of representations of emerging ideas as a means of enhancing science understanding and examining aspects of students' representational competence such as conventions of scientific representation. This presentation reports on a secondary analysis (case-to-case synthesis) of four case studies of middle school students' and teachers' use of representations to improve science literacy. The synthesis identified five overarching themes: the engaging nature of multimodal approaches, opportunities for differentiated instruction, opportunities for assessment, an emphasis on visual representations in science instruction, and the robustness of literacy strategies. Some important considerations for future classroom-based research and for classroom instruction can be asserted. While most representation research has focused on cognition, it is clear that the affective and likely psychomotor domains should also be investigated. The assessment opportunities afforded by students' multimodal projects would be another fruitful area for further research. Classroom instruction that leads to enhanced science literacy for all students should include visual representations and is likely to require a multiliteracies approach because scientific communication as a multimodal process that involves reading, writing, speaking, listening, viewing, and representing.

Beginning Secondary Science Teachers and Their Use of Technology in the Classroom During Their First Two Years

EunJin Bang, Iowa State University, ejbang@iastate.edu

Julie A. Luft, The University of Georgia

ABSTRACT: This two-year study examined the technology uses of beginning secondary science teachers, and explored factors facilitating or inhibiting their uses of technology. The interviews and observations data from 115 teachers were collected and analyzed. The results show that teachers use PowerPoint the most, and other, sometimes non-proprietary educational software, the least. Also, induction treatments were not significant, except in their Internet use in Year 2. Teachers in the online mentoring program used technology the most, and teachers from the Intern group used it the least. Finally, gender and SES populations were significantly correlated with the use of technology. Yet, beginning science teacher's technology uses in this study are very limited, in that teachers used technology for assisting traditional teaching and learning -- not necessarily for reform-based teaching. This study strongly urges that the value of technology used in science classrooms should be redefined, to bring 21st century skills up to date as soon as possible.

Empowering Teachers through a Professional Learning Program that Focussed on a Representation Intensive Pedagogical Approach

Gail D. Chittleborough, Deakin University, gail.chittleborough@deakin.edu.au

Peter Hubber, Deakin University

ABSTRACT: A representation-intensive pedagogical approach challenges students to generate and negotiate the representations (text, graphs, models, diagrams) that constitute the discursive practices of science, rather than focusing on the text-based, definitional versions of concepts. It thus represents a more active view of knowledge than traditional structural approaches. Previous research conducted on a small scale, successfully demonstrated enhanced outcomes for students, in terms of sustained engagement with ideas, and quality learning, and for teachers enhanced pedagogical knowledge, and epistemological understanding. This paper explores the efficacy of embedding a representations-intensive pedagogical approach into a state-wide professional learning program that was delivered to secondary science teachers in 2010/2011. The professional learning program involved participating teachers undertaking two successive days of professional development, then completing a small classroom-based project in their schools before returning for the third day of professional development.

Tuesday, March 27, 2012

Strand 8: In-service Science Teacher Education

Teacher Conceptions of Physical and Earth and Space Science

8:30am – 10:00am, Room 106

Presder: Manuela Welzel-Breuer, University of Education Heidelberg

Where is Earth Science? Mining for Opportunities in Biology, Chemistry and Physics

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

Toni Ivey, Oklahoma State University

ABSTRACT: The Earth sciences are currently marginalized in K-12 classrooms. With few high schools offering Earth science courses, students' exposure to the Earth sciences relies on the teacher's ability to incorporate Earth science material into a biology, chemistry, or physics course. This NSF-funded summer workshop proved to increase teachers' geoscience interest and content knowledge and enhance teachers' ability to incorporate geoscience concepts into their biology, chemistry, or physics curricula. Participant teachers (N=7) included non-Earth science teachers from underrepresented groups and/or high schools with a high percentage of students from underrepresented groups. Participants' student enrollment ranged from 96 to 2,243 students where underrepresented students were classified as American Indian (ranging from 10-52 percent) and economically disadvantaged (ranging from 18-71 percent). A variety of quantitative measures and qualitative measures assessed changes in teachers' readiness and propensity for incorporating geoscience concepts into their current curricula. Findings are compelling though these results are based on a small sample of teachers. In light of current politics, where Earth science is largely disregarded professional development workshops like this one can help science teachers become knowledgeable enough to incorporate and expand on geosciences connections in biology, chemistry and physics.

Petrified Wood's Effectiveness as an Interdisciplinary Science Portal: A Research Investigation with Inservice Teachers

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James H. Wandersee, Louisiana State University

ABSTRACT: Earlier research affirmed petrified wood's effectiveness as an interdisciplinary portal in college science classrooms. This investigation extends earlier research and probes inservice teachers' content knowledge of petrified wood, and related concepts in fossilization, geologic time, and evolution. Teachers in the southern US who participated in science professional development programs (N=97) were surveyed using the previously validated instrument (PWS). Some teacher groups (N=39) participated in petrified wood/modern wood comparisons, and a laboratory investigation mimicking the petrification process. All inservice teachers performed significantly better on the PWS than earlier college student populations ($\alpha = 0.05$). However, inservice teachers also exhibited difficulties with geochemical concepts, similar to earlier student populations. Teachers in geosciences professional development exhibited slightly higher averages, but results were inconclusive. Content analysis of comments with the modern wood/petrified wood comparisons revealed stable themes including 1) sample similarities of tree rings and structure; 2) differences in density, composition, and texture; and 3) compositional differences of rock and cellulose. Teachers' comments also revealed several misconceptions. The petrification activity was affirmed as useful for demonstrating fossilization for K-12 classrooms, although some inaccuracies about actual processes may be conveyed to students. More research and activity refinement are needed for effective implementation.

The Development of Experienced 9th-Grade Physics Teachers' Knowledge for Using Representations to Teach Energy

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Mark J. Volkmann, University of Missouri

ABSTRACT: The purpose of this study was to explore and identify the experiences that informed the development of three experienced 9th grade physics teachers' PCK for using representations to teach the topics of energy transformation and transfer. The primary sources of data were observations of an entire unit of instruction on

Tuesday, March 27, 2012

energy and a series of four stimulated-recall interviews throughout the unit of instruction. The results of the phenomenographic analysis revealed that three types of experiences informed the development of the three participant's PCK for using representations to teach the energy topics. The three categories were: 1) teaching experience, 2) Physics First professional development, and 3) collaboration with colleagues. The analysis also revealed that as a result of engaging in the three types of experiences, the participants developed more integrated PCK for using representations in their instruction. The results of the study highlight that the development of integrated PCK for using representations to teach topics in energy is best supported through a combination of reflection on teaching experience, collaboration with colleagues, and professional development that provides topic-specific instruction in terms of content and pedagogy. These findings have implications for pre-service teacher preparation programs as well as in-service teacher professional development.

Effects of an Astronomy Science Summer Camp on Astronomy Content Knowledge of In-service Physics, Science and Elementary Teachers

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Ayhan Karaman, Canakkale Onsekiz Mart University

ABSTRACT: The purpose of the study was to investigate the impact of a seven days long intensive science summer camp on astronomy content knowledge of the practicing elementary, science and physics teachers. The camp program supported financially by the Scientific and Technological Research Council of Turkey was successfully completed with two different teacher groups in the consecutive years of 2010 and 2011. The number of teachers attended the camp from the different provinces of Turkey included fifty two teachers in 2011 and fifty teachers in 2010. The camp program offered to the participant teachers consisted of a range of rich experiences from theoretical lectures and sky observations to hands-on activities and group works. The data were collected using the earth and universe instrument (Trumper, 2006) delivered to the participant teachers at the beginning and end of the camp as pre and posttest. The analysis of the available data was performed utilizing paired samples t-test statistics. Results of the data analysis indicated that many teachers were able to improve their astronomy content knowledge in spite of the resistance presented by some teachers in changing their misconceptions.

Strand 10: Curriculum, Evaluation, and Assessment

Item and Instrumentation Studies

8:30am – 10:00am, Room 308

Presider: Ann W. Wright, Canisius College

Using Rasch Theory to Establish Construct-related Evidence for an Educational Assessment—Brief Electricity and Magnetism Assessment

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ABSTRACT: According to the Standards for Educational and Psychological Testing, an important requirement for large-scale educational assessments involves the establishment of construct-related evidence. In science education, a number of research-based assessments have been developed to either test students' understanding of focused topics (i.e. Force Concept Inventory) or survey their ideas about a broader content domain (i.e. Brief Electricity and Magnetism Assessment, or BEMA). In the case of the former, the construct-related information for a carefully-designed assessment often is readily available. As for the latter, however, it lacks clear evidence for what exactly an assessment actually measures, or demonstrable evidence on the construct validity of the assessment. In this paper, we investigate the construct validity of BEMA through Rasch modeling and factor analysis. Results from the Rasch estimated BEMA item difficulty, person-item map, and fit statistics show that BEMA items, albeit testing a variety of topics, form a cohesive construct. A scree plot from the factor analysis of BEMA data further confirms this finding.

Tuesday, March 27, 2012

Chemistry Concept Inventory: Is it Appropriate for Summative Assessment?

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

ABSTRACT: The Chemical Concepts Inventory (CCI) has been used for summative assessment, in addition to its original purpose to be used as a diagnostic test to reveal chemistry misconceptions held by students. This study evaluates the appropriateness of using the total raw scores or percentage scores of the CCI items for summative assessment. The CCI was administered to 443 10th and 11th graders who took the first chemistry course between Spring 2007 and Spring 2008 in two high schools in the northeast region of the United States. A Rasch analysis was performed and it was found that the CCI was not sufficiently unidimensional, thus would not be appropriate for uses as a summative assessment tool. Recommendations for further actions were discussed at the end of the article.

In Search of Instructional Sensitivity: The Measurement Problem in Large Scale Studies of Professional Development Programs

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 Kathleen J. Roth, BSCS
 Joseph A. Taylor, BSCS
 Nancy Landes, BSCS
 Molly Stuhlsatz, BSCS

ABSTRACT: There is a considerable and consistent push for large scale comparative studies of interventions in science education, and for studies of interventions at the teacher level to measure impacts at the student level. Such research designs present a significant measurement challenge – one that requires assessments to have additional properties related to instructional sensitivity that allow researchers to make informed and accurate decisions about program effectiveness, above and beyond commonly described empirical properties. It is one thing for a theory of change to describe how a change in instruction will impact student learning, it is quite another for professional development to result in a change in instruction, and for that to result in a difference in performance on student assessments. Using the example of a Scale-Up study of a yearlong professional development program, in this paper we present some approaches to addressing this challenge during instrument development and pilot testing. These approaches include rigorous alignment with program learning goals; subsets of items at different cognitive levels and distances from the intervention; pilot testing and item analysis using classical and Rasch techniques with an emphasis on measuring instructional sensitivity; and carefully monitoring of the alignment between the enacted and the intended curriculum.

An Analysis of Science Concept Inventories and Diagnostic Tests: Commonalities and Differences

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ABSTRACT: This research study was a literature review of thirty-four science concept inventories (CIs) and thirty-four diagnostic tests (DTs) to find commonalities and differences. Focusing mainly on emerging themes, the researcher examined the processes used in each instrument's development, the structuring of test items, and the methods used in the validation of those assessments. Results of the study showed that since the middle of the 1980's, science education has seen an increase in the development and use of this type of formative assessment on the college level. These two terms, CIs and DTs, are the new "buzz words" in educational assessment and are sometimes used interchangeability when in fact there are clear cut distinctions between the two.

Tuesday, March 27, 2012

Strand 11: Cultural, Social, and Gender Issues

Globalization and Neoliberal Ideology: Implications for Science Education

8:30am – 10:00am, Room 107

Presider: Matthew Weinstein, UW Tacoma Education Program

Western teachers of Science/Teachers of Western Science: Perceptions of the Western Science Teacher Abroad

Lydia E. Carol-Ann Burke, OISE, University of Toronto, carolann.burke@utoronto.ca

ABSTRACT: As contemporary science educators negotiate the realities of globalisation and the effects of increasing international migration of teachers and students, we use a critique based on post-colonial theory to make an analysis of perceptions of the power-knowledge and resistance-complicity dynamics at play when western expatriate science teachers are recruited into a post-colonial setting. By exploring intercultural challenges, foregrounding the teacher as the individual who is culturally displaced, we aim to provide a further strand to the literature that seeks to strategize ways to promote greater equity and efficacy in contemporary science classrooms. We have employed an adaptation of Stephenson's Q methodology, in combination with a semi-structured interview format, to gain insight into the ways that expatriate teachers, their employers and their students describe the significance of the western origin and scientific knowledge base of the expatriate teachers. The research findings reveal the limitations of students, teachers and administrators in their conceptualisation of the hegemonic potency of certain modes of knowledge transfer and lead us to propose a science curriculum interpretation that emphasises the historical and philosophical underpinnings of western modern science in twenty-first century classrooms.

Global Capitalism and Neoliberal Ideology in Science Education: Towards Fundamental Change

Jesse T. Bazzul, University of Toronto/OISE, jesse.bazzul@utoronto.ca

John L. Bencze, Ontario Institute for Studies in Education/University of Toronto

ABSTRACT: Recently the Journal of Research in Science Teaching (JARST) published a special issue dealing exclusively with issues of globalization and science education. While the JARST editors should be given due credit for opening up a diverse discussion science educators need to continue develop some of the debates, tensions, and realities exposed in the recent journal edition. This theoretical paper attempts to broaden particular tensions and ideas brought forth by Bencze & Carter (2011), and the subsequent commentary by Peter Fensham (2011). For those that see science education as no less immune to the profound cultural and societal changes caused by the spread of global capitalism and neoliberal ideology, further debate and discussion is vital. This paper maintains that: i) the theoretical framework for STEPWISE proposed by Bencze and Carter (2011) represents a viable model for a community centred science education already under the sway of neoliberal/capitalist ideologies ii) the realities of global capitalism, neoliberal ideology, and its effects on science education can be elucidated by looking more specifically at the nature of ideology and how neoliberal/capitalist/consumer subjects are formed through (science) education.

Examining Power and Accountability Issues in a U.S. STEM School

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ABSTRACT: In this case study of a U.S. STEM school, I examine the discourse of accountability to understand how its effects play out in the administration and curriculum in a school context separate from the mainstream accountability system. Using Michel Foucault's theory of power, I conduct a microanalysis of narratives constructed from interviews with school administrators, teachers, students, and a student's parent, and lesson observations to examine how different forms of accountability works through diverse mechanisms and instruments to control teachers, students, teaching, and learning. The findings show that institutional, professional, and personal accountabilities were enacted through hierarchical observations, normalizing views, examination, and/or simple tools. Accountability increased with deviancy of structures from normalcy. In addition, accountability was used to maintain institutional credential, it did not have accumulative effects, and it enabled and limited teachers' curriculum work. This findings suggest that accountability effects on specialized

Tuesday, March 27, 2012

schools, teachers, and students are different and perhaps, more insidious. Deeper insights into how specialized school teachers and students are held accountable to themselves, school, and community is illuminated.

Science, Science Education and the Politics of Neoliberal Exceptionality

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ABSTRACT: This paper reconceptualizes the meanings of equity and social justice given the neoliberal restructuring of the economy and culture. It traces the meanings of neoliberalism for public institutions and the practice of science drawing on the political writings of Naomi Klein, who examines the use of social and natural catastrophe to force privatization, and Giorgio Agamben, who notes that these catastrophes are also used to suspend democratic practices and produce disempowered populations that can literally be “disposed” of. The paper then examines the implications of these shifts for science education, using discourse analysis of policy and curriculum documents, to note that science has been repositioned to serve the ends of private enterprise and depreciate the commitment to equity and justice. Finally, the paper looks at attempts to push back in the science classroom, noting that such efforts focus science education on survival and resistance for those being targeted for disposal.

Strand 12: Educational Technology

Modeling and Model-Based Reasoning through Technology

8:30am – 10:00am, Room 101

Presider: Sandra T. Martell, University of Wisconsin-Milwaukee

Enhancing Engineering Education through Hands-On Models and Computer-Based Simulations

Amy R. Pallant, The Concord Consortium, apallant@concord.org

Rachel E. Kay, The Concord Consortium

Charles Xie, The Concord Consortium

ABSTRACT: Engineering education has become an integral part of K-12 education. The National Resource Council has recently released a science framework that emphasizes the connectedness between engineering skills and science knowledge (NRC, 2011). Engineering education in high schools can benefit from integrating science and engineering into a design-based framework. Incorporating simulations into this framework has the potential to enhance it, as they provide powerful problem-solving tools—in addition to the hands-on tools—that can compensate for time, material, safety and environmental constraints. The Enhancing Engineering Education (EEE) project has developed two parallel curricula in order to explore how simulations enhance student learning in the context of creating energy efficient model houses. One curriculum uses hands-on experiments in which students manipulate physical materials and temperature sensors to examine heat transfer concepts and then apply these concepts to building their own energy-efficient model houses. The second curriculum uses Energy 2D, computer simulations developed at the Concord Consortium, in which students manipulate variables to explore the same heat transfer concepts, and then use Energy 3D, an additional model software, to help design and build their energy-efficient house. In this study we investigated how aspects of each program relate to students’ understanding and coordination of science and engineering principles. The program was implemented initially in the Spring, 2011 and is continuing into the 2011-2012 school year. Specifically, we aim to present how student reasoning differs when learning with simulations versus hands-on exploration, and examine particular strength of each curriculum.

A Study on Enhancing the Thought Experiment in Modeling-based Science Teaching to Improve the Learning Effect

Jen-Chin Lin, jclin@nknuc.nknu.edu.tw

ABSTRACT: The purpose of this research is to improve the effect of inquiry learning with the MCSI(modeling-based computer simulation inquiry) teaching mode and enhance the thought experiment. The isPM(Integration Simulation Pendulum Modeling) computer software system and tools of TE(thought experiment) aimed to promote students’ thought experiment and enable students’ empirical test. This research used the quasi-experiment design and the participants of this research were junior high school students (in ninth grade). There

Tuesday, March 27, 2012

were three groups, including 37 students who were taught with MCSI+TE teaching mode, 25 students who were taught with the MCSI teaching mode, and 34 students who were taught with general inquiry teaching mode. The learning effect was evaluated with the investigation composed of four aspects. The result of this research indicated that the performance of the groups taught with MCSI+TE and MCSI mode were obviously better than the performance of the group taught with the general inquiry mode in whole aspects. Although the MCSI+TE and MCSI modes had the similar teaching effect, the MCSI+TE was better than MCSI teaching mode on the aspect of “model application” that was the high-level cognitive learning.

Evaluation of an Ecological Niche Modeling Tool for Climate Change Education

Vanessa L. Peters, University of Michigan, vlpeters@umich.edu

Nancy B. Songer, The University of Michigan

ABSTRACT: We report the results of a two-part usability test of an ecological niche modeling tool designed for a curricular unit on global climate change. Twenty-two students from an inner city middle school participated in the study. Data were drawn from both qualitative and quantitative sources. Screencasting software recorded students' mouse and keyboard movements and time-on-task during collaborative think-alouds, while video recordings provided insight into the specific challenges students faced while working on activities with the modeling tool. The findings revealed that students spent only a small percentage of their total computer time on relevant activities. In addition, the findings showed that students were challenged not only by the usability of the technology, but also by the representation of content within the technology. The implications of this study for computer-supported science education are discussed.

Strand 13: History, Philosophy, and Sociology of Science

Symposium - How can Science Educators Improve Evolution Education in America and the World?

8:30am – 10:00am, Room 102

President: Leonard Bloch, UGA

Presenters:

Charles Allen, Grace Unlimited Butler University Indiana University- Purdue

Warren D. Allmon, Cornell University

Barbara A. Crawford, Cornell University

Jeremy Peacock, Monroe Area High School

Mike U. Smith, Mercer University

ABSTRACT: Evolution explains the unity and the diversity of life. It explains the amazing intricacy of life processes, and the imperfections that plague all living things. It explains how species change over time, and it explains why some species appear stable for millions or even billions of years. As powerful as evolutionary theory has been in helping us understand life, accelerating developments in biotechnology and computer technology mean that future citizens of the world will need to be fluent in evolutionary theory if they are to understand and influence developments in science and technology. Unfortunately, many people, especially in the United States and the Middle East, are not learning the basics of evolutionary theory in school. In this symposium, we will talk with a broad range of speakers including three educational researchers, a teacher, a biologist and museum director, and a member of the clergy about what we can do, as NARST members to improve Evolution Education in America and the world.

Strand 14: Environmental Education

Environmental Education in Practice

8:30am – 10:00am, Room 103

Field-based Geoscience Education for Students with Physical Disabilities

Christopher Atchison, Georgia State University, catchison@gsu.edu

Tuesday, March 27, 2012

ABSTRACT: Opportunities of experiential education should not be limited to students who are physically able to perform hands-on, instructional activities. In the geosciences, most traditional field-based learning experiences are held in environments that are typically inaccessible to students with mobility impairments. As part of this study, students with mobility impairments learned about geologic processes in a classroom setting and then participated in a field-based learning experience relative to those processes. A primary objective of the study was to determine how first-hand experience in a geologic field environment assists in the overall construction of content knowledge for these students. An evaluation of the field experience required an understanding of internal and external barriers to learning, and how these students interact with the environment in the midst of those barriers. This study was accomplished through six individual case studies of the students' lived experience. This presentation will discuss a study of accessibility, inclusion, and accommodation for students with mobility impairments in a field-based geology course. Based on an identified need to accommodate current instructional practices that will include students with mobility impairments, this presentation will discuss internal and external barriers derived from the perspective of the students' first-hand experiences during the study.

A Longitudinal Study of Environmental and Outdoor Education: A Cultural Change

Tali Tal, Technion, rtal@cc.technion.ac.il

Orly Morag, Technion

ABSTRACT: In this case-study, we continue a longitudinal study of one elementary (grades 1-6) school's environmental education (EE) and field trip program. The school, which was known for its school-based EE curriculum that encompasses an intensive outdoor-education component, has gone through changes in the staff, and the student population. Our study aimed at understanding the current challenges of the school outdoor education, in light of its two decade tradition of environmental and outdoor education school based curriculum. We observed three field trips and interviewed the principal, teachers and students. Our analysis indicated the following challenges: the place of the school's tradition in light of current staff, challenges and agenda; power struggle between the EE coordinator and the newer teachers in school; the separation between the EE program that was an integrative holistic program in the past, and the other fields taught in school. In conclusion, we argue that the main issue is the change in the school culture that reflects the changes the community went through. We suggest that the school should examine old assumptions and revise its EE curriculum in light of changes in the school social and physical environment and in accordance to development in the field of EE.

Environmental Science Education in K-12 School Programs: Recent Research

Elizabeth Hufnagel, The Pennsylvania State University, exh5064@psu.edu

William S. Carlsen, The Pennsylvania State University

Gregory J. Kelly, The Pennsylvania State University

ABSTRACT: The purpose of this paper is to review trends in empirical environmental science education (ESE) research conducted in K-12 school settings in the period 2005-2011. From a set of 70 publications, which we located using specific search criteria explained in the paper, we identified common themes regarding (a) conceptions of learning, (b) how the subject matter is defined, (c) research methods and methodologies, and (d) future visions of how learners apply environmental understandings. Using these themes as a framework, we discuss how a potential dualism, defining features of ESE, and research mechanisms can hinder the influence of ESE on science education. Throughout this critical review of the literature, we consider how ESE research relates to research in other K-12 science subjects, and discuss implications of ESE research for the teaching of science and other school subjects.

Student Science Achievement and the Integration of Indigenous Knowledge in the Classroom and on Standardized Tests

Juliann Benson, University of New Hampshire, juliann.benson@wildcats.unh.edu

Eleanor D. Abrams, University of New Hampshire

ABSTRACT: In science education there has been an increased amount of research investigating the impact of culturally relevant curriculum adaptations on Indigenous students' achievement in standardized assessments.

Tuesday, March 27, 2012

However, little research has focused on Indigenous students' achievement on science standardized tests when Indigenous knowledge is integrated into the test questions. The present study focuses on how American Indian students in Montana perform on standardized state science assessments when knowledge from a cultural curriculum, "Indian Education for All", has been included on these tests. Montana is the first state in the U.S. to use a culturally relevant curriculum in all schools as well as incorporating this curriculum into a portion of the standardized test items. This study compares White and American Indian student test scores on these particular test items to determine the effectiveness of the culturally relevant educational initiatives implemented by Montana's Office of Public Instruction in terms of student achievement on state standardized tests. Understanding the connections between student achievement and an adapted culturally relevant science curriculum brings valuable insights to the fields of science education, research on student assessments, and Indigenous studies.

Co-Sponsored Session - Strand 14: Environmental Education & Strand 15: Policy

Strand Sponsored Session - Science Education and Climate Change: Policy in K-12 Education in Diverse Global Contexts

8:30am – 10:00am, Room 303

Presider: Sarah J. Carrier,

Presenters:

Charles W. Anderson, Michigan State University

J. Randy McGinnis, University of Maryland

Teddie Phillipson Mower, University of Louisville

Elly Walsh, University of Washington

Chris McDonald, University of Maryland

ABSTRACT: In line with the conference theme of "Re-Imagining Research in 21st Century Science Education for a Diverse Global Community," this special symposium will examine challenges and progress in policy for climate change education around the world. For example in the United States, as science teaching and learning policy is being made is in the No Child Left Inside Legislation and work being done by the National Council for Science and the Environment (and more specifically the Council for Environmental Deans and Directors), we would like to ask why there are few representatives from education on these boards (NCSE) and organizations (CEDD). We will also consider talking about policy in K-12, pre-service/inservice training, other post secondary education, and community EE.

Strand 15: Policy

Globalization of Science Reforms

8:30am – 10:00am, Room 104

Presider: Gavin W. Fulmer, National Science Foundation

Consequences of the Globalization of Science Testing: A European Case Study

Jens Dolin, University of Copenhagen, dolin@ind.ku.dk

Robert H. Evans, University of Copenhagen

Lars B. Krogh, Aarhus University

ABSTRACT: This study examines the consequences of the uses by teachers and policy makers of the large scale test results from PISA in a European case study context. A systematic analysis looks at influences both on teachers and teaching as well as at educational systems at the national level. Comparisons are made between the degree to which the PISA science assessment framework and test system are in accordance with the educational goals in science for a representative group of European countries. The consequences of this alignment and therefore the relevance of PISA results as a catalyst for the educational actions taken are discussed. Research questions were examined through analytical comparison of goal categories, content, contexts and priorities; concept maps of national statements of scientific literacy (SL) and PISA SL; interviews in each country; an in-depth look at one

Tuesday, March 27, 2012

country using a survey of a representative sample of science teachers (N=1159) and a re-assessment of PISA results. Findings showed large differences in national statements of scientific literacy and that PISA's paper-and-pencil format was not able to capture all aspects of knowledge that its scales credit. However, implied hypotheses as to the negative effects of unfamiliar test protocols on PISA results were unsubstantiated.

There's More to Science than Recall: An Analysis

Anna MacPherson, Stanford University, annamac@stanford.edu

Jonathan F. Osborne, Stanford University

ABSTRACT: Researchers and practitioners frequently lament that state science tests emphasize basic recall at the expense of higher order thinking. However, there are few examples of systematic analyses of such tests. Therefore, in this paper we report an analysis of items released from the Grade 8 California Standards Test (CST) in Science to determine the extent to which the test emphasizes recall of declarative knowledge. In addition the analysis was also conducted of NAEP and PISA items to determine the degree of alignment between state, national, and international assessments of science achievement. We found that, compared with NAEP and PISA, the Grade 8 Science CST over-emphasizes recall of declarative knowledge. This work adds to our understanding of the intersection between grand visions, policies, assessment programs and practices in science education by examining the reality of what is assessed. In particular, it offers insight into the way in which educational values might be communicated to classroom teachers via the format of assessment items.

A Country Specific Insights into the Impact of International Comparative Studies on Educational Reforms

Imbi Henno, Tallinn University, imbi.henno@tlu.ee

Priit Reiska, Tallinn University

ABSTRACT: The purpose of this study was to give an input on national curriculum development and examine the Estonian students' science achievement trends in PISA surveys and differences of ethnically different students' attitudes in PISA 2006. For analyzing students' attitudinal responses in PISA 2006 the students were categorized into three groups: students with a high, a moderate and with a low level of proficiency. The strongest correlations were between science achievement and indices: self-efficacy, general value of science and an index of economic, social and cultural status (ESCS) in both language groups. The self-efficacy and ESCS were important predictors of science achievement for high performing students from Russian language instruction schools. The measures: self-efficacy, self-concept, personal value of science, and ESCS were predictors of the science achievement for high performing students from Estonian language instruction schools. For moderate performing students from Russian language instruction schools, ESCS was not factors related to the science achievement. The future-oriented motivation was higher in the Russian language instruction school. The results reveal that the students' performance and attitudinal differences are not due to the language problems or immigrant status, but rather connected with classroom level instructional approaches and learning culture.

Science Curriculum Policy-making in Ontario: Global Influences, Localized Political and Economic Landscapes and Curriculum Reform

Marietta Bloch, Roehampton University, mars_bloch@edu.yorku.ca

ABSTRACT: This paper discusses a qualitative study on how global and local influences impacted science curriculum policy-making by Ontario governments since 1985. As there is no tradition of policy studies in science education research (Fensham, 2008; DeBoer, 2011), this paper outlines my interpretation of the intersection of science education research and education policy studies. A policy cycle approach (Bowe, Ball and Gold, 1992) was used to examine the contexts of influence, policy text production and practice within each government time period and to examine trends and patterns across governments. Findings indicate that the interplay of political and the economic landscapes were a significant factor for governments in reforming curricula as a means to compete in an increasingly globalised world. A demand for more accountability resulted in curriculum documents detailing specific knowledge and skills that have become part of Ontario's 'audit culture' (Power, 1997). Although the structure, format and presentation of the documents have differed across governments, much of the content

Tuesday, March 27, 2012

reflects Cuban's (1992) notion of the 'historical curriculum' (p.223) in that each curriculum continued to exert influence on successive curricula.

Plenary Session #2

Student Diversity and Science Education Research in a Global Context: Research Agenda and the Role of NARST

10:30am – 12:00pm, White River Ballroom A – E

President: Sharon Lynch, George Washington University

Keynote Presenter: Okhee Lee-Salwen, New York University

ABSTRACT: As human migration patterns around the world have made student diversity a global phenomenon, science education for student diversity has become synonymous with science education for all. This presentation consists of four parts. The presentation will start with a brief description of changing demographics among K-12 students and achievement gaps by demographic subgroups in science education within the U.S. and internationally. Then, major theoretical frameworks guiding the research on diversity and equity in science education, along with key findings and insights for effective classroom practices, will be presented. Next, the National Research Council (2011) document, "A Framework for K-12 science education," that is guiding the development of Next Generation Science Standards will be discussed with a focus on both challenges and opportunities for diverse student groups. Finally, the presentation will conclude with thoughts about research agenda and the role that NARST can play to promote science achievement of all students within the U.S. and internationally.

Tuesday, March 27, 2012

International Sponsored Session

Symposium - Linking Science Educators Program in Rwanda: Supporting Learner-Centered Approaches in Rwandan Science Classrooms

2:15pm – 3:45pm, Room 313

Presider: Sibel Erduran, University of Bristol

Presenters:

Sibel Erduran, University of Bristol, sibel.erduran@bristol.ac.uk

Paul Denley, University of Bath, UK

Alphonse Uworwabayeho, Kigali Institute of Education, Rwanda

Mengesha Ayene, Bahir Dar University, Ethiopia

ABSTRACT:

Strand 1: Science Learning, Understanding and Conceptual Change

Related Paper Set - Learning about Ecosystems: Conceptualizing and Designing Learning Environments

2:15pm – 3:45pm, Room 310

Presider: Catherine Eberbach, Rutgers University

ABSTRACT: In recent years, new conceptual frameworks and approaches have provided productive lenses for developing deeper understanding of how students learn about complex phenomena such as ecosystems. Such frameworks have informed the design of new learning environments. In this session, we examine an array of approaches for providing learners with opportunities to engage with ecosystems phenomena for the purpose of exploring: 1) their potential for scaffolding deep understanding of ecosystems, 2) their contributions to the design of learning environments, and 3) their connections to science practices. Why focus on ecosystems? Complex, emergent, and dynamic, ecosystems are particularly challenging for learners to understand. Often, learners focus on surface, immediately present features and behaviors. They may fail to think about underlying causal mechanisms, especially those that are not readily available to unaided perception. Yet, the ability to navigate and reason about complex phenomena is increasingly central to scientific literacy (Sabelli, 2006).

Causal Tensions in Reasoning about Ecosystems Dynamics: A Theoretical Analysis of Supportive Instructional Contexts

Tina Grotzer, Harvard University, Tina_Grotzer@pz.harvard.edu

Shane Tutwiler, Harvard University

Fostering and Assessing Model-Based Learning with SimScientists Ecosystems

Barbara C. Buckley, WestEd, bbuckle@wested.org

Edys Quellmalz, WestEd

Matthew Silbergliitt, WestEd

Structure, Behavior, and Function: A Lens for Observing Complex Ecosystem Relations

Cindy E. Hmelo-Silver, Rutgers University, cindy.hmelo-silver@gse.rutgers.edu

Catherine Eberbach, Rutgers University

Rebecca Jordan, Rutgers University

Ashok Goel, Georgia Institute of Technology

Engaging Students in Modeling to Develop Understanding of Ecosystems

Michelle Cotterman, Vanderbilt University, michelle.e.cotterman@vanderbilt.edu

Eve I. Manz, Vanderbilt University

Richard Lehrer, Vanderbilt University

Leona Schauble, Vanderbilt University/Peabody College

Deborah Lucas, Vanderbilt University/Peabody College

Mayumi Shinohara, Vanderbilt University/Peabody College

Tuesday, March 27, 2012

Strand 2: Science Learning: Contexts, Characteristics and Interactions

Attitudes and Identities

2:15pm – 3:45pm, Room 302

Presider: Lynn D. Dierking, Oregon State University

Are Undergraduates' Attitudes toward Science Affected by Epistemological Beliefs?

Gavin W. Fulmer, National Science Foundation, gfulmer@nsf.gov

ABSTRACT: Prior study has examined the role of epistemological beliefs on students' reasoning about science phenomena, as well as its influence on other aspects of daily life outside of school settings. However, no prior research has explored how epistemology may relate to students' attitudes toward science. This study explored the relationship of epistemological beliefs to attitudes in a sample of university undergraduate students. Existing attitude and epistemological instruments were used, and subscales created using the Rasch measurement model. The findings indicate that students' attitudes are related to their perception of science as inclusive, the belief that knowledge is uncertain, and the belief that scientific knowledge is incommensurate with religious knowledge. Women had less positive attitudes to science than did men, but there were not significant interactions with epistemic beliefs. The paper describes directions for future research on possible causal relationships among these variables and on pedagogy to help raise students' attitudes toward science.

Place and the Structuring of Science Identities in a Science Center

Jennifer D. Adams, Brooklyn College, jdadams215@gmail.com

Preeti Gupta, New York Hall of Science

ABSTRACT: Science education research often points to the disconnection between school science and students' day-to-day lived experiences as reasons for a lack of interest in science. However many of these same youth experience success in science in out-of-school settings. This study is part of a larger study with an overall research question: in what ways does working in a science center support developing one's identity around science? Specifically, we examine how a science "place" structures youth science-related identities and the youth in turn structure the science learning enacted in that place. We define a science person as a person who likes science, can articulate that she views science as part of her everyday life and is excited by the role science plays in society. The analysis from this study demonstrates that students develop place-related identities around science that are enacted in ways that are specific to their roles in the science center. That identity can be evoked in school and other settings when the environment resonates with what the student experienced when developing that identity. We will further discuss the research and findings as relevant to creating spaces in formal and informal settings that allow youth to build positive science identities.

An Ethnographic Analysis of How Students' Perceived Identities Shape Science Classroom Discourse

Minjung Ryu, University of Maryland, College Park, mryu@umd.edu

Tiffany-Rose Sikorski, University of Maryland, College Park

ABSTRACT: Discursive participation is essential in science classrooms in which students articulate their reasoning with appropriate evidence, listen to and evaluate each other's ideas, and construct knowledge. Classroom discourse, however, is not a merely cognitive endeavor, but also involves social dimensions of interpersonal interactions. In this study, we present an analysis of a ten-minute-long classroom discourse from a high school Advanced Placement Biology class. Findings show how one student's ideas about evolution are not taken seriously by classmates. We argue that these interactional dynamics are mainly attributable to the student's identity as religious and disabled, rather than to classmates' assessment of the quality of his ideas. We discuss the implication of these findings in terms of complexity in science classroom discursive practices.

Development and Validation of an Instrument to Assess Precollege Arabic Speaking Students' Attitudes toward Science

Ryan Summers, University of Illinois at Urbana-Champaign, summers4@illinois.edu

Tuesday, March 27, 2012

Fouad Abd-El-Khalick, University of Illinois at Urbana-Champaign
 Ziad Said, College of the North Atlantic
 Heather Freissen, College of the North Atlantic
 Michael Culbertson, University of Illinois at Urbana-Champaign

ABSTRACT: This study reports on the development and 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 (grade 3 through 12) Qatari students’ interest in, and attitudes toward, science. The development was primarily motivated by the fact that no instruments have been specifically designed and systematically validated for use with Arabic speaking students. Additionally, most extant instruments were developed for use with a specific grade or school level, and many lacked grounding in a robust theoretical framework. ASSASS was grounded in the most recent revision of the theories of reasoned action and planned behavior. A 10-member international panel of science educators and education researchers reviewed an initial pool of 74 items, which were aligned with the theoretical framework. The resulting revised pool of 60 items was piloted with a representative sample of 396 grades 3 through 12 Qatari students. Survey administration was followed by individual interviews with a 10% random sample of students. Confirmatory factor analysis suggested an initial item clustering that resembled ASSASS’s theoretical domains. The model had a reasonably good fit with a Root Mean Square Error of Approximation (RMSEA) at .052.

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

2:15pm – 3:45pm, Room 301

Presider: Carolyn S. Wallace, Indiana State University

Fostering Teachers’ Curricular Knowledge and Curriculum Design Capabilities About Modeling-Centered Scientific Inquiry

Marios Papaevripidou, University of Cyprus, mpapa@ucy.ac.cy
 C. P. Constantinou, University of Cyprus
 Zacharias C. Zacharia, University of Cyprus

ABSTRACT: The purpose of this study was to examine the influence of a professional development course on the development of teachers’ curricular knowledge about Modeling-Centered Scientific Inquiry (MCSI) and curriculum design capabilities. The participants were twenty teachers enrolled in 13 three-hour sessions of a course about MCSI. The course was organized in two phases. During Phase 1, the teachers as learners were engaged in multiple cycles of model development and deployment of collision phenomena. During Phase 2, the teachers shifted from learners to thinkers of the underlying design principles of curricula that were grounded on the MCSI perspective, and were also asked to re-design an existing unit from their science curriculum to foster the development of understanding of the unit’s concepts through a MCSI approach. Teachers’ responses to a written pre/post questionnaire about their views of modeling as both a learning process and a teaching approach, and their own created curriculum designs served as data sources for evaluating their informed understandings about the design principles of MCSI instruction. Findings revealed that the participants expanded their curricular knowledge about MCSI and, at the same time, efficiently transformed this knowledge for the purposes of the design of their own MCSI curriculum.

Preservice Elementary Teachers’ and Mentors’ Evidence Based Reflection Using a Web-Based Video Analysis Tool (VAT)

Eulsun Seung, Indiana State University, esseung@gmail.com
 Soonhye Park, University of Iowa

ABSTRACT: Evidence-based reflection was proposed as an effective tool for stimulating self-reflection and collaborative reflection between experts and novices in mentoring. In this study, we explored preservice elementary teachers’ and their mentors’ use of evidence to reflect upon teaching practice in terms of inquiry-

Tuesday, March 27, 2012

based science teaching. Specifically, we explored what evidence preservice teachers select to reflect on during their teaching practice and how their evidence selection differs from that of their mentors and science educators. A web-based video analysis tool (VAT) system was used to support preservice teachers' evidence based self reflection and cooperative reflection with their mentors during field experience. Data analysis showed that even though the preservice teachers had an opportunity to discuss features of inquiry science teaching in the science methods class, not all the features were practiced in their actual teaching. More so than their mentors, preservice teachers perceived that their classes were more inquiry-based. In addition, both the preservice teachers and mentors either tended to interpret each feature too broadly or misunderstood it. They also tended to have a teacher-centered view by focusing on the attempts of teachers rather than student performance. This study has implications for elementary science teacher education, particularly regarding the encouragement of elementary preservice teachers' understanding of inquiry science teaching by encouraging evidence-based reflection. Evidence-based reflection provides a good opportunity for a preservice teacher's self reflection. By finding evidence that represents each feature of inquiry science teaching, preservice teachers can evaluate whether their lessons are inquiry-based.

Elementary Teachers' Enactment of Science Curriculum Materials: Investigating Early Learners' Engagement in Scientific Practices

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

Mandy Biggers, University of Iowa

Laura Zangori, University of Iowa

ABSTRACT: We employ a newly-developed observation protocol, the Practices of Science Observation Protocol (P-SOP), to investigate essential characteristics of scientific practices in which early learners engage in elementary classrooms. This research is part of a multi-year professional development program designed to support elementary teachers (K-6) in a large, urban school district to learn to better engage students in scientific practices. Project teachers videorecorded enacted science lessons (n=124) which were used as data. Findings illustrate essential features of scientific inquiry and scientific practices observed in elementary classrooms, as well as establish the P-SOP as a valid and reliable observation protocol. These findings have important implications for the design of elementary science learning environments and associated research and development efforts in the field.

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

Assessment and Review Strategies

2:15pm – 3:45pm, Room 303

Presenter: J. Steve Oliver, The University of Georgia

Analyzing Biology Teachers' Pedagogical Content Knowledge and Content Knowledge by Using a Paper and Pencil Test

Melanie Jüttner, Biology Education, University of Munich, melanie.juettner@lrz.uni-muenchen.de

Birgit Jana Neuhaus, Biology Education, University of Munich

ABSTRACT: Due to the lack of direct measurement instruments for science teachers' professional knowledge the project ProwiN - a cooperation of the University of Munich, of Duisburg-Essen and of Bochum, granted by the Federal Ministry of Education - exposes three dimensions of science teachers' professional knowledge in two German federal states. The theoretical conceptualization of biology teachers' professional knowledge, the development of items as well as the results of the study about content knowledge (CK) and pedagogical content knowledge (PCK) of biology teachers will be focused. The theoretical structure of PCK-items will exemplarily be demonstrated by a new approach for developing PCK-items by using empirically analyzed students' errors (N = 461). The PCK- and CK-test were given to biology teachers (N = 158) and analyzed concerning test criteria by using the partial credit model (Winsteps). The tests showed a satisfactory model-fit and items reliability. Additional validation studies of the measurement instruments by using think-aloud interviews (N = 5) and comparing contrast groups (biologists and psychologists) will be reported as well. In the future, the combination of students'

Tuesday, March 27, 2012

achievement tests and teachers' PCK- and CK-tests could be compared to analyze correlations and the influence of teachers' knowledge on their students' learning outcome.

Developing an Instrument to Examine the Relationship between Pedagogical Content Knowledge and Science Teaching Orientations

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

ABSTRACT: Although there are numerous pedagogical content knowledge (PCK) studies in science education, little attention has been paid to the link between PCK components and different types of orientations to science teaching (OST). According to the model of Magnusson, Krajcik and Borko (1999), an instrument was developed with satisfactory content and construct validity in this study. This study chose sampling represented 220 middle science teachers from northern, central, southern, and eastern Taiwan. It was found the didactic orientation was the most commonly used methods of science teaching in Taiwanese middle schools. According to the Pearson correlation analysis, it was found that the didactic orientation was positively connected with Knowledge of Instructional Strategies (KIS), whereas the academic rigor orientation was negatively related to KIS. With particular respect to student-centered orientations, the project-based science orientation and the guided inquiry orientation were all positively correlated with Knowledge of science curricula (KSC), Knowledge of Students' Understanding of Science (KSUS), KIS, and Knowledge of Assessment of Scientific Literacy (KASL). Further, it was demonstrated that the KASL could play the most important role in nine types of orientations to science teaching. Research implications of this study are provided along with suggestions for future research.

Exploring the Potentials and Challenges of Integrating Formative Assessment in Examination-Oriented Science Classrooms

Xinying Yin, Indiana University, yinx@indiana.edu

Gayle A. Buck, Indiana University

ABSTRACT: Formative assessment provides a means to successfully scaffold learning. However, under the pressure of high-stakes exams, transmission styles of teaching are persistent in *** (possessive form of the country' name) high school science classes. The purpose of our collaborative action research study was to explore the potentials and challenges of integrating formative assessment into the high-stakes context and large classroom sizes inherent in *** high schools. Over the course of this study, we worked together with a secondary science teacher to integrate formative assessment into his teaching. The subsequent findings of our study revealed that as the teacher allowed his original views about students' learning and assessment tasks to be challenged by the students' learning, his teaching practice and understandings of formative assessment were transformed. Students' learning experience was also explored in the formative assessment process. The findings from this study suggests that formative assessment can be implemented in *** high school science classrooms to enhance students' learning and meet the imperative needs for high-stakes exam preparation. In addition, formative assessment is a potential breakthrough point to change behaviorist-based instruction towards constructivist-based instruction. This study has implications for teacher professional development in integrating formative assessment to enhance students' science learning.

Facet-based Assessment of Teacher Knowledge and Skills of Formative Assessment

Jim Minstrell, FACET Innovations, JimMinstrell@FACETInnovations.com

Min Li, University of Washington

Ruth A. Anderson, FACET Innovations, LLC

ABSTRACT: While formative assessment (FA) has been shown to be effective in promoting student learning, teachers have difficulty enacting it in an effective way. Typically when teachers do implement formative assessment, it focuses on whether students "got it" or not, then whether the teacher feels she/he can move on or re-teach. Teachers who are getting better results in student learning are collecting information intentionally, interpreting responses for strengths, weaknesses and to determine learner needs, and designing actions that address student needs. This project developed pen and paper tasks to assess teachers' knowledge and skills at anticipating student ideas and interpreting responses to identify learning needs and design actions that address

Tuesday, March 27, 2012

the needs and promote deeper learning. The tasks were validated by experts and tested through open response by teachers and through thinkalouds. Four facet clusters were developed to help researchers and professional developers interpret actions by teachers in order to give teachers formative feedback about their knowledge and actions. Reliability of the interpretive clusters was tested against interpretations from video observations of the same teachers. These tasks and interpretive clusters of ranked typical responses are being used and tested for effectiveness in promoting teacher reflection and improvement in practices of professional development.

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

The Impact of Research Experiences

2:15pm – 3:45pm, Room 304

Presider: Ann W. Wright, Canisius College

Learning to do Research in a Research Experience for Undergraduates (REU) Program

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

Dilek Ozalp, University of South University

ABSTRACT: In this paper we report on a two-year study of a National Science Foundation (NSF) funded Research Experiences for Undergraduates (REU) program. The purpose of our study was to understand what undergraduates learn about doing research and how they learn it while participating in a research experience in a Research Intensive university in the southeast US. Twenty-one students were recruited from universities and colleges throughout the US, including territories in the Caribbean. They were placed in research groups led by professors in engineering and public health. The REU program lasted for 10-weeks during the summer. We found that the students learned research skills, but not the ones needed to be independent researchers. We also found that almost all their learning occurred as part of apprenticeship activities structured and facilitated by professors within the research groups. In addition, the ways the research groups were organized and the level of involvement of the professors in the education of the undergraduates affected how much they learned about doing research. Our paper includes implications for providing teachers with the knowledge and skills needed for them to teach their students how to engage in authentic scientific research practices.

How do Summer Undergraduate Research Experiences Compare to Other Models?

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Ann Bessenbacher, Purdue University

Loran Carleton Parker, Purdue University

Amy C. Childress, Purdue University

Lisa P. Kirkham, Purdue University

Dorothy Teegarden, Purdue University

Wilella D. Burgess, Purdue University

ABSTRACT: Undergraduate research experiences (UREs) have been shown to be effective in recruiting, retaining and graduating students, especially underrepresented minorities, in science, technology, engineering and mathematics (STEM) majors. A variety of URE program models exist across American colleges and universities. Despite the wide range of URE models, current URE research and evaluation rarely considers differences in models when examining student experiences and outcomes in research programs. The goal of the current paper is to compare the impact of URE structure on student outcomes. The study uses a nonequivalent pre-post control group design to compare program outcomes among four models of URE participation: summer term, single academic semester, two academic semesters, and full academic year. The analyses revealed no significant group differences in program outcomes between summer and single semester participants. However, compared to the summer group, students that participated for two academic semesters reported higher gains in awareness of available research career opportunities and writing research papers for publications. Similarly, participants in yearlong experiences reported higher gains than the summer participants in research skills, understanding of

Tuesday, March 27, 2012

research procedures, and awareness of available research career opportunities and awareness of specialized research career options. The implications and limitations of the study are discussed.

A Longitudinal Study of how Graduate Students in Field Ecology Acquire Research Expertise

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Jeff Dodick, The Hebrew University of Jerusalem, Israel

ABSTRACT: In recent years expertise studies have focused on graduate student learning in lab-based sciences. In this paper, however, we analyze graduate student learning in the field-based science of ecology. Using a qualitative approach, we longitudinally tracked both the students' challenges and coping strategies during their initial two-year research period. Concerning challenges the M.Sc. students had difficulties with independent decision-making and were most concerned with practical application of field methods, as well as the role of environmental conditions. In contrast, Ph.D. candidates were more independent and showed more concern with theoretical issues, most notably the "variance" of the field. Regarding coping strategies, the M.Sc. students are strongly dependent on their written protocols (i.e., protocol-dominated) to guide their research. In opposition, Ph.D. students are more flexible in responding to the field and by the end of their second research year are "field-dominated". These overall differences are derived from both previous research experience and the fact that the advisor usually provides her M.Sc students with their initial protocol. This work is significant because by understanding challenges and coping strategies in field ecology, we can improve how novice grad students acquire expertise, as well as how they are guided by their advisors.

The Impact of a Summer Research Program on Rising College Freshmens' Integration Into a Science Community of Practice

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Jennifer H. Forrester, The University of Wyoming

Penny Shumaker Jeffrey, North Carolina State University

ABSTRACT: Opportunities for undergraduates to participate in authentic research projects in university science and engineering laboratories are becoming more commonplace. Students in Science, Technology, Engineering, and Mathematics (STEM) fields are reporting participation rates in some form of approximately 53%. Despite the prevalence of undergraduate research participation little is known about the efficacy of these programs in achieving desired student learning outcomes due to evaluative research being methodologically weak or limited in scope. Typical learning objectives for these programs revolve around integrating students into a community of practice through learning science content in context, gaining science process skills, and practicing scientific habits of mind. The goal of this study was to understand the process and degree to which an undergraduate science research program for rising college freshman achieved its stated objectives to integrate participants into a community of practice and to develop students' research identities. A mixed methods approach was utilized for grounded theory construction. The major findings demonstrated that integration into a research community of practice revolved around students redefining the responsibilities of research scientists in the laboratory and negotiating the complex relationships in research settings.

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

Symposium - Undergraduate Science Assessment: Current Innovations and Future Obstacles and Opportunities

2:15pm – 3:45pm, Room 309

President: Marcelle A. Siegel, University Of Missouri-Columbia

Presenters:

Janet Coffey, Gordon & Betty Moore Foundation University of Maryland, College Park

Sandra K. Enger, The University of Alabama in Huntsville

Ellen Osmundson, CRESST, The University of California-Los Angeles

Sarah B. Woodruff, Ohio's Evaluation and Assessment Center for Mathematics and Science Education

Jerome M. Shaw, University of California - Santa Cruz

Tuesday, March 27, 2012

Dennis W. Sunal, The University of Alabama
 Robert E. Yager, The University of Iowa
 Marcelle A. Siegel, University Of Missouri-Columbia
 Jennifer Clasegens, Northern Arizona University
 Michelle Sinapuelas, University of California-Berkley

ABSTRACT: Classroom assessment is a key obstacle on the road to improving college science courses. Even in cases when college science instruction has improved, assessment often is not aligned with new instructional approaches. Furthermore, postsecondary instructors receive less professional development than K-12 teachers, and do not have as many assessment resources available for advanced science courses. We see a need to develop expertise, resources, and models for reform. This symposium gathers experts in assessment, college science instruction, and equity to discuss major obstacles and opportunities in reforming college science assessment. We apply current research to discuss innovations at the undergraduate level, as well as innovations that have not yet been applied to the undergraduate context. Panelists present a national study on the current state of assessment, innovations at the undergraduate level, and research-proven perspectives on ways to achieve reform. This symposium will generate discussion among participants in small and large groups. We will engage participants in discussing questions, such as: 1) What supports are needed for college science faculty to improve assessment practices? 2) What strategies and frameworks can be applied from the K-12 setting to the postsecondary setting? 3) What obstacles and opportunities exist for future reform efforts?

Strand 6: Science Learning in Informal Contexts

Families Encouraging Science Learning and Participation

2:15pm – 3:45pm, Room 305

President: Janell Nicole Catlin, Teachers College, Columbia University

An Exploratory Study of Parent Involvement by Take-Home Science Activities in Taiwan

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Huey-Por Chang, National Changhua University of Education

ABSTRACT: Recent years, some researchers have noted the importance of parental participation in their children's learning. If parents help out with homework, for example, improved test results and overall performance often result. The authors believe that science education ought to begin at home, reinforcing parents' knowledge as well as helping the children to learn. To date, however, relatively little work has been done on this topic in Taiwan. To emphasize this point, this study addresses to evaluate the effectiveness and the influence in the Family Involvement project by using "Science bags" and having families work together at home with hands-on, inquiry science activities. The results revealed science bags could improve parents' attitudes toward science activities and interact with their children. Moreover, it is worth to carry out take-home science activities (Science bags) in Taiwan.

Family Meaning-Making and Identity Negotiation at Telescope Observing Events

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ABSTRACT: This qualitative study is an exploratory look at family experiences at night time telescope observing events, often called star parties. Four families participated in this study which looked at their expectations, experiences and agendas as well as the roles that identity and family culture played in the negotiation of meaning. The results of this study showed that learning is constantly occurring among families, and that star parties and family culture were mediational means for making meaning. Expectations and agendas were found to affect the families' star party experiences. These data also showed that family members are actively negotiating their individual and family identities. These families use their cultural history together to make sense of their star party experiences; however, the meaning that families were negotiating was often focused more on developing family and individual identity rather than science content. The families in this study used the star party context as a way

Tuesday, March 27, 2012

to connect with each other, to make sense of their prior experiences, and as raw material for making sense of future experiences.

The Association of Parental Hobbies and Male Physicists' Interest in Science

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

Robert H. Tai, University of Virginia

ABSTRACT: Early parent-child participation in science activities at home leads to development of greater interest in science. In this paper, we examine the influence of parental hobbies in determining science interest. We use SCCT theory to explain how parental hobbies impact career interest. We use a grounded theory approach to analyze 3 interviews of male physicists from Project Crossover, a sequential mixed methodological study broadly examining the transition experiences of physical scientists from graduate students to independent researchers. We found that early science interest is fostered at home when parents encourage or participate in hobbies. Parental hobbies influenced career aspirations of male physicists both directly (e.g., specific interest in the subject), and indirectly (e.g., teaching skills, creating interest in field work, or, developing mechanical inclination with objects). Fewer interviewees reported the role of their mother in participating in science-based hobbies. Parental hobbies lead to motivation and knowledge, generating science-interest. Thus family is an important socially interactive group for children, instrumental in developing interest. Also, parents foster science-interest in children that sometimes influences their career trajectories. Hence, it is important to study the role of parents in generating science-based interest by encouraging children to pursue participatory activities at home.

Documenting Family Interactions at Touch Tanks: Is the Talk More Important than the Touch?

Shawn Rowe, Oregon State University, shawn.rowe@oregonstate.edu

James F. Kisiel, California State University, Long Beach

ABSTRACT: Despite their popularity, few studies have examined visitor engagement at touch tank exhibits featuring live marine or aquatic animals. The value or benefit of these and other similar experiences (e.g. petting zoos, aviaries, butterfly houses) featuring living organisms is a critical question currently being debated in many zoos and aquarium. Yet before such value can be assessed, it is important to understand just what people are doing (and saying) at these exhibits—such baseline data may point to possible learning outcomes and the influence of interpretive messages. This investigation involved analysis of video and audio recordings of 41 families as they engaged with touch tank exhibits at four different aquarium sites. Qualitative analysis reveals a variety of distinct activities and discourse that span across the different touch tank settings. Basic quantitative analysis revealed both common activities (e.g. touching, pointing out, and naming), as well as those that were less frequent (e.g. talking with staff, reading labels), suggesting that engagement may be independent of interpretation efforts at the exhibit. One common routine, ‘the debrief’, seems to serve as a trigger for new discourse and activities, thereby sustaining engagement, and supporting learning beyond the basic mastery of content knowledge.

Strand 7: Pre-service Science Teacher Education

Pre-service Teacher Beliefs and Efficacy

2:15pm – 3:45pm, Room 306

President: Sherry S. Herron, University of Southern Mississippi

An Exploration of the Relationship between Preservice Teachers' Teacher Efficacy Beliefs and Constructivist-based Teaching Practice

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Mustafa S. Topcu, Mugla University

ABSTRACT: The aim of this study is to explore the relationship between preservice teachers' (PT) teacher efficacy beliefs and their constructivist-based teaching practices. Data were gathered through the questionnaire (Teachers' Sense of Efficacy Scale) and the observation protocol (Reformed Teaching Observation Protocol) administered to the participants. A total number of 101 PT (53.5% from science education and 46.5% from mathematics education)

Tuesday, March 27, 2012

from a university in eastern part of Turkey participated in the study. Results indicated that PT's constructivist-based teaching practice was positively correlated with their teacher efficacy beliefs in the consideration of each dimension and total dimension of both instruments. As a conclusion, PT with high teacher efficacy are more likely to employ constructivist approach in their teaching while PT with low teacher efficacy are more likely to use traditional approach, lecturing in their teaching.

Impact of a Content Area Practicum Experience on Pre-Service Science Teacher Content and Pedagogical Efficacy
 Timothy A. Goodale, College of Coastal Georgia, tgoodale@ccga.edu

ABSTRACT: The Content Area Practicum Experience (CAPE) places middle grades science teacher candidates in government agencies and informal science organizations that focus on science. The theoretical framework behind this program is centered on the reality that secondary education is evolving and the demand for content expertise for today's educators is dramatically increasing. Much of today's college content interaction resides in coursework. A real life "experience" with science is lacking in the traditional college curriculum. In the spring of 2010 the College of Coastal Georgia placed approximately 24 science teacher candidates in organizations that ranged from the local department of natural resources to the Georgia Sea Turtle Center. Here the future educators interacted, engaged and interned with professional scientists. This session will outline the framework of this experience, the process of networking and developing partnerships with local organizations and outcomes of the Content Area Practicum Experience.

Understanding Preservice Teacher Belief Systems with the Use of a Complex Systems Model
 Brian S. Fortney, The University of Texas at Austin, bfortney@austin.utexas.edu

ABSTRACT: Research including preservice teacher beliefs has increased in the last 15 years, as well as research employing General Systems Theory. We posit that change in preservice teacher beliefs is an individual, idiosyncratic process and offer a framework to make sense of this change. Previous work on belief systems has primarily focused on beliefs within one domain, with some research attempting use of multiple domains. In this paper, we propose a General Systems Theory model utilizing Hierarchical Theory to further develop Green's 1971 metaphor of belief structure, highlighting similarities across individuals, and suggest reasons for change in structure. We describe a framework for belief change, the multidiscipline, mixed methodological study highlights unresolved or inconsistent findings as well as offer alternative explanations.

Strand 8: In-service Science Teacher Education

Mentoring and the Induction Years

2:15pm – 3:45pm, Room 105

President: Martina Nieswandt, University of Massachusetts, Amherst

Qualitative Indicators of Successful Induction: Case Studies of Four Beginning Secondary Science Teachers' Meaning Making and Identities-in-Practice

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, the relation between induction programs and retention is not necessarily unidirectional, with much beyond a formalized induction program impacting the induction experiences and retention of beginning secondary science teachers. Given this, the purpose of this qualitative case study is to examine the meaning making and identities-in-practice of beginning secondary science teachers as they engage in their various induction experiences. The experiences of four beginning secondary science teachers are used to make the following arguments: First, these cases demonstrate that many of the messages the beginning secondary science teachers received about the meanings of "science teacher" and "science teaching" centered mostly on policies and procedures, rather than quality instruction. Second, the beginning secondary science teachers viewed

Tuesday, March 27, 2012

their mentors and/or colleagues as their greatest supports. Third, the roles available to the beginning secondary science teachers during their formal induction experiences were narrowly defined.

Mentoring Science and Mathematics Teachers Using the Plus/Delta: Assessing an Induction Experience

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Saundra L. Shillingstad, University of Nebraska at Omaha

ABSTRACT: The paper focuses on research conducted on a beginning science and mathematics teacher induction project at a mid-west university. The induction project is a collaborative teacher induction project between the College of Education and a consortium of local school districts. This research chronicles the effort of the induction team to demonstrate the usefulness of the Plus/Delta instrument in assisting beginning science and mathematics teachers and their mentors in identifying and addressing the development and growth of teaching skills in first year teachers. The beginning teachers were videotaped while teaching lessons and later viewed the tape with their mentors and separately filled out the Plus/Delta about the lesson taught. The results of these Plus/Delta instruments were analyzed to determine what each group, beginning teachers and mentors, found as the best aspects of the lessons and the areas they recommended for improvement. In general, the area most mentioned for change was management with student engagement coming in at a close second. The areas most mentioned as what went well were management and instructional strategies. Overall both beginning teachers and mentors focused on the same issues, with some variation based on the time of year the Plus/Delta was given.

Teacher-to-Teacher Mentoring: A Model for Meaningful Professional Development that Facilitates Teacher Change

Jason Petula, Penn State Harrisburg, jason.petula@psu.edu

ABSTRACT: Contemporary science education reform movements stress the importance of the professional development of teachers as an avenue for facilitating teacher change. Educational research on the professional development of teachers often focuses on the effect of hierarchical approaches on teachers enacting an authoritative perspective. Little understanding exists about the professional development of teachers that is nonhierarchical. The participants in this study were teachers involved in the National Science Foundations' (NSF) Teachers Experiencing Antarctica and the Arctic (TEA) program. This study examines meaningful interactions between three mentor teachers (i.e., TEA teachers) that participated in authentic scientific polar research and twelve protégé teachers (non-TEA teachers) that resulted in teacher change. The research questions that guided this study were: 1. How do meaningful interactions among teachers occur? 2. How do teachers describe professional collaborations associated with authentic science research experiences? 3. What elements of interactions among teachers are meaningful? 4. Why are these elements of interactions meaningful to teachers? Grounded theory was the analytical approach used in this study within the context of naturalistic inquiry. Theoretical sampling required simultaneously interviewing participants, coding, and data analysis. Data analysis revealed three categories that described the participants mentoring experiences: (a) actions, (b) interactions, and (c) engagement results.

Beginning Secondary Science Teachers' Beliefs, Practices, and Experiences: A Five-Year Mixed Methods Study

Julie A. Luft, The University of Georgia, jaluft@uga.edu

Jonah B. Firestone, Arizona State University

Charles B. Weeks, Arizona State University

Sissy S. Wong, University of Houston

Krista Adams, University of Nebraska

Irasema B. Ortega, University of Alaska

ABSTRACT: Science teacher educators have acknowledged that the induction years of beginning teachers are an important component of teacher development. This mixed methods study focuses on the induction years of beginning content specialists, with the intention of understanding how their induction experience impacted their development as a new science teacher. The secondary science teachers in this study were followed during their two-year induction program and into their fifth year of teaching. The findings from this study suggest that new teachers can benefit from different types of induction support initially, but over time the teachers are more

Tuesday, March 27, 2012

influenced by their school culture. The findings also suggest that beliefs are more likely to change in the first years of teaching, and the instructional practices of teachers are impacted by an induction program. This study suggests that the induction of science specialists is an important area of work. It also explores the complex process of induction, and calls for more research into how beginning secondary science teachers learn and what types of induction experiences can best support beginning science teachers.

Strand 8: In-service Science Teacher Education
Curriculum as a Basis for Professional Development
 2:15pm – 3:45pm, Room 106
Presider: Eva Erdosne Toth, West Virginia University

In-service Teachers' Attitudes and Beliefs about Climate Change
 Shiyu Liu, University of Minnesota, liux0631@umn.edu
 Jeremy Wang, University of Minnesota
 Keisha Varma, University of Minnesota
 Gillian Roehrig, University of Minnesota

ABSTRACT: In this research, we examined in-service teachers' beliefs about climate change and how that related to their content knowledge and intended classroom practices. Teachers were recruited to participate in a climate change education professional development program, which aimed to provide support to enhance understanding and teaching of climate change among Native American populations. Measures such as surveys, concept maps, and journal reflections were used to assess the nature of teachers' attitudes and beliefs about climate change and how those were related to their classroom implementation. We found that the majority of participating teachers' beliefs in climate change would classify them as concerned. Teachers considered it critical that students are aware that climate change is happening and that they have a good understanding of its causes and effects. However, cultural considerations and limitations in curriculum standards are barriers that have prevented some teachers from implementing curricula on this topic in their classrooms. The lack of sufficient recent information as well as pedagogical content knowledge may have also influenced their confidence in teaching this topic, but increased awareness and concern for climate change issues during the program may help them better integrate relevant knowledge for future classroom teaching.

The Effect of Curriculum-based Professional Development on Science Instruction: Findings from a Randomized Control Trial
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 Stephen R. Getty, BSCS
 Susan M. Kowalski, BSCS
 Christopher Wilson, BSCS
 Janet Carlson, BSCS

ABSTRACT: The research described in this paper is part of a larger, IES-funded study that seeks to use a cluster-randomized trial design, with schools as the unit of assignment, to make causal inferences about the effect of treatment on both students and teachers. This paper reports on the portion of the study that focuses on treatment effects on teacher practice. The treatment is defined as participation in a seven-day professional development (PD) program that is directly focused on use of research-based instructional materials. The comparison group continues to receive extant professional development (i.e., business-as-usual). The RTOP was used as a comparative metric of classroom instruction across treatment groups. Researchers found both a statistically and practically significant effect of the professional development intervention. Findings are attributed to the PD program's focus on introducing teachers to the physical and philosophical components of the instructional materials as well as strengthening their content background and use of key instructional strategies essential to effective, high-fidelity use of the materials.

Tuesday, March 27, 2012

A Model for Teacher Learning in the Context of a Curriculum Renewal

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Cees Terlouw, Saxion Universities of Applied Sciences

ABSTRACT: Teachers play a crucial role in curriculum changes, as they are the ones to implement the new curriculum in class. Therefore, teachers need to bring their knowledge and beliefs (pedagogical content knowledge) in line with the new curricular demands. The reason for the study is the introduction of a context-based chemistry high school curriculum in the Netherlands, and the question was how to best prepare teachers for such a new curriculum. Teacher learning for two groups of teachers form the bases for this model. One group developed and subsequently class enacted student learning material for this new curriculum, and the other group only class enacted this learning material. The combination of developing student learning material and class enactment proves instrumental for teacher learning. In the model, based on the Interconnected Model of Teacher Professional Growth, teacher learning during the development phase and the class enactment phase becomes visible. The consequence of this model is that for teacher learning in the context of a curriculum renewal to take place, both a (re)development phase as a class enactment phase are essential. Especially the design of the External Domain facilitates initial teacher learning.

Content vs. Process within Systemic Reform: The Narrative Construction of a Science Teaching Identity

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ABSTRACT: Currently an urban public school district is enacting a systemic reform initiative dedicated to science education intended to improve the quality of its teaching. This includes a scope and sequence designating science topics taught in grades K – 8 which address state learning standards. Moreover, given the subject matter chosen the district office selected commercially produced, research-based curriculum for voluntary adoption by area schools that is also intended to facilitate alignment to standards surrounding the teaching of science as inquiry. Despite one area school securing this curriculum its fifth grade teacher has at times favored the use of her own science curriculum over that which is assigned to her grade level. The purpose of this study is to understand what perceptions of this curriculum emerge as relevant to this teacher's use of it, or lack thereof, in her classroom. Moreover, I want to appreciate how these perceptions reflect a broader science pedagogy relative to her experiences with science. Finally, I discuss how these perceptions formulate the construction of a science teaching identity that not only informs her curricular decisions. I argue it offers expanded considerations for how we think about professional development within the context of district driven science education reform.

Strand 10: Curriculum, Evaluation, and Assessment

Assessment Development and Application in Undergraduate Sciences

2:15pm – 3:45pm, Room 308

Presider: Mandy L. Kirchgessner, Temple University

Fostering the Development of Quantitative Life Skills through Introductory Science: Can it be Done?

Katherine B. Follette, University of Arizona, kate.follette@gmail.com

Donald McCarthy, University of Arizona

Erin Dokter, University of Arizona

ABSTRACT: We present preliminary results from a student survey designed to test whether the all-important life skill of numeracy/quantitative literacy can be fostered and improved upon in college students through the vehicle of non-major introductory courses in Astronomy. Many instructors of introductory science courses for non-majors would state that a major goal of our classes is to teach our students to distinguish between science and pseudoscience, truth and fiction, in their everyday lives. It is difficult to believe that such a skill can truly be mastered without a fair amount of mathematical sophistication in the form of arithmetic, statistical and graph reading skills that many American college students unfortunately lack when they enter our classrooms. In teaching what is frequently their "terminal science course in life" can we instill in our students the numerical skills that they need to be savvy consumers, educated citizens and discerning interpreters of the ever-present polls, studies and

Tuesday, March 27, 2012

surveys in which our society is awash? In what may well be their final opportunity to see applied mathematics in the classroom, can we impress upon them the importance of mathematical sophistication in interpreting the statistics that they are bombarded with by the media? Our study is in its second semester, and is designed to investigate to what extent it is possible to improve important quantitative skills in college students through a single semester introductory science course.

Building New Assessments for the "New Biology": Establishing Content Validity for a Genomics and Bioinformatics Test

Chad Campbell, The Ohio State University, campbell.742@osu.edu

Ross H. Nehm, The Ohio State University

Brian Morton, Barnard College, Columbia University

ABSTRACT: Revolutionary changes in the life sciences have been accompanied by hundreds of studies introducing new curricula and laboratory activities about genomics and bioinformatics. One aspect of the New Biology (NRC, 2009) that has not kept pace with scientific innovation is the development of new assessment instruments capable of measuring corresponding knowledge, skills, and performances. Prior to developing items for bioinformatics and genomics assessments, content validity must be established. Content validity evidence is typically established using expert or professional judgments about how relevant the content of a test is relative to a particular domain of interest. Our study reports on the results of a survey research study of expert biologists' (n = 42) opinions about genomics and bioinformatics content appropriate for an assessment for biology undergraduates. Two major questions were answered: First, how did experts in genomics and bioinformatics conceptualize the distinctions between these two subjects—are they separate and distinct, or overlapping bodies of biological knowledge? Second, within this domain, what subtopics should be included in a knowledge assessment for biology undergraduates? We discuss the findings from the study as well as the implications for item development.

Using Machine-Learning Methods to Detect Key Concepts and Misconceptions of Evolution in Students' Written Explanations

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Ross H. Nehm, The Ohio State University

ABSTRACT: Multiple-choice assessment formats are only capable of measuring a small subset of important disciplinary competencies. Consequently, science educators require additional assessment tools that can validly measure more advanced skills and performances. Our study explored the use of automated scoring software as a new approach for assessing undergraduate biology students' ability to construct scientific explanations of evolutionary change. We used machine-learning methodologies to examine whether computerized scoring models can successfully evaluate students' written evolutionary explanations (specifically, the presence of scientific concepts and misconceptions, and overall explanatory model type). In order to do so, we used a corpus of approximately 10,000 human-scored written evolutionary explanations generated in response to a variety of items differing in surface features (e.g., type of plant, animal, etc.). Overall, we found that machine-learning methods were able to evaluate students' written explanations with a high degree of accuracy. All key concepts were detected at "near perfect" Kappa levels; two of the four misconceptions also met our benchmark; and explanatory model type scoring (scientific, mixed, or naive) was concordant with human scoring in 86% of cases. Overall, our work demonstrates that machine-learning methods may be used to validly assess written work in biology education.

Guiding Attention on Physics Problems Using Visual Cues Modeled After Experts' Eye Movements

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Amy Rouinfar, Kansas State University

Allison Coy, Kansas State University

Adam Larson, Kansas State University

Lester C. Loschky, Kansas State University

N. Sanjay Rebello, Kansas State University

Tuesday, March 27, 2012

ABSTRACT: To maximize learning one must ensure most of the learner's cognitive resources are spent on relevant tasks and avoid instructional environments that facilitate focusing on the irrelevant. To help novice learners focus on elements relevant for learning it may be helpful to give them insight into the way experts allocate their visual attention, for example, by using visual cues. To design appropriate cues, we must first understand how experts allocate their visual attention by recording their eye movements. In Study 1, we record eye movements of novices and experts in physics while answering conceptual physics problems containing a diagram to determine differences in visual attention. We use the experts' eye movements to design visual cues for use in Study 2. In Study 2, we overlay these dynamic visual cues onto the same physics problems and find evidence of increased conceptual understanding in novices who view the problems overlaid with cues.

Strand 11: Cultural, Social, and Gender Issues

Religion, Evolution, and Indigenous Science: National and International Contexts

2:15pm – 3:45pm, Room 107

Presider: Bhaskar Upadhyay, University of Minnesota

Islam and Evolutionary Science: Secondary Students' Conceptions of Evolution from Five Countries

Anila Asghar, McGill University, anila.asghar@mcgill.ca

Joshua Rosenau, National Center for Science Education

Jason R. Wiles, Syracuse University

Saouma B. Boujaoude, American University of Beirut

Minoo Derayeh, York University

Quinn O., McGill University

Brian Alters, Chapman University

ABSTRACT: This study explores how secondary students from five predominantly Muslim societies (Egypt, Lebanon, Indonesia, Pakistan and Turkey) construe evolutionary science in relation to their Islamic beliefs about the origin and evolution of life. Data were collected through an anonymous survey from over 5000 students from public and private schools. Evolution is a part of the required national biology curriculum in all study countries except Lebanon. Data were analyzed using descriptive and advanced statistical techniques (frequencies, correlations, chi-squared tests, factor analyses, logistic regression and multi-level modeling). It appears that although most students are informed, and agree, that evolution is supported by extensive scientific evidence, many believe that it cannot be accurate since it contradicts their religious beliefs. Additionally, substantial numbers of students carried misconceptions regarding the contents and interpretation of evolutionary concepts. Most did not exhibit a comprehensive understanding of evolution and many did not accept it. Moreover, the majority demonstrated significant misconceptions about the nature of science. Interestingly, Muslim female students appeared to be more supportive of evolution than male students on average. This study informs North American science educators about how Muslim students might think about the evolutionary science being taught in relation to their religious beliefs.

Interrelating Attitudes toward Evolution, Climate Change, and Genetic Engineering in Students' Lives

David E. Long, Valdosta State University, delong@valdosta.edu

ABSTRACT: As part of a larger ethnographic study, college student attitudes toward three potentially contentious science topics were collected; evolution, climate change, and genetic engineering. Building upon previously published work on one of these topics (evolution), this paper expands this research dialogue to examine socio-cultural and socio-psychological factors that mediate student understanding of climate change science along with genetic engineering, and how, if at all, attitudes towards these three topics interrelate. Past a body of survey research disconnected by topic, this research interrelates these topics, grounded in the rich context of students' lives.

Tuesday, March 27, 2012

How Universal is Students' Interest in Biology? Correlation between Interest in Biology, Gender, Culture and Religion

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 Galit Hagay, Technion - Israel Institute of Technology
 Jaume Ametller, University of Leeds
 Gultekin Cakmakci, Hacettepe University
 Betina Lopes, University of Aveiro
 Aurora Moreira, University of Aveiro
 Helena Pedrosa-de-Jesus, University of Aveiro

ABSTRACT: In order to bridge the existing gap between biology curricula and students' interests in biology, a strategy for identifying students' interest based on their questions and integrating them into the curriculum was developed. In order to characterize the level of generalizability of students' science interests over 600 high school students from Portugal, Turkey, England and Israel, who chose biology as an advanced subject, were asked to rank their interest level in 36 questions that were originally raised by high school students. Results indicate that students from four different countries show interest in similar science questions. The most intriguing questions were the ones that dealt with human health and new developments in reproduction and genetics. Religious affiliation had the strongest effect on students' interest level, followed by national affiliation and gender. The findings suggest that students' interest in one context is relevant to the development of interest-based learning materials in a different context. However, despite these similarities, cultural and sociological differences need to be taken into account.

Imaginary Subjects: School Science, Indigenous Students, and Knowledge–Power Relations

Eleanor D. Abrams, University of New Hampshire, eleanor.abrams@unh.edu
 Joanna Kidman, University of Wellington, New Zealand
 Hiria McRae, University of Wellington New Zealand

ABSTRACT: The perspectives of indigenous science learners in developed nations offer an important but frequently overlooked dimension to debates about the nature of science, the science curriculum, and calls from educators to make school science more culturally responsive or 'relevant' to students from indigenous or minority groups. In this paper the findings of a study conducted with indigenous Maori children between the ages of 10 and 12 years are discussed. The purpose of the study was to examine the ways that indigenous children in an urban school environment in New Zealand position themselves in relation to school science. Drawing on the work of Basil Bernstein, we argue that although the interplay between emergent cultural identity narratives and the formation of 'science selves' is not as yet fully understood, it carries the potential to open a rich seam of learning for indigenous children.

Strand 12: Educational Technology

Evaluation and Instrumentation of Technological Endeavors

2:15pm – 3:45pm, Room 101

President: Noemi Waight, University at Buffalo

An Animation-based Approach to Clarify the Meanings of Questions in a Technology-enhanced Science Learning Environment Preference Questionnaire

Yu-Ta Chien, National Taiwan Normal University, yutachien@ntnu.edu.tw
 Chun-Yen Chang, National Taiwan Normal University

ABSTRACT: Based on our previous work on investigating students' preferences towards science learning environments, we found that students encountered great difficulties in understanding the meaning of questions which described how educational technologies would be used in a classroom setting. Therefore, this study used animations as visual aids to assist students in clarifying the meanings of questions in a technology-enhanced science learning environment preference questionnaire. The purpose of this study was to explore the impact of

Tuesday, March 27, 2012

animation-based items on students' responses and its association with students' visual images. The results revealed that students' responses to the Animation-Based Questionnaire (ABQ) were significantly different from their responses to the Text-Based Questionnaire (TBQ). Moreover, we found that the vividness of students' visual images is a significant predictor in explaining the students' response changes between ABQ and TBQ ($p = .005$). It suggests that the clearer the students' visual images stimulated from the description of a survey question in TBQ, the more likely the students will change their responses more prominently to that question on ABQ. This finding confirms that students interpret a survey question not only based the verbal representations they form from the question descriptions but also visual images. The questionnaire design should more cautiously take this individual difference into account.

Development of a Short Form Measure of Science and Technology Self-Efficacy using Rasch Analysis

Richard L. Lamb, George Mason University, lambrl9137@gmail.com

David B. Vallett, George Mason University

Leonard A. Annetta, George Mason University

Rebecca Cheng, George Mason University

ABSTRACT: Student achievement in science and technology within the United States has fallen to near the bottom in international testing results. There is considerable pressure on educators to help remedy this outcome and place students into STEM based career paths. There is some evidence that intrinsic attitudes such as science and technology self-efficacy may affect this outcome. The lack of a short form, diagnostic, screening instrument makes it difficult for educators to develop a full picture of student cognitive factors that relate to science attitudes in the classroom. The goal of this paper is to establish a valid and reliable measure of self-efficacy as it relates to science and technology. The secondary goal of this paper is to determine if the instrument meets the formal requirements of measurement as defined by the Rasch Model. Results using both IRT and CTT analysis suggest that the Self-Efficacy in Technology and Science Short Form Survey (SETSSF) is an adequate measure of the science and technology self-efficacy.

Analytical Framework to Assess Scientific Discourse in Connected Science Classrooms

Soon C. Lee, Ohio State University, lee.3552@osu.edu

Karen E. Irving, Ohio State University

ABSTRACT: Scientific ways of knowing, understanding, and reasoning can be practiced through classroom discourse that can be assisted by teachers. Since teacher feedback has a variety of positive or negative effects on students' learning due to ways it is implemented, feedback should be considered important knowledge for teachers. If a teacher delivers feedback formatively, it fosters students' reasoning skills through classroom discourse. Classroom Connectivity Technology (CCT) can assist teachers to facilitate formative feedback by providing the data on how well the entire class understands concepts provided in an appropriate and timely manner. This study develops an analytical framework to assess science classroom discourse focusing on teachers' feedback with two aspects: (1) how feedback is delivered, and (2) the content of feedback associated with scientific reasoning methods. With the classroom observation data from a larger research project, the results of analyses by using the analytical tool will provide deeper understanding of how teachers' feedback forms scientific discourse. The specific information will be produced about how CCT can affect classroom discourse and how it facilitates teacher feedback for scientific discourse. Furthermore, this study's results can help teachers with self-evaluation of their classroom talk to make informed decisions regarding their instructional practices.

Strand 13: History, Philosophy, and Sociology of Science

Elementary Teachers' View of NOS

2:15pm – 3:45pm, Room 102

Presenter: Selina Bartels, Illinois Institute of Technology

Tuesday, March 27, 2012

Exploring How Elementary Teachers Translate Their Nature of Views into Classroom Practice after a Graduate Level Nature of Science Course

Hasan Deniz, University of Nevada Las Vegas, hasan.deniz@unlv.edu

Elif Adibelli, University of Nevada Las Vegas

Mehmet F. Dulger, University of Nevada Las Vegas

ABSTRACT: The purpose of this study is two-fold. The first purpose of this study is to examine to what extent a graduate level nature of science course that is designed around explicit-reflective conceptual change learning principles can improve elementary teachers' nature of science views. The second purpose of this study is to explore how elementary teachers translate their nature of science views into classroom practice after completing a graduate level nature of science course. It was found that elementary teachers improved their NOS views after the graduate level nature of science course. It was also found that elementary teachers' NOS views are somewhat related to their classroom practice.

Factors Affecting Early Elementary (K-4) Teachers' Introduction of the Nature of Science

Sophia J. Sweeney, Northeastern State University, sweeney@nsuok.edu

William F. McComas, University of Arkansas

ABSTRACT:

Preservice Elementary Science Teachers' Connections among Aspects of NOS: Toward a Consistent, Overarching Framework

Sinan Ozgelen, Mersin University, sozgelen@gmail.com

Deborah L. Hanuscin, University of Missouri-Columbia

Ozgul Yilmaz-Tuzun, Middle East Technical University

ABSTRACT: Early elementary teachers' beliefs and practices regarding nature of science (NOS) instruction were gathered with a researcher-developed questionnaire mailed to a random national sample. Half (N = 377) of the respondents introduced the inferential, empirical, creative, collaborative, tentative, and cultural aspects of NOS and the idea that no single step-by-step scientific method exists (multiple methods). Over 90% of respondents identified the inferential, empirical, and creative aspects of NOS as developmentally appropriate for the grade level taught. The inferential, empirical, creative, collaborative, cultural, and tentative NOS, the importance of replication and multiple methods were identified as somewhat important to include in K-4 science instruction. Binary logistic regression was used to determine the impact of three predictor variables (developmental appropriateness, importance, and presence in state standards) on teachers' self-reported introduction of each of the NOS elements. Teachers who identified a particular NOS element as developmentally appropriate or important were more likely to teach those NOS elements. However, the presence of a NOS element in a state's science standards only impacted teachers' introduction of that NOS element for the creative aspect of science and the lack of a universal scientific method.

Exploring Elementary Science Methods Course Contexts for Improving Nature of Science Conceptions and Understandings of NOS Teaching Strategies

Valarie L. Akerson, Indiana University, vakerson@indiana.edu

Ingrid S. Weiland, University of Louisville

Kader Bilican, METU

Khemawaddee Pongsanon, Indiana University

Meredith A. Park Rogers, Indiana University

ABSTRACT: This study aims to explore the connections preservice elementary science teachers' (PSTs) made among various aspects of nature of science (NOS). Totally, 52 PSTs enrolled in the Laboratory Application in Science II course. The laboratory course provided meaningful and practical inquiry-based experiences, as well as explicit and reflective instruction to help PSTs' gain a deeper understanding of NOS. Each week, instructors targeted a specific NOS aspect related to the laboratory investigation. The design of the study was qualitative and exploratory in nature. Data sources included PSTs' responses for the VNOS-B, semi-structured interviews, and PSTs' weekly written reflections about NOS. This study was concerned with the development of PSTs'

Tuesday, March 27, 2012

understanding of NOS and specifically their ability in connecting their understandings of the various aspects of NOS to one another. Findings showed that 43 PSTs made connections among NOS aspects and generally, these connections were emphasized at the end of the semester, following the intervention. Interviews revealed 180 statements indicating the connections among NOS aspects. Only seven of them were collected from pre-semester data, others from post-semester data. The study showed that reflective component of explicit-and-reflective instruction provided opportunities for PSTs to revisit their ideas about NOS aspects throughout instruction in such a way that fostered building of connections.

Strand 14: Environmental Education

Fostering Decision Making to Promote Sustainable Environmental Attitudes and Behaviours

2:15pm – 3:45pm, Room 103

Presider: Maurice DiGiuseppe, University of Ontario Institute of Technology

Learning for Environmental Decision-Making

Sameer Honwad, sameervhonwad@gmail.com

ABSTRACT: This study is designed to find out how youth in rural communities residing in the middle Himalayas use different sources of knowledge to support environmental decisions while addressing water and land use related concerns. The study not only serves to enrich our understanding of community decision-making, especially as connected to land use and water issues, but also helps us understand how youth in village communities in the Himalayan bioregion negotiate a balance between formal and informal knowledge while making decisions about their environment. The study also examines the decision making process situated within the context the environmental education curriculum our land our life (the current environment education curriculum in public schools). Therefore this study was designed into three parts: 1. Identify indigenous knowledge in the Kumoan Himalayas 2. Find out how much indigenous knowledge youth would use for environmental decision making? 3. Discuss relevance of merging knowledge systems to the existing environmental education curriculum?

Human Nature: Chemical Engineering University Students' Attitudes about Human Relationships with the Natural World

Daphne Goldman, Beit Berl Academic College, dafnag@netvision.net.il

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

Julia Dranik, Ben Gurion University of the Negev, Israel

ABSTRACT: Chemical engineers play a significant role in implementing environmental principles in a wide range of industries (health, food, transportation). Little is known about their attitudes towards nature which is important for promoting sustainable practice in this field. This study used an expanded NEP-scale (scores and written explanations for NEP-items) to investigate chemical engineer students' attitudes about human relationships with the natural world. Findings may contribute to developing updated chemical engineering programs integrating principles of SD and environmental ethics. NEP-scale scores indicate overall pro-environmental orientation(3.51/5). "Possibility-of-eco-crisis" scored highest(3.79)-they endorse that man's present course is abusing the environment to an extent increasing likelihood of severe ecological catastrophe. "Limits-to-growth" scored lowest(3.11) indicating moderate agreement that earth's resources are finite. Students' agree with the idea that the equilibrium of earth's natural systems can be easily upset(3.72) and generally support the idea that humans aren't exempt from ecological constraints(3.35). Insight into the nature of students' environmental attitudes was extracted from explanations for NEP-scale items. While explanations support overall anti-anthropocentric attitudes, they indicate complexity of students' positions on NEP-scale items. For example, while explanations on "anti-exemptionalism" show ecocentric tendency, they also demonstrate belief that man will eventually know enough how nature works to control it.

Urban Elementary Students' Ideas about the Environment, Activism, and Jobs

Daniel L. Dickerson, Old Dominion University, ddickers@odu.edu

Tuesday, March 27, 2012

Stephanie Hathcock, Old Dominion University

ABSTRACT: This NOAA-funded study examines urban fifth grade students' ideas about the environment, environmental stewardship, and careers in science after the implementation of an environmental education curriculum. The study population is 89% African American and consists of 1277 students from a large urban school division located near the Chesapeake Bay. A literacy activity involving students' written responses to a writing prompt on five different posters was administered. Major findings include: scientists working together for altruistic reasons, ideas of varied ways science will be involved in non-traditional science-related careers and current jobs (i.e. chores), a strong focus on the individual as opposed to corporations, and almost equally frequent reporting of influences from environmental education curriculum and non-formal sources.

Being Responsible and Respectful: A Case Study of Collective Knowledge Building

Mijung Kim, University of Victoria, mjkim@uvic.ca

Hoe Teck Tan, Singapore School of Science and Technology

ABSTRACT: Environmental learning requires interdisciplinary collaboration of various dimensions of disciplines to enhance the sustainability of the living world. This study attempts to enhance students' collective problem solving by designing collaboration amongst different scientific research topics and students in different grade levels. 18 secondary students and 18 junior college students from Singapore public schools participated in field study to experience collective decision making process on environmental tasks. The students in groups collected, analyzed data from the field work and shared their findings together. Their field work and discussions were video-recorded and later transcribed for data analysis. Reflection notes were also collected for data coding. Through the study, the students learned the difficulties and necessity of collaboration and further developed responsible relationships for their knowledge building and problem solving. This study further explores potential of the development of leadership, implications of collaborative knowledge building, and communication in environmental science learning.

Strand 15: Policy

Symposium - Developing Resources that Connect Learning Progression Research to Science Standards

2:15pm – 3:45pm, Room 104

President: Aaron D. Rogat, Teachers College, Columbia University

Discussant: Amelia Wenk Gotwals, Michigan State University

Presenters:

Joseph S. Krajcik, University of Michigan

Marianne Wiser, Clark University

Jennifer Hicks, Indiana Department of Education

Stephen Pruitt, Achieve

ABSTRACT: We have brought together science education researchers and state science supervisors to develop hypothetical learning progressions that connect to the newly release NRC framework for K-12 science education which are to inform the Next Generation Science Standards. These learning progressions describe how students understanding of, and ability to use, core scientific concepts and explanations and related scientific practices grow and become more sophisticated over time, with appropriate instruction. We developed hypothetical learning progressions for two core ideas in the NRC framework and they are meant to help science supervisors in their tasks of supporting science teaching and learning. These products also serve as an example to researchers who wish to connect their research to practice and suggest alternative ways that the research community can support the implementation of new science standards. A symposium will be held in which key participants from the project provide an overview of the work that has been accomplished and its implications for research, policy, and practice. The products of the work will be distributed at the session.

Tuesday, March 27, 2012

Strands 1 and 2 Joint Sponsored Administrative Session

Symposium – Connecting Research and Practice of Science Education: A Symposium in Honor of Phil Scott

4:00pm – 5:30pm, Room 313

Presiders:

Jan H. Van Driel, janvandriel@aol.com

Xiufeng Liu, State University of New York at Buffalo

J. Randy McGinnis, University of Maryland

Presenters:

Eduardo F. Mortimer, Universidade Federal de Minas Gerais, Brazil

Asma Almahrouqi, University of Leeds

Edenia Ribeiro do Amaral, Universidade Federal Rural de Pernambuco

Jouni Viiri, University of Finland

Carl Angell, University of Oslo, Norway

Jonathan Emberton, Teacher of Physics in the North of England

Jim Ryder, University of Leeds, UK

ABSTRACT: Professor Phil Scott, ex-member of the Board of Directors of NARST, co-editor of *Studies in Science Education* and an internationally recognized researcher in the field of teaching and learning science, died on 15 July 2011. Throughout his career, Phil Scott demonstrates through his publication and his work with teachers that the insights provided by research could be effectively communicated to classroom practitioners. Phil Scott had also a natural gift as a teacher, both in secondary school and higher education. In this symposium, seven of Phil's collaborators in the different areas of his expertise will try to communicate these three dimension of his career, giving their personal perspectives on how it was to work with him and, at the same time, focusing on the variety of research and practical results that Phil left to the world of science education.

Strand 1: Science Learning, Understanding and Conceptual Change

Learning Using Mental and Conceptual Models

4:00pm – 5:30pm, Room 310

President: Saouma B. Boujaoude, American University of Beirut

Learning Ecology in a 3rd Grade Classroom Using Design-based Learning: An Embodied Modeling Approach

Amanda C. Dickes, Vanderbilt University, amanda.c.dickes@vanderbilt.edu

Pratim Sengupta, Vanderbilt University

Gokul Krishnan, Vanderbilt University

ABSTRACT: Emergence is the process by which complex phenomena (e.g., flocking of birds, formation and collective movement of a traffic jam, formation of ant colonies, etc.) arise out of the interactions between many individual objects, actors or agents (Strogatz, 2003; Holland, 1998; Wilensky & Resnick, 1999; Resnick, 1994). Students at various levels (K-16) find understanding emergent phenomena quite challenging (Hmelo-Silver & Azevedo, 2006; Jacobson & Wilensky, 2006). In this paper we demonstrate that elementary (3rd grade) students can understand some introductory concepts of complex ecological systems if their learning is supported through 1) embodied modeling, 2) use of computational agent-based models, and 3) development of representational practices (e.g., graphing), based on both (1) and (2).

Learning University Physics Using Multiple Representations

David F. Treagust, Curtin University Perth Australia, d.f.treagust@curtin.edu.au

Yen-Ruey Kho, Curtin University Perth Australia

Marjan Zadnik, Curtin University Perth Australia

Salim Siddiqui, Curtin University Perth Australia

Mihye Won, Curtin University Perth Australia

Tuesday, March 27, 2012

ABSTRACT: In recent years, many science educators have argued that the scientific discourse itself involves flexible use of multiple representations and students need to be able to understand and link different scientific representations to develop a deeper understanding of science concepts. To effectively teach using multiple representations, it is necessary to explicitly present students with different forms of representations. In this case study, such instruction was enacted for first year university students in a physics course for non-majors. We designed two questionnaires on Thermal Physics and Optics to assess students' conceptual understanding and their use of multiple representations (description using words, diagrams, formulas and coordinate graphs) to explain the concepts. We also conducted interviews to link students' explanations to their responses in the questionnaire items. Two research questions guided the study: 1) How and to what extent do students use different representations to learn and communicate physics concepts? and 2) How do different representations help students build deeper understanding? The results showed that even with explicit teaching, learning physics using different representations is not straight forward and a large number of students were unable to apply the four representations effectively to solve physics problems.

Supporting Students' Conceptual Change in Physics: Utilizing Teaching Strategies from the OGEM Cycle
Grant Williams, St. Thomas University, grantw@stu.ca

ABSTRACT: Science education research widely supports the notion that in order for students to move from naive misconceptions about physical phenomenon toward more scientifically supported understandings, they need to experience some form of conceptual change (Strike & Posner, 1992; Smith et al., 1993; Driver et al., 2000). This study explores the strategies that two experienced high school physics teachers used during whole class discussions to foster their students' construction of explanatory models for electricity. Pre and post-instructional data reveal that, through the construction of these explanatory models, with guidance from their teachers, students' conceptual understanding of electricity appeared to improve. The teaching strategies identified were found to be situated within the OGEM phases of the model construction cycle. This acronym refers to the phases of Observation, Generation, Evaluation, and Modification that students and teachers were found to co-operatively engage in during whole class conversations. It is believed that the strategies used by these teachers contributed to the conceptual change that the students in this study experienced. The purpose of this paper is to describe these strategies and contribute hypotheses as to the particular roles each played in the process of student conceptual change they are believed to have supported.

Learning about Chemical Energy: Mapping the Progression Landscape
Vicente A. Talanquer, University of Arizona, vicente@u.arizona.edu

ABSTRACT: The central goal of this work is to explore the landscape of implicit assumptions and reasoning strategies that guide students' reasoning when learning about chemical energy. Our results are based on the analysis of the ideas and strategies used by college general chemistry students to solve problems and build explanations. Research data was collected over several academic terms using a variety of research instruments, from single short-answer questions, to individual interviews, to multiple-choice questionnaires. These research probes engaged students in different tasks, from building and evaluating explanations to designing chemical substances with specific properties. Our results indicate that students' ideas about energy seem to evolve from thinking of energy as a product, to thinking of energy first as a passive agent contained in substances and later as a source of bond strength. However, students' mental models of energy transfer in chemical reactions can be quite varied. In general, students tend to build explanations about these phenomena based on the analysis of one single factor, failing to integrate the effect of multiple variables. The results of our study may help support the development of learning progressions about chemical energy that recognize the core challenges that students face when learning this topic.

Tuesday, March 27, 2012

Strand 2: Science Learning: Contexts, Characteristics and Interactions

School Contexts

4:00pm – 5:30pm, Room 302

Presider: Martina Nieswandt, University of Massachusetts, Amherst

Contestation and Labeling across the Spectrum of Inclusive Urban Science Education and Teacher Preparation

Nicole K. Grimes, York Preparatory School, nkygrimes@gmail.com

Wesley Pitts, Lehman College, CUNY

ABSTRACT: In this paper, we aim to illuminate the complexities that labels introduce into the urban science classroom. Across the gamut, urban science students differ in a multitude of ways: racially, ethnically, religiously, linguistically etcetera and thus, educators must mediate the complexities that urbaneness brings to teaching and learning. However, a typically neglected aspect of classroom diversity is student ability. In attempts to address this question, we will highlight the plethora of difficulties of teacher preparation and teaching science in urban mainstreamed classrooms like NYC. We also aim to shed light on the continual rifts that tend to occur among general and special educators in urban schools. We argue that rightful focus should be placed on the hybridity produced as different individuals come together and utilize the same geographic spaces. These creolized spaces (Hall, 1990), created by the copresence of unique learners, retain new possibilities for learning in urban schools. Lastly, we will make a case for the utility of coteaching, cogenerative dialogues and teacher research as approaches which both pre- and in-service science teaching experiences can incorporate in order to better educate the diversely-abled student population of urban niches.

Developing Decision-making about a Familiar Socio-scientific Issue: A Four Nation Comparison

Marcus Grace, University of Southampton, UK, mmg1@soton.ac.uk

Yeung C. Lee, Hong Kong Institute of Education

Anita Wallin, University of Gothenburg, Sweden

Roman Asshoff, Münster University, Germany

ABSTRACT: This study explores how decision-making discussions about whaling (a globally familiar socio-scientific issue), can help develop the views of students in four countries. The students in each location were provided with the same background information (scientific, political, cultural and pro and anti-whaling materials) and after structured discussions, each small group made a video presentation which was subtitled and viewed by the students from the other locations. Early findings show that students in each country are able to engage in such decision-making discussions, that the vast majority modified their views, and that these views could be fairly clearly categorised. The video presentations gave students an insight into how their international counterparts viewed the issues, thus revealing and helping to break down some cultural stereotyping. Global controversial issues such as whaling require determined international efforts, and this approach to engaging students from different localities in decision-making enables them to establish some mutual understanding. Findings from this study could provide a model for teachers wishing to promote an awareness of how their students' counterparts in other parts of the world feel about and respond to such issues.

Exploring the Potential of Gamification for Urban Science Education

Christopher Emdin, Teachers College Columbia University, ce2165@columbia.edu

Joey J. Lee, Teachers College Columbia University

J. Hammer, Teachers College Columbia University

Jenny D. Ingber, Bank Street College of Education

ABSTRACT: Research in urban science education indicates that many issues hamper the success of urban youth in science education. I argue that two of these issues; student motivation/engagement, and the inability of educators to develop tools/strategies that support the development of academic skills that support the learning of science can be addressed through gamification -the incorporation of game elements into non-game settings. This paper helps science educators better understand what gamification is, how it functions, and why it might be useful for addressing engagement in science and the development of broad academic skills that lend themselves to success

Tuesday, March 27, 2012

in science. More specifically, the paper addresses the questions, – what, how, and why bother? – with using gamification in urban science education.

Effects of Class Size and School Location on Students' Perception of Learning Environment in Turkey

Muhammet Mustafa Alpaslan, Texas A&M University, alpaslan27@tamu.edu

Nevezat Yigit, Karadeniz Technical University

Yasin Cinemre, Karadeniz Technical University, Trabzon, Turkey

Bilal Balcin, Karadeniz Technical University, Trabzon, Turkey

ABSTRACT: The purpose of the present study is to examine the middle school students' perspectives of the constructivist learning environment in the Science and Technology course in Turkey in terms of the environmental system, defined by Moss (1979), which are school location and school population. In the study the Assessing of Constructivist Learning Environment (ACLE) questionnaire was administered to measure students' constructivist learning environment perceptions. The sample included 1882 students from Grades 6-8 randomly selected in Trabzon Province in Turkey. The ACLE questionnaire consists of 28 items in six scales: Student Centered, Thought Provoking, Collaborative, Life Relevance, Concurrent Learning and Assessment, Bringing Different Viewpoints. Data were analyzed using SPSS (e.g. Tukey test, ANOVA and MANOVA). Significant differences between the perceptions of students who live in rural and urban areas were found in scales of Thought Provoking, Life Relevance, Concurrent Learning and Assessment, and Bringing Different Viewpoints although no significant difference was found on the perceptions of students in Student Centered and Collaborative. In general, students in small classroom perceived their learning environment more positively than students in large classroom.

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

Teacher Knowledge

4:00pm – 5:30pm, Room 301

Presenter: Therese B. Shanahan, University of California - Irvine

Improving Teacher Pedagogical Content Knowledge and Student Science Understanding with Inquiry-based Science Kits

Sarah J. Brasiel, Edvance Research, Inc., sbrasiel@edvanceresearch.com

ABSTRACT: This paper summarizes the findings of an elementary science instruction reform effort using inquiry-based science kits to improve student learning and student growth and to close achievement gaps in science for high-need students by strengthening teacher pedagogical content knowledge and quality of instruction at the classroom level in science. This reform effort is based on the National Science Resources Center (NSRC) inquiry-centered science education reform model, which is an organizational model and a systemic change model, not a curriculum or pedagogical strategy. The year 1 participants were from four districts in the Southwest region, including 10 schools, 147 teachers and 2,937 students (grades K-6). The preliminary results from kit-based measures of science knowledge show support for improved teacher understanding following professional development and improved student understanding after completion of each science kit (1 implemented in the fall and 1 in the spring semester). A comparison group developed through propensity score matching will be included in an analysis that compares the inquiry-science kit group with the comparison group on state assessment performance in science, reading, and math to determine if there is a statistically significant difference associated with participation in the inquiry-science kit program.

Preservice Elementary Teachers' Pedagogical Content Knowledge of Inquiry-based Astronomy Investigations

Julia D. Plummer, Pennsylvania State University, jdp17@psu.edu

Arzu Tanis Ozcelik, Pennsylvania State University

ABSTRACT: Learning about astronomy involves more than just understanding the content; students also need to understand the application of scientific inquiry to the domain. Ideally, this begins with teachers implementing inquiry investigations at the elementary level. This study examined preservice teachers' pedagogical content

Tuesday, March 27, 2012

knowledge (PCK) as they designed and implemented investigations for children addressing K-6 astronomy standards. Preservice teachers (N=30) spent five weeks learning elementary astronomy concepts through guided inquiry instruction in their elementary science methods courses. Then, pairs of students taught groups of children in afterschool programs once a week for five weeks; their assignment was to teach a multi-day inquiry investigation about astronomy. Pre/post content assessments and five lesson plans from each pair were analyzed using a mixed-methods approach to understand the successes and challenges in developing PCK by new teachers in this domain. Findings suggest that while most preservice teachers were able to implement inquiry investigations in elementary astronomy topics, many also struggled to successfully connect a scientific question to an explanation based on evidence. A correlation between the teachers' content knowledge and the sophistication of their extended investigation was found. Implications for designing curriculum and supporting new elementary teachers in teaching astronomy will be discussed.

Investigating the Impact of Teachers' Physics Content Knowledge on Students' Interest in Elementary School Science

Annika Ohle, University Duisburg- Essen, Annika.Ohle@uni-due.de

Hans E. Fischer, University Duisburg-Essen

ABSTRACT: Decreasing student interest and achievement in science, as students move to higher grades, is a problem which has been observed in many countries. It has been well observed that teachers' play an essential role for students' learning achievements. What has not yet been investigated is the influence teachers' professional knowledge has on students' interest in elementary school science classes. The aim of the presented study is to investigate the influence of teachers' content knowledge (CK) in physics, as one component of their professional knowledge, on students' interest in physics topics in elementary school. It is assumed that the impact of teachers' CK on students' interest is mediated by the teachers' own interest in physics and the quality of teaching. In the presented study quality of teaching is described by the contents of the lessons (representing teachers' CK in a lesson) and the sequencing of learning processes. Data has been assessed in n=30 4th-grade elementary school classes using questionnaires for assessing teachers' and students' interest in physics, a teacher CK test and videos of the teachers' lessons. Multilevel analyses could not confirm the assumed mediation hypothesis but revealed a positive impact of teachers' interest in physics on students' interest.

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

Symposium - Learning from Children: A Conversation about Science Education in the Early Years

4:00pm – 5:30pm, Room 303

Discussant: Cynthia C. Deaton, Clemson University

Presenters:

Cassie Quigley, Clemson University, cassieq@clemson.edu

Christina Siry, University of Luxembourg

Deborah C. Smith, Penn State University

Bhaskar Upadhyay, University of Minnesota

Maria Varelas, University of Illinois at Chicago

Lynne Pieper, University of Illinois at Chicago

Amy Arsenault, University of Illinois at Chicago

ABSTRACT: In this proposed symposium, several early childhood science educators will discuss the findings of their most recent work with young children. We intend the structure of these presentations to be interactive—led by the discussant but including ideas and thoughts from the participants. All of our research is conducted in schools in grades K-3. The overarching themes among these papers are young children's reasonings and wonderings about science, the use of texts and lived experiences in the early years, and creating child-centered science curricula and communities. Because of the interactive nature of the symposium, the conversation will also include specifics of how research is conducted with young children including ethical ways of collecting data, theoretical frameworks that guide our methodological choices, and current challenges we face with early childhood science education.

Tuesday, March 27, 2012

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

Fostering Problem Solving Skills

4:00pm – 5:30pm, Room 304

Presider: Ross H. Nehm, The Ohio State University

Building a Valid and Reliable Assessment of Physics Identity

Geoff Potvin, Clemson University, gpotvin@clemson.edu

Kylie Paige, Clemson University

Carrie E. Beattie, Clemson University

ABSTRACT: We report on efforts to build and validate an instrument that can be used to estimate students' physics identity, an important construct for understanding student attitudes and physics-related career choices. We analyze data taken from 275 college students enrolled in one of two introductory physics courses (physics for physical science majors and physics for life and non-science majors, respectively) for various aspects of validity and reliability. An exploratory factor analysis (EFA) indicates a set of items which load onto seven relevant factors: science interest, physics interest, science recognition, physics recognition, and three aspects of performance/competence beliefs (laboratory/scientific, academic/classroom, and interpersonal/conversational). A stability analysis finds the items have good-to-high degrees of test-retest stability and the internal consistency is high, with a measured Cronbach's alpha of 0.95. The implications of the unexpected grouping of performance/competence beliefs into different contextual domains, rather than as separate performance and competence domains, is discussed.

Does Explicit Problem Solving Teaching Strategy Improve Pre-service Elementary Teachers' Problem Solving Ability in Chemistry?

Lloyd M. Mataka, Western Michigan University, lloyd.m.mataka@gmail.com

William W. Cobern, Western Michigan University

George V. Akom, University of Hong Kong

ABSTRACT: This study compares the effectiveness of two teaching approaches: an inquiry with added 'Explicit General Problem Solving Teaching Strategy' (EGPSTS) and traditional inquiry which excludes this EGPSTS on pre-service elementary school teachers' ability to solve heat transfer problems. The pre-service elementary teachers in this study were enrolled in two sections of chemistry for pre-service elementary teachers' class at a four year university in spring 2011 semester. One section of this class was taught a treatment method, the explicit general problem solving approach, while the other section was taught an inquiry approach which excluded the explicit problem solving. Quantitative data was obtained using post-tests while qualitative data was obtained using semi-structured interviews. Although there was no statistical difference in the two groups' performance to the post-test, the treatment group had higher mean percentage than the control group. There was not much difference in the way participants thought through their problems during interviews between the two groups although subjects in the treatment group seemed more organized than their control counterparts. Hence, this study concludes that both EGPSTS and traditional inquiry have comparable effectiveness to teaching problem solving although EGPSTS has a slight edge over traditional inquiry.

Facilitating Students' Transfer of Learning in Physics Problem Solving Using a Computer-Based Assessment

Dehui Hu, Kansas State University, dehuu@phys.ksu.edu

Joshua Von Korff, Kansas State University

N. Sanjay Rebello, Kansas State University

ABSTRACT: We have developed a research-based tutorial which aims to facilitate students' construction of conceptual understanding and application of mathematical concepts in a physics context. Our assessment is based on the preparation for future learning (PFL) model of transfer and is consistent with Vygotsky's Zone of Proximal Development (ZPD). We investigate students' ability to solve a transfer task, but also probe their ability to utilize online hints to activate resources provided during a 50 minute tutorial. We found that students who used our tutorial became more successful with the guidance of online hints even though they did not do any better on the

Tuesday, March 27, 2012

first trial. Thus, our assessment shows evidence that completion of our tutorial facilitated students' transfer of learning from a PFL perspective.

Undergraduate Life Science Students' Critical Evaluation of Research Articles

Edwin B. Van Lacum, University of Groningen, e.b.van.lacum@rug.nl

Miriam A. Ossevoort, University of Groningen

Martin J. Goedhart, University of Groningen

ABSTRACT: Being able to critically evaluate science texts is an important skill for scientists and science students. To determine undergraduate life science students' ability to critically evaluate research articles, we gave 51 students two articles which contained seemingly contradictory evidence about vitamin C and oxidative stress. Students individually made a number of written assignments, which allowed us to answer the following research questions: (1) How do students evaluate the articles' main conclusions? (2) Are they able to come up with additional points of criticism not mentioned by the authors? (3) How do they resolve the contradictory evidence? Analysis of the students' answers showed that the majority was able to provide additional points of criticism. However, most students thought that the data in the two articles showed that vitamin C reduces levels of oxidative stress, even though both studies did not directly observe such effect. We conclude that most students were able to criticize a research paper by formulating new points of criticism, although it seems that the reasoning of students when they had to resolve contradictory evidence was often of poor quality. We hope that these insights can be used to improve students' ability to critically read science texts.

Strand 6: Science Learning in Informal Contexts

Gender and Science: Understanding Boys and Girls Engagement with Out-of-School Science

4:00pm – 5:30pm, Room 305

President: Lynn D. Dierking, Oregon State University

An Exploration of Girls' Socialization Patterns in a High School: University Science Partnership Program

Megan E. Faurot, Illinois Institute of Technology, mfaurot@hawk.iit.edu

Stephen A. Bartos, Illinois Institute of Technology

Norman G. Lederman, Illinois Institute of Technology

Teresa K. Woodruff, Northwestern University

Cathryn Smeyers, Northwestern University

Nadia Reynolds, Northwestern University

ABSTRACT: Women and minorities remain underrepresented in the U.S. science workforce. Socialization patterns along the science career trajectory remain to be fully understood, especially of underrepresented groups in science. Thirty minority high school girls' who were considering science careers and participants of a high school – university science partnership program, developed by a public high school and a private university, was the sample and setting of this study, respectively. Other groups from the high school and university social networks involved in the program, included alumnae, parents/guardians, science teachers, university students and professionals. Qualitative assessments collected data on the high school girls' nature of experiences with each group. Emergent themes of the girls' nature of experiences were learning, relationship-building, and personal development experiences and were analyzed to observe socialization patterns. Data analysis revealed the girls' had distinct socializations patterns with the high school and university social networks. Findings can directly be used to inform revisions to the science partnership program to improve its' effectiveness and portability to other schools. Building high school-university science partnerships into the U.S. educational system has the potential to influence the socialization patterns of the science career trajectory and, ultimately, increase the diversity of the U.S. science workforce.

Innovating to Address Community Needs: Girls Learning 21st Century Skills of Innovation in Out-of-School Science

Melissa Koch, SRI International, melissa.koch@sri.com

Tuesday, March 27, 2012

Patrik Lundh, SRI International
 Christopher J. Harris, SRI International

ABSTRACT: Scientific creativity and innovation are considered essential skills for addressing the important environmental challenges of the 21st century. There is increasing recognition that science education can and should cultivate creativity and help students become familiar with innovation practices. Yet, in K-12 classrooms, creativity and innovation are rarely incorporated into science instruction. We report on our out-of-school science program that gives high school girls the opportunity to address community-relevant environmental challenges by applying Earth science concepts in concert with innovation skills. Girls present and receive feedback on their ecologically sustainable innovations from an audience of scientists, innovators, investors, and community members. This paper shares evaluation data from the first two years of the pilot implementation of the program on girls' understanding and practice of innovation. Findings from the first two years of enactment indicate that innovation-focused curriculum, assessments, and evaluation strategies can teach girls innovation skills and encourage girls to innovate in science.

Informal Science Inquiry in U.S. Boy Scouts' Science and Technology Merit Badges

Matthew E. Vick, University of Wisconsin-Whitewater, vickm@uww.edu

ABSTRACT: The Boy Scouting program in the United States features a non-formal education system for boys from ages 10-17. Over 100 Merit badges exist to entice Scouts to learn about vocations and hobbies that may be of interest to them. Twenty-three merit badges related to science and nature. Ten of these merit badges involve potential for science inquiry. This study evaluates the requirements for these merit badges against the elements of inquiry from the National Academies of Science. Strong examples of science inquiry in terms of data collection, formulation of explanations and connections to scientific knowledge are found. Few examples of the Scout asking his own scientifically oriented question or communicating results are found. Scouting's merit badge program has the potential to engage young people in inquiry-based science based upon its curriculum. Further research into the instructional practices used to deliver this program will be able to determine the effectiveness of this curriculum.

The Impacts of Informal Science on Girls' Interest, Engagement, and Participation in Science Communities, Hobbies and Careers

Lynn D. Dierking, Oregon State University, dierkinl@science.oregonstate.edu

Dale McCreedy, Franklin Institute Science Museum

Jessica Luke, Institute for Learning Innovation

ABSTRACT: This paper describes results of a study investigating long-term impacts of informal science, technology, engineering, and mathematics (STEM) programming on girls' interest, engagement, and participation in STEM. Findings address the lack of in-depth research on long-term impacts of such programs, including for whom and under what conditions they are beneficial. Girls were recruited from five successful programs; data collection included a web-based survey and life story interviews. Data were analyzed with SPSS, utilizing a Community of Practice lens. Research participants (n=213) were from diverse sites: urban, suburban, and rural communities, different cultures, ethnicities, and socioeconomic status. All were 18 years or older and had participated in programming at least five years earlier. Results indicate that gender-focused free-choice STEM programs have powerful, lasting effects on young women's interest, engagement, and participation in science communities, hobbies and careers, even those not pursuing STEM careers or education currently. Noteworthy, impacts were particularly significant and impactful for girls living in urban areas. Findings demonstrate that in addition to providing girls access to quality experiences that enhance understanding of STEM, programs helped women under-represented in STEM build social capital, during participation, and long after, in ways that influenced future choices in careers, education and hobbies.

Tuesday, March 27, 2012

Strand 7: Pre-service Science Teacher Education

Pre-service Science Teachers' Understanding and Usage of Various Assessment Strategies

4:00pm – 5:30pm, Room 306

Presider: Tamara H. Nelson, Washington State University Vancouver

Preservice Formative Assessment Interviews: The Development of Responsive Questioning

Julie Amador, Indiana University, jamador@indiana.edu

Ingrid S. Weiland, University of Louisville

Rick Hudson, University of Southern Indiana

ABSTRACT: When engaging in reform-oriented teaching methods (Harlen, 2001; Steffe & Thompson, 2000), teachers engage in discourse with students and rely on PCK as they question students to elicit mathematical and scientific reasoning. We were interested in determining how preservice teachers focus on children's thinking and develop their ability to question students over the course of one semester. As a result, we followed two preservice teachers as they participated in an innovative field experience program and conducted formative assessment interviews with elementary students to gain an understanding of student thinking and reasoning and to improve pedagogical content knowledge (Abell, 2007; van Drield, Verloop, & de Vos, 1998). Case study methodology was followed (Yin, 2009) and data were analyzed based on previously established questioning frameworks (Crespo & Sinclair, 2008; Moyer & Milewicz, 2002). Findings indicated preservice teachers decrease their use of non-specific questions and increase their use of competent questioning over the course of a semester. Results are of interest to researchers and practitioners interested in examining preservice and inservice teachers' questioning abilities over time.

Exploring Portfolio Assessment in Saudi Pre-service Science Teachers' Education Program

Hiya Almazroa, Princess Nora Bint Abdul Rahman University, hmalmazroa@pnu.edu.sa

ABSTRACT: The study explored the influence of portfolio assessment on Saudi pre-service science teachers' learning experiences. The participants were nine pre-service science teachers in Science Teacher Education program. Qualitative data was collected, coded and analyzed to make meaning of the participants experiences. The primary methods were semi-structured interviews, self-assessment portfolios, and reflective journals. The findings indicated that pre-service science teachers found that portfolios have many benefits: portfolios were useful in organizing learning, helpful in making them aware of their learning strategies, and in learning self assessment skills. Thus some difficulties were reported preparing portfolios.

Diagnosis in Teacher Education – Theoretical and Methodological Considerations

Claudia von Aufschnaiter, University of Giessen, Claudia.von-Aufschnaiter@didaktik.physik.uni-giessen.de

Gabi Duebbelde, Justus Liebig University of Giessen

Juergen Mayer, University of Kassel

Andrea Moeller, University of Trier

Joachim Stiensmeier-Pelster, Justus Liebig University Giessen

Anett Wolgast, Justus Liebig University Giessen

Janine Cappell, Justus Liebig University Giessen

ABSTRACT: Among the competences outlined to be relevant for pre- and in-service teachers, assessment and diagnosis are frequently mentioned. Teachers need to be able to identify students' conceptions and their learning outcomes and they have to monitor students' learning trajectories in order to design instruction accordingly. Even though diagnosis plays an important role in teacher profession, it is rarely explicitly addressed in educational research. The presentation will describe a distinction of different types of diagnosis: diagnosis of a status, of a solution process, of progression in status/solution process, and of learning processes. These different types can be assigned to the notion of summative and formative assessment, but help to describe more precisely the different diagnostic activities teachers should apply. In our project, it also serves as theoretical framework for the methods we use to investigate teacher learning. Two cohorts of prospective teachers are monitored through their university education. Using questionnaires but also video we assess their prior knowledge and their progress for both CK and

Tuesday, March 27, 2012

those aspects of PCK and PK which are related to diagnosis. The main focus of the presentation will be on our theoretical considerations and the methodological challenges we face. Some results will also be presented.

Eliciting, Identifying, Interpreting and Responding to Students' Ideas: Teacher Candidates Growth in Formative-Assessment Practices

Amelia Wenk Gotwals, Michigan State University, gotwals@msu.edu

Daniel Birmingham, Michigan State University

ABSTRACT: With the goal of helping teacher candidates become well started beginners, it is important that methods courses in teacher education programs focus on high-leverage practices. Eliciting and responding to students' science ideas (i.e., formative assessment) is a high leverage practice in science teaching that can be used to support all students in learning science successfully. This study follows seven secondary science teacher candidates in a yearlong practice-based methods course. Course assignments (plans for and reflections on teaching) as well as teaching videos were analyzed using a recursive qualitative approach. In this proposal, we present themes and patterns in teacher candidates' abilities to elicit, identify, interpret and respond to students' ideas. We then present a mini-case study of one teacher candidate's growth over the course of the year. Findings suggest that teacher candidates, with scaffolding, were able to plan for some aspects of ambitious formative-assessment practices, even in the Fall. In the Fall, their enactment of the practices was sporadic, but these practices became more systematic in the Spring semester. Teacher candidates grew particularly in their ability to elicit students' ideas, but still struggled to respond to students' ideas "on the fly".

Strand 7: Pre-service Science Teacher Education

Addressing Culture/High Need Classrooms in Teacher Preparation

4:00pm – 5:30pm, Room 309

Presider: Gale A. Seiler, McGill University

Pre-Service Science Teacher Understandings about the Role of Culture in the Classroom

Stephen Krajewski, Penn State University, sek194@psu.edu

ABSTRACT: The purpose of this study was to investigate how pre-service science teachers view the role of culture in the classroom. Research questions for the study included: (1) How do pre-service science teachers initially view the role of culture in teaching science and to what degree do these influences affect classroom teaching; and, (2) Do pre-service science teachers modify or strengthen their initial conceptions about the role of culture in teaching

Tuesday, March 27, 2012

science after interactions with middle school children? Results show that, while pre-service science teachers tend to be thoughtful about considering the needs of culturally diverse classrooms, there is little evidence to show that these pre-service science teachers have the necessary tools in order to be effective within diverse settings. Potential intervention programs specifically designed for providing the necessary tools for effective science teaching within culturally diverse settings is discussed.

Teaching the Content in Context: Preparing Science Teachers for Meaningful, Relevant Instruction in Underserved Classrooms

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

ABSTRACT: This paper describes results from a mixed methods study that investigated changes in preservice secondary science teachers' knowledge, beliefs, and practices about contextualization within a teacher education program designed to prepare teachers for instruction in underserved classrooms. Contextualization is defined as facilitating authentic connections between science learning and relevant local, sociocultural and political contexts of students in diverse classrooms. Surveys and interviews were administered at the beginning and end of the credentialing year to all preservice science teachers who participated in a fifth-year teacher Masters/credentialing program (n = 13). Three classroom observations were conducted of each of 4 case study student teachers enrolled

in the secondary science cohort (12 observations total). Results from surveys and interviews demonstrated that student teachers developed more sophisticated understandings of contextualization, moving from a contributions/additive approach, i.e., including contributions of minority scientists, toward promoting community engagement and activism in science. Student teaching observations of case study participants revealed that participants' abilities to contextualize instruction were tempered by a lack of effective mentoring around issues of diversity, limited instructional autonomy, and inadequate preparation time. Also of concern is that many preservice teachers maintained deficit views about the role of families in underserved communities.

Preparing Teachers for Teaching in High-need Schools: A Comparison of Two Science Education Programs

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

Juanita Jo Matkins, College of William & Mary

Jacqueline Theresa 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 study compares two such initiatives (both Noyce Scholars programs), each using a distinct, locally adaptive approach. One university adopted an immersive, naturalistic strategy, with modified field placements that gave preservice teachers protracted experiences in high-need classrooms under the guidance of a specially trained, proven veteran of such environments. The other university instead provided supplemental field experiences in high-need schools, coupled with frequent, explicit exercises to provoke reflection, cultural self-awareness, and cross-cultural consciousness and commitment. Participants graduated from both programs with high, heightened self-efficacy in two domains: science teaching and cultural responsiveness. However, they followed divergent pathways in getting there, as revealed by a series of quantitative surveys and qualitative interviews conducted throughout the year. Those undergoing the naturalistic, immersive approach experienced a midstream dip in confidence and cultural responsivity, followed by a dramatic ascent. Those undergoing the supplemental, reflective approach, by contrast, exhibited no such dip, instead growing gradually. More than one strategy may be able to support the development of culturally responsive science teachers.

Tuesday, March 27, 2012

Strand 8: In-service Science Teacher Education

Using Technology to Facilitate Professional Development

4:00pm – 5:30pm, Room 105

Presider: Marissa S. Rollnick, Wits University

Professional Development Integrating Technology - Does Delivery Format Matter?

Lori Rubino-Hare, Northern Arizona University, lori.hare@nau.edu

Jennifer Claesgens, Northern Arizona University

Kristi Fredrickson, Northern Arizona University

Nena Bloom, Northern Arizona University

Carol Henderson-Dahms, Southwest Evaluation Research, LLC

James Sample, Northern Arizona University

Mark Manone, Northern Arizona University

ABSTRACT: To encourage reformed teaching practices, teachers need professional learning experiences which are designed to immerse teachers as learners in the disciplines they teach, and to provide time for them to reflect on what they have experienced (NSDC, 2004). Two professional learning models were conducted to encourage teachers to utilize geospatial information system (GIS) technologies to teach STEM content through project-based instruction (PBI). Teachers were engaged in learning knowledge and skills through an inquiry-based process. In one model teachers attended a two-week summer institute, and in the other model teachers met monthly throughout the academic school year. Our study examines differences in the delivery format of teacher professional development on teacher and student learning outcomes. We found that teachers in both formats of

professional development built an understanding of GIS and content, but that both the format and the timing of professional development affected outcomes. This will be further discussed in terms of gains in teacher knowledge, level of implementation, participant retention, and correlation to developing students' STEM skills.

Promoting a Learning Community: Using Wikis in a Professional Development Program for Chemistry Teachers
 Yael Shwartz, Weizmann Institute of Science, yael.shwartz@weizmann.ac.il

Dvora Katchevitch, Weizmann Institute of science

ABSTRACT: This study focused on using wiki as a learning environment, as part of a professional development program for chemistry leaders-teachers. Using the wiki environment aimed at constructing a community of practice that builds and shares knowledge. The research investigates the relationship between teachers' own experience, beliefs and the extent in which they support their students in constructing knowledge collaboratively. Twenty teachers participated in a two years long "teachers-leaders" program. The research tools consisted on automatic data obtained from wiki database, evaluation of teachers' artifacts, interviews, and a questionnaire. Different participation profiles emerged from data analysis. 28% of the teachers could be defined as peripheral members of the community, 44% could be considered central members, and 28% were considered as leaders of this community. Teachers' increasing level of engagement and centrality was also tracked. Some of the teachers developed a genuine sense of community of practitioners and promoted collaboration in other means and frameworks than the wiki. Teachers' who were central members of the wiki community tended to describe their classroom practice in their own classes as more 'student-centered'. Supporting teachers in acknowledging the values of collaborative learning and the role of technology in facilitating communities of practice is recommended.

The Use of Blogging as a Tool to Support Teachers' Identity Development as Leaders

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Ya-Wen Cheng, University of Missouri

Carina M. Rebello, University of Missouri

Somnath Sinha, University of Missouri

Nilay Muslu, University of Missouri, Columbia

ABSTRACT: Increasingly, teacher leadership is being recognized as an essential ingredient in education reforms (York-Barr & Duke, 2004); however, few teachers consider themselves leaders. For many teachers, becoming a

Tuesday, March 27, 2012

leader is not just acquiring knowledge and skills, but developing a new professional identity. Recent literature notes a number of key challenges that teachers face, and how their identity as a leader might put them at risk with dominant school culture where norms of egalitarianism, isolation, and seniority persist (Barth, 2006).). Luehmann (2008) emphasizes the value in offering opportunities for safe spaces in which teachers can take risks as they 'try on' new identities, such as teacher leaders. We integrated the use of Blogs in a professional development program to support teachers in participating in a community that could nurture the development of common perspectives, commitments, and visions for teacher leadership (Luehmann & Tinelli, 2008). Our findings illustrate the potential benefits of blogging for supporting teachers' identity development as leaders. Specifically, by participating in pedagogical transactions, social interactions, and intellectual deliberations, teachers were able to rethink their roles as teachers and leaders, and receive support and encouragement in their efforts to be leaders in their classrooms, schools, and districts.

Development of a Teacher Training Course on the Use of Computer Aided Material in Science

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Jari Lavonen, University of Helsinki, Finland

Helga Stadler, University of Vienna, Austria

Zhelyazka Raikova, University of Plovdiv "Paisii Hilendarski", Bulgaria

Roger Erb, University of Education Schwaebisch Gmuend, Germany

Karine Bécu-Robinault, University of Lyon, France

George S. Ioannidis, University of Patras, Greece

Sönke Graf, University of Education Heidelberg, Germany

Clemens Nagel, University of Vienna, Austria

ABSTRACT: A huge amount of excellent computer aided teaching and learning (CAT) material exists in Europe, but there is far less experience and competence at using and choosing these materials effectively. This is especially true with respect to getting girls and boys interested to study science, and motivated to get acceptable learning results. Recent research results show, that there are good chances of improving the classroom practice if the material is appropriately used and adapted to the specific needs within the schools of the different countries. A transfer of those results into teaching practice within Europe is organized by our project. International scientists and teachers, experienced within this field, worked together and adapted their nationally oriented ideas and research results to those needs. The intention was to develop and implement modules for a teacher-training course, which enables teachers to judge the quality of CAT environments in science teaching, to adapt appropriate examples to their own teaching, and to evaluate their activities. For this purpose, we use already existing environments of the project-countries. We show that discussing and judging the quality of CAT for science teaching is an actual and international question.

Strand 8: In-service Science Teacher Education

Teachers Learning Content, Inquiry, and Universal Design

4:00pm – 5:30pm, Room 106

Presenter: Irene U. Osisioma, California State University, Dominguez Hills

Assessing an Innovative Program for K-12 Teachers that Integrates Scientific Inquiry with UDL

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Stacey Skoning, University of Wisconsin Oshkosh

John Lemberger, University of Wisconsin Oshkosh

ABSTRACT: This study explores (both quantitatively and qualitatively) the effects of an innovative University-based outreach program for K-12 in service teachers. The program specifically focuses on teaching science content, principles of universal design, and science inquiry. It scaffolds teachers' beliefs about the ability of their students who have a variety of disabilities to learn science content through inquiry. Teachers are learning to integrate principles of scientific inquiry and Universal Design in their teaching of inclusive science lessons. The results of the **Tuesday, March 27, 2012**

study are that the program holds great potential but in practice there are significant practical issues that need to be addressed in order for this model to be sustainable and generalized.

Case Studies in Teacher Content Learning in a Problem-Based Learning Professional Development Setting

Tom J. McConnell, Ball State University, tjmcconnell@bsu.edu

Joyce M. Parker, Michigan State University

Jan Eberhardt, Michigan State University

ABSTRACT: Teaching science effectively requires a deep understanding of science content. Professional development (PD) is one venue for improving content knowledge for teaching. The [PD Project] included content development for teachers. Project researchers developed a strategy for assessing science content knowledge using open-response, general-knowledge and application questions and a scoring system for comparing pre/post responses that could be used across seven different content strands. This presentation shares four case studies of elementary and middle school teachers' content learning that illustrate common patterns of content knowledge development. Some teachers entered the program with little or no content knowledge of the specific concepts addressed in a content strand, while others had incomplete, inaccurate or confused understandings. Teachers' growth in content came in the form of clarification or elaboration of concepts they were already using and/or use of new concepts. The case studies illustrate the information that can be provided by this type of study that can be useful for other PD projects and suggest questions that can be answered by analysis of the larger data set. The latter include whether gains in content knowledge are dependent on incoming knowledge and which ideas are most difficult for teachers.

Supporting Inquiry-Rich Teaching through Professional Development within a District-Higher Education Partnership

Jay A. Fogleman, University of Rhode Island, fogleman@mail.uri.edu

Joshua Caulkins, University of Rhode Island

Sarah Knowlton, Rhode Island College

Laura Schifman, University of Rhode Island

Daniel Murray, University of Rhode Island

ABSTRACT: There is a substantial need for usable instructional materials to help teachers enact inquiry-rich teaching in their science classrooms. Technology-enhanced investigations can provide students with opportunities to collect data using probeware and investigate complex systems through models and simulations. In this district-university partnership, stakeholders are collaborating to develop inquiry-rich activities addressing state standards and provide meaningful learning opportunities for students statewide. A challenge faced within the partnership was how to design investigations and PD that participating teachers found usable and relevant for their classrooms. This study describes how 11 “Resource Teams” consisting 2-3 scientists from higher education and teachers from grades 8-12 developed investigations and PD short courses. We used course evaluations, pre/post assessments, short course observations and interviews to determine the degree the short courses supported classroom inquiry, and the effects they had within the partner school districts. Results describe how inquiry was represented within the various PD sessions, and the degree to which these experiences were valued by teachers. This study illuminates the successes and challenges experienced by teams while developing innovations and PD that are usable and sustainable within a district university partnership.

A Vygotskian Theoretical Framework for Understanding High School Science Teachers' Talk in Professional Development

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

ABSTRACT: Under what circumstances does professional development scaffold high school science teachers' self-generative learning about teaching inquiry? Using a Vygotskian perspective, I will present the results of text analysis of teachers' talk in discourse-based professional development sessions as “semiotic bootstrapping,” that is, the creation of new knowledge through talk. In such meetings, I understand teachers to have “pulled themselves up by their bootstraps” to create ideas which were new to all participants. I argue that using this text analysis framework allows us to gain access to teachers' learning as co-constructed within a professional learning

Tuesday, March 27, 2012

community. The methodology emerged from analysis of teachers' talk in a professional learning planning session. I apply the methodology to a different setting, a school-based 90-minute collaborative curriculum development meeting, to see whether it illuminates teachers' talk across contexts. I argue the analysis suggests intertextuality is a prominent feature of the way expert inquiry teachers talk. This allows consideration of how and when science teachers' professional talk can be consciously designed as a zone of proximal development.

Strand 10: Curriculum, Evaluation, and Assessment

Approaches to Measures of Curriculum Effectiveness

4:00pm – 5:30pm, Room 308

Presenter: Christopher Wilson, BSCS

Advancing Tools for Research on Science Instruction: Results from the National Field Test of a Classroom Observation Protocol

Jacqueline DeLisi, Education Development Center, Inc., jdelisi@edc.org

Daphne Minner, Abt Associates, Inc

Linda Hirsch, Education Development Center, Inc.

Ruth Krumhansl, Education Development Center, Inc.

ABSTRACT: There is increasing emphasis in science education policies and programs on developing and supporting quality science teachers. Yet, there is limited documentation of the components of quality science instruction and

few tools for conducting this research. This paper describes the process undertaken to develop a new tool that can be used by science education researchers and evaluators to comprehensively and reliably examine the details of secondary science instructional practice through classroom observations. The tool contains a set of indicators that measure the duration of the lessons discrete events, the types of verbal practices employed by the teacher, the alignment of content taught with the national science education standards, the types of investigation experiences present, and teacher style and management skills. Results from two pilot tests, expert reviews, and a national field test consisting of 18 teams of science education researchers (37 participants) indicate that the tool can be used reliably and across a variety of secondary science classroom settings.

Instructional and School Factors and their Influence on Science Competencies

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Chia-Lin Tsai, University of Missouri-Columbia

Lloyd H. Barrow, University Of Missouri

ABSTRACT: The purpose of the study is to examine 1) the impact of reform-based science teaching strategies on students' science competency, and 2) the impact of interactions between school characteristics and these reform-based teaching strategies on students' science competency using a large-scale assessment. We used the data from the 2006 Program for International Student Assessment (PISA) science assessment. The data contains 4810 students (50% male and 50% female) from 145 schools within the U.S. A two-level hierarchical linear model (HLM) was used. At the student level, we found that the four reform-based strategies (i.e., interactive teaching, hands-on activities, student investigation, and use of application) were significant predictors of students' science competency. At the school level, we found the three school characteristics (i.e., school responsibility for curriculum and assessment, school activities to promote science learning, and students' average science self-efficacy within each school) can buffer some of the negative impacts from the reform-based strategies (i.e., interactive teaching and student investigation). The results and implications will be discussed fully in the conference paper.

Assessment Tools for Studying the Effect of Educative Curriculum Materials

Peggy Trygstad, Horizon Research, Inc., ptrygstad@horizon-research.com

P. Sean Smith, Horizon Research, Inc.

Elizabeth A. Davis, University of Michigan

Tuesday, March 27, 2012

Annemarie S. Palincsar, University of Michigan

ABSTRACT: There is general agreement in the field that teacher knowledge of disciplinary content directly and positively affects student learning, but empirical support for this claim is thin. Few valid and reliable measures of teacher and student content knowledge exist for investigating the relationship between teacher knowledge of specific science content and student learning of the same content. This paper describes the development of pairs of multiple choice assessments in two content areas often taught initially in the upper elementary grades: ecosystems and electric circuits. We describe the development cycle, which involves domain specification, expert review, cognitive interviews with the target audience, and large-scale piloting. We detail findings from the cognitive interviews, in particular the misconceptions identified among teachers and students. This work takes place in the context of a larger project studying the effects of educative curriculum materials.

Assessing the Quality of Teaching of Brown's Pre-College Courses

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Robin Rose, Brown University

James Chansky, Brown University

Maria Byerly, Brown University

ABSTRACT: This paper describes the assessment of 80 STEM courses that are part of Brown University's Pre-College Summer Program. The courses are for high school students who desire a college experience. They are taught by Brown faculty, adjuncts, and graduate students. The courses meet for 3 hours daily and range from 1 to 4 weeks in length. Some of the courses are shortened versions of 100 level introductory undergraduate courses while others are on more unique topics. The quality of instruction is evaluated in three ways: (1) by the students

themselves, (2) by using the Reformed Teacher Observation Protocol (RTOP), and (3) by a scale developed by us. These evaluation results are compared, contrasted, and discussed. In universities, faculty are often promoted or given tenure based in part on student evaluations. Our study shows that student rankings of their instructors are not necessarily the only way of evaluating teaching performance. In this paper we propose a comprehensive approach to evaluating university faculty.

Strand 11: Cultural, Social, and Gender Issues

Exploring Elementary Science Education and Parent Participation for STEM Pipeline

4:00pm – 5:30pm, Room 107

Presider: Felicia M. Mensah, Teachers College, Columbia University

Effective Urban Elementary Teachers of Inquiry Science: Beliefs, Knowledge, and Resources Shaping Teacher Planning

Elaine M. Silva Mangiante, University of Rhode Island, emangiante@cox.net

ABSTRACT: This multi-case study examined the planning for inquiry science lessons by three upper elementary teachers identified as effective in inquiry science instruction in urban schools. One understudied area in science education is the planning for science inquiry practices by urban elementary teachers despite limitations they face such as accountability pressures or resource availability. This study's conceptual framework included teachers' beliefs, knowledge, and agency with resources as contributing factors to urban teachers' planning decisions for inquiry science. Through interviews, observations, and document analyses over the course of a science unit, preliminary findings suggested that effective urban elementary teachers of inquiry science valued their students' gaining scientific literacy skills. To promote their inquiry planning, they sought out knowledge of their students' backgrounds, additional science inquiry training and materials, consistent support of a science education specialist, and collaboration with like-minded fellow faculty members. Findings suggested that teachers with more science content knowledge tended to plan explicitly for students' development in supporting claims with evidence. The planning of teachers with limited content background was less targeted, but they sought out resources and assistance to address their weaknesses. However, inconsistent access to human and material supports continued to pose challenges for teachers in urban schools.

Tuesday, March 27, 2012

Exceptional Practices and Unconventional Norms: Parents' Initiatives for assisting their Children's STEM Learning

Rashmi Kumar, University of Pennsylvania, rashmikupenn@gmail.com

ABSTRACT: Using a case study analysis, this study reveals a range of unconventional approaches assumed by parents in order to encourage their children towards exploring and entering the STEM pipeline. Although purposefully limited to a specific group of parents, this study reveals parents' utilization of externally available resources in order to primarily encourage their children's exploration of STEM fields, and secondarily, to mitigate hurdles for STEM learning within school system. Parents (n = 35/39) attribute children's sustained participation in STEM fields to their resourcefulness and self-courage to break established practices. Parents (n = 39) and children's (n = 32) respective attributions and reflections demonstrate high level of consistency. The presentation will share the research methodology, supporting documents, and artifacts gathered during research, emergent findings, and implications for parents, schools and OST STEM organizations.

Geeks or Freaks? How Primary School Children View Science-keen Peers

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

Louise Archer, King's College London

Jonathan F. Osborne, Stanford University

ABSTRACT: Declines in the pursuit of post-compulsory science have contributed to international interest in understanding the factors that may play a role in deterring children from pursuing science qualifications and careers. Despite student claims that their decisions about whether or not to pursue science are not strongly influenced by peers, peer relationships do form an important part of the context in which children come to identify

– or not – with science. Drawing on data from a survey of over 9000 children and, especially, from interviews conducted with 92 children, this presentation will examine the possible relationship between children’s views of peers who are 'really into' science and their own developing science aspirations. Data revealed that, although those with strong science identities are generally regarded in a positive light, they are simultaneously regarded by many students as somehow 'other'.

Factors at the School Level Contributing to Reduced Achievement Gaps on Elementary Science Tests

John Settlage, University of Connecticut, john.settlage@uconn.edu

Regina Suriel, University of Connecticut

ABSTRACT: The persistence of science achievement gaps seemingly defies efforts that address changes to curriculum materials and/or instructional practices. Within school effectiveness research, a systemic perspective of school buildings has revealed that school organization and leadership practices have discernible beneficial impacts on student achievement. Unfortunately, the vast majority of such research has been restricted to language arts and mathematics. Given the public availability of statewide science performance, there is an opportunity to evaluate whether those patterns for non-science apply to our favored subject matter. Having gathered data for two years about the relationships between school organization and science achievement, this paper serves as a theoretical regrouping exercise as a federally funded five-year research study gets underway. In this presentation, we consider the opportunities and shortcomings evident in other achievement studies in urban school systems. This discussion serves as an important prelude to instrument development (i.e., questionnaires and interviews) and offers a forum for inviting other perspectives to complement our efforts.

Strand 12: Educational Technology

Symposium - Digital Resources to Support Science Instruction: Research, Development and Practice

4:00pm – 5:30pm, Room 101

President: Alice Anderson, Education Development Center, Inc.

Discussant: Eric N. Wiebe, North Carolina State University

Presenters:

Lauren Goldenberg, Education Development Center, Inc.

Tuesday, March 27, 2012

Catherine E. Milne, New York University

Ruth Schwartz, New York University

Mimi Recker, Utah State University

Al Byers, National Science Teachers Association

Chad Dorsey, The Concord Consortium

Marian Pasquale, Education Development Center, Inc.

Ted Sicker, WGBH Teachers' Domain

ABSTRACT: Increasingly, science teachers integrate digital resources into their teaching “toolbox,” alongside more familiar activities such as laboratory investigations, demonstrations and observations. Digital resources refer to web- or computer-based animations, simulations, games, and videos. While these resources sometimes replicate a non-digital experience, more often they offer a way to illustrate or visualize or a scientific concept beyond what non-digital tools can provide. But how might these resources help students learn? How should they be integrated into instruction? In this session, panelists will share their research and content development experiences as well as the theoretical underpinnings of their work to discuss implications of using digital resources in science instruction. Presenters will share varying perspectives on these issues through discussion of their research and development projects. The symposium presiders will facilitate audience comments within the framework of the guiding questions and the discussant will lend a constructive, critical view to the participants’ ideas and suggest future directions for research. Symposium attendees will gain an understanding of the issues and contribute to the discussion about setting a research agenda for digital resource use in science education.

Strand 13: History, Philosophy, and Sociology of Science

Assessing NOS

4:00pm – 5:30pm, Room 102

Presenter: Jonah B. Firestone, Arizona State University

Pathways of a Humanistic Approach to Science Education: A Review of the Literature

Jeremy Price, Boston College, jeremy.price@bc.edu

ABSTRACT: In this review of the literature, I assert that the conventional science curriculum exhibit particular purposes and underlying assumptions which are out of sync with the lives and experiences of students. These contribute to a lack of access to the knowledge necessary to address the scientific and environmental issues faced by students and their communities. I further assert that the consideration of humanistic approaches to science education in the development of curriculum, the facilitation of classroom practices, the setting of research agendas, and the planning of policy provides the base necessary to transcend the uncritical acceptance of the purposes and assumptions of the conventional science curriculum. I will provide a survey of three humanistic pathways in science education: liberal, renewal, and cultural-progressive. In exploring these pathways, for each I explore their implications for science education as a field, what teachers need to know, and what students experience. By considering a pluralistic view of three pathways together, I assert that we can provide an appropriate science education for students as they face the 21st century in a way that cannot be met by considering each one in isolation.

Turkish Preservice Teachers' Epistemological beliefs in Physics, Chemistry, and Biology: A Mixed Study

Mustafa S. Topcu, Mugla University, msamitopcu@gmail.com

ABSTRACT: The purposes of the study were to assess Turkish preservice teachers' domain-specific epistemological beliefs and to investigate whether Turkish preservice teachers distinguish disciplinary differences (physics, chemistry, and biology) in domain-specific epistemological beliefs. Mixed method research design guided the present research. The researcher explored three epistemological dimensions: certainty and simplicity of knowledge, justification for knowing, and source of knowledge. Both quantitative and qualitative results suggested that a domain-specific epistemological beliefs system is a valid model to explain preservice teachers'

Tuesday, March 27, 2012

epistemological beliefs. In terms of epistemological beliefs, disciplinary differences among physics, chemistry, and biology were discussed in the last parts of the study.

Development and Validation of a Rubric to Score the Views of Nature of Science (VNOS) Questionnaire

Fouad Abd-El-Khalick, University of Illinois at Urbana-Champaign, fouad@illinois.edu

Jeremy Belarmino, University of Illinois at Urbana-Champaign

Ryan Summers, University of Illinois at Urbana-Champaign

ABSTRACT: The 1990s witnessed a major shift, which entailed adopting more qualitative, open-ended instead of quantitative, convergent-type instruments to assess K-12 students' understandings of nature of science (NOS). A widely used valid and reliable qualitative instrument is the Views of Nature of Science (VNOS) Questionnaire. However, there currently is interest and need for using quantitative approaches to researching the teaching and learning about NOS in K-12 classrooms and teacher education settings. Still, using convergent-type standardized NOS instruments for this purpose means ignoring two decades of research on NOS in science education. Thus, to capitalize on the validity of the VNOS and enable quantitative research in the domain, this study aimed to develop and validate a rubric to score VNOS responses. The rubric guides the assignment of a score ranging from 0 to 5 points to a VNOS respondent's views related to eight widely emphasized NOS aspects by reference to a 6-point criterion-based scale. After establishing inter-rater agreement, the rubric was applied to VNOS-C questionnaires completed by 142 undergraduate and graduate students enrolled in a secondary science teaching certification program. Data analyses indicated that the VNOS Rubric was reliable and featured good measures of validity.

Using Text Mining Technique to Categorize Science Writings According to Their Inclusion of Nature of Science: Implications for Practice and Research

Feng Jiang, University of Arkansas, fjiang@uark.edu
 William F. McComas, University of Arkansas

ABSTRACT: Knowledge of the nature of science (NOS) is one of the most essential elements of science literacy. Research has demonstrated that NOS should be taught in an explicit and reflective approach. However, previous analyses found that presentations of NOS in science textbooks generally were insufficient and inaccurate and teachers lack educational materials. Popular science writings could provide supplementary source of materials for teaching NOS. However, one challenge is to provide a mechanism by which educators could locate science writings that address NOS explicitly from among the countless science writings that focus primary on content. Text mining is a powerful technique which discovers patterns from textual data sources. Based on those patterns, predictive models can be established and applied to automatically identify specific features of text. The purpose of this study was to establish and evaluate a classification model which can be used to categorize science writings based on their inclusions of NOS. Our preliminary study found that by training the model with philosophy of science books and science textbooks, our classification model, which is based on Support Vector Machine (SVM) algorithm, achieved excellent accuracy (99%) in cross validation. Moreover, good accuracy (86%) was obtained when testing with benchmarks statements at sentence level. It is also hoped that the accuracy of the classification model can be improved in future study leading to the characterization of entire narratives.

Strand 14: Environmental Education

Using Placed-based Frameworks to Engage Learners in Environmental Education

4:00pm – 5:30pm, Room 103

Presider: Rita Hagevik, The University of North Carolina at Pembroke

Merging Place-based Environmental Science and Traditional Ecological Knowledge in Secondary and Postsecondary Educational Settings

Daniel R. Zalles, SRI International, daniel.zalles@sri.com
 Brian D. Collins, University of Washington
 Cynthia Updegrave, University of Washington

Tuesday, March 27, 2012

David R. Montgomery, University of Washington
 Thomas G. Colonese, University of Washington
 Amir J. Sheikh, University of Washington, Seattle

ABSTRACT: Instructional designs with a place-based focus have great potential to lead to greater engagement in science among American Indian students, yet there are cultural discontinuities with science that limit the realization of this potential, such as scientists' perceived detachment from nature and use of analytical and mechanical metaphors for Earth systems. An NSF-funded project called Data-driven Inquiry in Geoscience Environmental Restoration Studies (DIGERS) will be described. The project has taken its cue from research suggesting that these discontinuities can be overcome by integrating into an environmental science curriculum the diverse meanings that a place holds for its Indian groups and promoting the ecological and cultural aspects of sustainable living in the place. A collaborative team composed of educational researchers and university faculty developed and implemented aligned high school and college level curricula that integrated river geomorphology with ecology, traditional ecological knowledge, and knowledge of treaties and other facets of recent history impacting the local Indian populations and river conditions. Results have been very promising and the project team is creating templates for the instructional designs that can be adapted to other place-based curricula about environmental sustainability. This paper will describe the DIGERS instructional designs, classroom implementations, and student outcomes.

Engaging Underrepresented Youth through the Enactment of an Urban Environmental and Geoscience Place-based Curriculum

Amy DeFelice, CUNY, amyferguson3@hotmail.com
 Jennifer D. Adams, Brooklyn College- CUNY
 Pieranna Pieroni, Brooklyn College- CUNY
 Brett Branco, Brooklyn College- CUNY

ABSTRACT: High school students in a large urban area, undergraduate students, and geoscience faculty at a local college, addressed real geoscience problem-based inquiry situated within a place-based pedagogical approach in a major local urban park. The overarching goals of this research were to determine a) how are students' science identities influenced through participation in a week-long geoscience research experience with college students and faculty, and b) how can a place-based environmental geoscience curriculum increase the engagement of urban youth, living in a particular area, in science? Student researchers participating in the activity (N=22) completed Likert-scale pre- and post-surveys, which were analyzed using paired t-tests. Student journal reflections were analyzed. Survey and journal reflection results show that students' science identities were enhanced and student interest in learning science outdoors increased through participation in the program. This research adds to the body of knowledge describing how outdoor settings and place-based pedagogies can be used to increase urban students' interest in science, and demonstrates how students working with scientists who conduct scientific research in students' communities can be a source of STEM motivation and identity development.

Teaching Earth Smarts: A Pragmatic, Nonpartisan Educational Construct for Socioecological Literacy

Bryan H. Nichols, University of South Florida, bryanhnichols@gmail.com
 Dana L. Zeidler, University of South Florida

ABSTRACT: Successfully adapting to a changing world may be the next generation's most formidable challenge. This study, a construct analysis, designed, analyzed and validated the components of essential ecoliteracy, or "earth smarts", an educational construct based on justly maintaining or improving quality of life in a changing world. The construct emerged from an extensive literature review and analysis of topics related to environmental literacy, ecological consciousness, global citizenship and sustainability. The interrelated components were refined and clarified using a set of systems analysis tools, and input was solicited from a range of experts and stakeholders for validation. Four primary domains for essential ecoliteracy emerged: concepts (including historical ecology, thermodynamics and earth systems), competencies (cognitive skills including self-regulation, scientific reasoning, systems thinking and community skills), a sense of place (affective components including local/global awareness, self-efficacy and environmental sensitivity), and values (including respect for other cultures and species, and

Tuesday, March 27, 2012

justice as fairness). As increasing urbanization obscures critical environmental connections for both students and teachers worldwide, essential ecoliteracy can provide researchers, educators, and policy makers with a pragmatic, nonpartisan tool for curriculum design and implementation. Earth smarts provides a framework to help students connect science and society in a beneficial framework.

This is More Like Home: Enriching Students' Thou Relationship with Nature through Community Mapping

Susan Jagger, OISE/University of Toronto, s.jagger@utoronto.ca

ABSTRACT: The life and works of Aldo Leopold exemplify a deep connection to and understanding of place. Drawing from Leopold's A Sand County Almanac, Knapp (2005) identified ten ways of knowing nature that can enhance and strengthen one's I-Thou relationship with the environment—a connection that makes one feel part of a greater whole. In this paper, Knapp's framework is used to explore if and how community mapping can support the development of this relationship in students. Looking at the case study of a fourth grade class that completed a community mapping project, this paper discusses themes of observing, situated knowing, identifying, restoring, and transforming. Its findings suggest that community mapwork can enrich students' developing connections to place and the broader environment and community mapping's use as a pedagogical tool in environmental education is encouraged

Membership and Elections Committee Sponsored Session
Early Career and Junior Faculty Early Career Discussion

5:45pm – 6:45pm, Room 101

Presiders:

Reizelie Barreto-Espino, Towson University

ABSTRACT: This session is particularly designed for the early career, junior faculty who need support during the first years of their academic career. The focus will be a panel discussion with experienced faculty who can guide junior faculty through important issues that pertain to the tenure process and other issues. Discussion topics include, but are not limited to: publications, research in the new position, collaboration with different colleges within the university setting, teaching loads, the tenure and promotion process, etc. We invite all junior faculty interested in this topic to join us.

Wednesday, March 28, 2012

Equity and Ethics Committee Sponsored Session

New Scholars Symposium Sponsored by the Equity and Ethics Committee: Teaching and Learning Science in Diverse Contexts -- Local and Global Perspectives

8:30am – 10:00am, Room 313

Presider: Bhaskar Upadhyay, University of Minnesota

Discussant: Valarie L. Akerson, University of Indiana-Bloomington

Presenters:

Femi Otulaja, University of Witwatersrand-Johannesburg, South Africa

Vanashri Nargund-Joshi, Indiana University-Bloomington

Minjung Ryu, University of Maryland-College Park

Nai-en Tang, University of Missouri-Columbia

Idaykis Rodriguez, Florida International University-Miami

Renee Michelle Goertzen, Florida International University-Miami

Eric Brewe, Florida International University-Miami

Laird H. Kramer, Florida International University-Miami

Ingrid M. Sanchez Tapia, University of Michigan

Consuelo J. Morales, University of Michigan

Teresa Satterfield, University of Michigan

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

Nievita Bueno Watts, Purdue University

ABSTRACT: Five emergent scholars -- last year's recipients of the Jhumki Basu Scholars Award -- present compelling investigations situated in the context of racially and ethnically diverse in-school and out-of-school settings. These studies span urban contexts in the United States, as well as internationally. The scholars bring diverse global perspectives that have shaped science education globally with locally applicable nuances and values. These five new scholars help us understand challenges and successes of science teachers, students, and programs. These studies also help us broaden our knowledge of science education from the United States to India and to Korea.

Strand 2: Science Learning: Contexts, Characteristics and Interactions

Science Inquiry

8:30am – 10:00am, Room 302

Presider: Jonathan F. Osborne, Stanford University

Inquiry and Elementary Science Learning: Evidence from a Randomized Trial of the Science Writing Heuristic

Mack Shelley, Iowa State University, mshelley@iastate.edu

Christopher Gonwa-Reeves, Iowa State University

Joan Baenziger, Iowa State University

Ashley Seefeld, Iowa State University

Brian M. Hand, University of Iowa

William Therrien, University of Iowa

ABSTRACT: We present results from implementation of a cluster randomized field trial of the Science Writing Heuristic (SWH) inquiry-based instruction with students in grades 3-5 in Iowa. SWH and control students' results are compared on the Iowa Tests of Basic Skills (ITBS) scores on science content and science inquiry skills and on Cornell Critical Thinking (CCT) tests. SWH students had significantly higher gains in levels of induction and deduction, and overall, compared to control students. A structural equation model showed significant positive effects of SWH treatment compared to control on Science Inquiry and Math Concepts/Estimation. These preliminary results provide the basis for drawing potentially major implications for inquiry-based science instruction. Statistically significant improvements have been shown in critical thinking skills and in key aspects of student knowledge and comprehension following relatively brief exposure to the SWH approach. These findings also provide policy implications for the interplay between science education and the evidence-based study of how

Wednesday, March 28, 2012

student achievement is affected by structural and classroom-level shifts in instructional approaches. This paper provides new tools for enhancing the quality and impact of elementary-level science classroom instruction in increasingly diverse classrooms.

Integrating the Outdoor Learning Environment into Formal Science: Testing the Model across Culture and Age
 Molly L. Yunker, Weizmann Institute of Science, molly.yunker@weizmann.ac.il
 Nir Orion, Weizmann Institute of Science

ABSTRACT: One challenge in middle grade classrooms is to expose students to key ideas in science to promote learning while engaging learners in personally relevant phenomena in a local context. The outdoor learning environment has largely been ignored as a legitimate setting for learning in the formal school curriculum. A curricular unit was designed following a model developed in a different culture and context, that grounds Earth systems concepts in students' local environment, while engaging them in integrated classroom, laboratory, and outdoor learning experiences. The unit targets Earth systems concepts related to interactions between the geosphere and hydrosphere. One teacher and 111 sixth graders participated in this curricular enactment over an eight-week period. A mixed methods approach (interviews and survey data) was used to validate the holistic model that integrates the outdoor and indoor activities in a culture different from the one in which the model was developed. In addition, this study explored students' perceptions of the role and value of outdoor learning experiences in providing connections between learning environments. This study has implications for curriculum developers and teachers, as the outdoor setting was found to have a valuable cognitive and affective influence when the outdoor environment was an integral component.

Assessment of Group Learning in Interdisciplinary Environments
 Bijaya Aryal, University of Minnesota-Rochester, baryal@umn.edu
 Robert L. Dunbar, University of Minnesota-Rochester
 Rajeev S. Muthyala, University of Minnesota-Rochester

ABSTRACT: Contemporary scientific investigations are increasingly multi-disciplinary and require interactions across diverse research communities. To effectively work in such communities, collaborative learning is critical. Although assessments of effective group work are routinely conducted in a discipline-specific context, it is unclear what the most effective mode of group work is for interdisciplinary learning. Further it is not known whether a specific mode of interaction facilitates subsequent transfer of learning at an individual level. We designed interdisciplinary learning activities that encouraged students to use knowledge and modes of thinking from multiple disciplines. A series of group-based, problem-solving activities were designed and implemented throughout a semester in an introductory level physics course. Holistic solutions of these problems required a multi-disciplinary approach. We examined problem solving strategies employed by students when they worked cooperatively in class. Our investigation revealed that different modes of group interaction had differential outcomes on student learning and transfer of learning. Three modes of group interaction were observed: a scaffolding mode, a parallel mode and a leading-following mode. Within each mode, the group used specific problem solving strategies. Our results suggest that the scaffolding mode of interaction allowed for better transfer of problem-solving skills at the individual and group level.

Studying the Process of Decision-making in an Inquiry-based Module
 Eduardo F. Mortimer, Universidade Federal de Minas Gerais Brazil, mortimer@ufmg.br
 Fábio Augusto R. Silva, Universidade Federal de Ouro Preto Brazil

ABSTRACT: This study investigates the decision-making processes experienced by a group of students who did a module of their Biological Sciences course, offered by the Department of Biochemistry and Immunology from a University located in Minas Gerais, Brazil. The students were engaged in inquiry-based teaching and worked in a research project which they chose and that aimed at investigating whether, first chives and then clove pink, had a repellent property on a species of ant known as "ghost ants". The seven students who did the project were videotaped over a semester. In our study we describe and analyze the movements and discourse that emerge in events of production and communication of scientific knowledge. We emphasized the times when group members

Wednesday, March 28, 2012

were faced with problematic situations that generated discussions and decision-making related to their investigative procedures. In this examination of the negotiations engendered in the course of the research we identified their epistemic practices, showing the changes they made and the reasons that determine decisions negotiated by the group. With this study we hope to contribute to the understanding of the factors that influence the epistemic learning of students engaged in inquiry-based teaching.

Strand 2: Science Learning: Contexts, Characteristics and Interactions

Secondary Science

8:30am – 10:00am, Room 311

Presider: Phyllis Katz, University of Maryland

Hearing the Meanings Expressed by High School Students of Science: A Qualitative Study

Jeremy Price, Boston College, jeremy.price@bc.edu

ABSTRACT: Science education in schools is often inadvertently designed so that it is frequently inconsistent with students' lived experiences. Science is therefore seen by students as an endeavor for someone else. This research promotes an exploration of meanings, allowing students to find their place in science and the roles that science fills for them. With meanings in the open, students can engage fully in science, experimenting with the potential identities they may take on as citizens and scientists and consider the actions they may make as scientifically-educated persons. Utilizing qualitative research methods, this project draws upon interviews with and observations of the diverse range of students and teacher in a high school biology class and student artifacts from two card sort activities and the depiction by students of what doing science looks like. Analysis of this data suggests that students' views of the meanings of science were strongly influenced by their teacher, yet they were looking to relate science to life's problems. Students' engagement with science was influenced by their developing sense of identities, but was also impacted by cognitively- and aesthetically-rich "Aha!" moments. This research provides ways to consider these findings in the development of meaningful science curricula.

The Influence of Lab Activities, Teacher Certification and Subject on Students' Engagement, Motivation and Learning

Diana J. Zaleski, Northern Illinois University, DZaleski07@gmail.com

Lee Shumow, Northern Illinois University

Jennifer A. Schmidt, Northern Illinois University

ABSTRACT: High school science teachers consider laboratory lessons an essential part of their curriculum yet few recent studies examine how labs are conducted and whether they contribute to student learning, engagement and motivation. In addition, prior research has documented that subject area and teacher certification significantly affects students' classroom experiences (Schmidt, 2010; Zaleski, 2011). This study examined 11 high school science classrooms to compare students' in the moment reports of their learning, engagement and motivation during laboratory and non-laboratory activities. Data were collected using the Experience Sampling Method (ESM) over the course of ten class periods. Students' experiences were compared using a 3-Level Hierarchical Linear Model (HLM, Raudenbush & Bryk, 2002). The analysis also examined whether the relationships between student engagement, learning, and motivational processes varied by teacher certification and type of science course. During lab activities students reported less challenge, concentration and relevance, however, reported higher enjoyment and interest than during non-lab activities. Subject area and teacher certification were found to be significant factors affecting students experiences in science as well. Results are discussed in terms of how laboratory lessons might be improved to enhance student learning, engagement, and motivation.

Positionality in the Physics Classroom: Implications for Student Engagement

Zahra Hazari, Clemson University, zahra@clemson.edu

Cheryl A.P. Cass, North Carolina State University

Carrie E. Beattie, Clemson University

Wednesday, March 28, 2012

Robynne M. Lock, Clemson University

ABSTRACT: In the process of reforming physics education over the last several decades, a natural tension has developed between compelling students to leave their comfort zones and engage with the content more meaningfully, and at the same time helping them identify with physics so they are motivated to learn physics. Through case studies of four high school physics teachers, who were identified through a national survey study as using strategies that help students see themselves as a “physics person”, we explored how positionality or relations established between the teachers and students influenced the level of student engagement. Our findings suggest that teachers’ and students’ physical positioning (implied from the space they occupied), temporal positioning (through changing roles within a class period), and social positioning (derived from modes of interaction and communication) influences the extent to which students actively engage in their physics class. In varying instances across the cases, different positionings served to narrow the hierarchical distance between the teacher and students, allowing students to share their ideas and problems with greater ease. This work was supported by NSF grant 0952460.

Comparative Study of the Learning Environments of Secondary Science Classrooms in Government and Private Schools

Adit Gupta, Model Institute of Education and Research, Jammu, India, aditgupta@yahoo.com

ABSTRACT: The present study compares the science classroom learning environments of selected Private and Government schools at secondary stage in relation to attitudes towards science and academic efficacy. Data was collected from 246 students studying science at secondary stage in three Private and two Government co-educational schools. To assess the science classroom learning environments Actual and Preferred versions of the What Is Happening In This Class? (WIHIC) Questionnaire along with Attitude Towards Science and Academic Efficacy Scale were administered. The results show that WIHIC along with Attitude and Efficacy scale are reliable and valid tools for assessing the science classroom learning environments at the secondary school stage. The results also show that students of both types of schools would prefer an enriched learning environment than the one they presently perceive on all WIHIC dimensions. The results also highlight students’ positive attitude towards science and their higher academic efficacy. This study strongly supports the view that the nature of the classroom learning environment strongly influences students’ attitudes towards science and their academic efficacy. Significant gender differences in students’ perceptions of their science classroom learning environments and attitudes towards science and academic efficacy have also been observed in this research. The results of the comparison of the science classroom learning environments between selected private and government schools show that three out of the seven scales of WIHIC (Teacher Support, Investigation and Task Orientation) differ significantly in the two types of schools in terms of their science classroom learning environments.

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

Related Paper Set - Beyond Student Test Scores: A More Comprehensive Look at Quality of Teaching

8:30am – 10:00am, Room 301

Discussant: Kathleen J. Roth, BSCS

ABSTRACT: Beyond Student Test Scores: A More Comprehensive Look at Quality of Teaching It has been argued that teachers are a critical factor in explaining what matters for student learning. What they know, do, and care about when they interact with students seems to determine the quality of teaching and what students learn. In this related paper set session, we present five studies focusing on different angles of quality of teaching in 28 fifth-grade science teachers and how these practices are related to student learning. The session will provide information about the journey taken by a group of researchers from two institutions that partnered to learn about what assessment characteristics can better reflect the quality of teaching students received based on their performance. The project from which the studies are drawn focuses on developing an approach for constructing instructionally sensitive assessments. A set of validity studies focusing on the quality of instruction students received and the relation to students’ performance was conducted over two years. These studies lead to an

Wednesday, March 28, 2012

unfolding story about quality of instruction from different perspectives that will be presented followed by a discussant, external to the project, who will address the contribution of the studies to the quality of teaching field.

Examining Quality of Teaching from Different Perspectives

Maria Araceli Ruiz-Primo, University of Colorado Denver, maria.ruiz-prim@ucdenver.edu
Min Li, University of Washington

Knowledge of Learning Goals as a Navigation Tool in Curriculum Implementation

Ming-Chih Lan, University of Washington, mclan@uw.edu
Michael Giamellaro, University of Colorado Denver
Min Li, University of Washington
Maria Araceli Ruiz-Primo, University of Colorado Denver

Supporting Students to Make Conceptual Connections

Min Li, University of Washington, minli@u.washington.edu
Ming-Chih Lan, University of Washington
Maria Araceli Ruiz-Primo, University of Colorado Denver
Michael Giamellaro, University of Colorado Denver
Ting Wang, University of Washington
Jennifer Feehan, University of Colorado Denver
Mchale Aaron Orgeron, University of Colorado Denver

Quality Teaching as Reflected in Productive Failure

Michael Giamellaro, University Of Colorado Denver, michael.giamellaro@ucdenver.edu
Maria Araceli Ruiz-Primo, University of Colorado Denver
Min Li, University of Washington
Kellie Wills, University of Washington
Ming-Chih Lan, University of Washington

Knowing where Students are: Finding out What Students Know and Moving their Learning Forward

Hillary Mason, Hillary.Mason@ucdenver.edu
Maria Araceli Ruiz-Primo, University of Colorado Denver
Min Li, University of Washington
Michael Giamellaro, University of Colorado Denver

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

Inquiry Based Teaching and Learning

8:30am – 10:00am, Room 303

President: Jodie Galosy, Knowles Science Teaching Foundation

Influences on Teachers' Capacities to use Educative Curriculum Materials as Intended

Sihan Xiao, University of California, Los Angeles, shxiao@ucla.edu
William A. Sandoval, University of California, Los Angeles

ABSTRACT: Educative curriculum materials provide teachers with resources to learn and use reform-oriented materials and pedagogy. However, teachers commonly do not take up the materials in the same way. What makes curriculum materials educative, and for whom? This paper presents a case study of two middle school teachers' efforts to implement a novel biology curricular unit designed using principles of educative materials. These teachers participated in the CENSEI project that developed guided inquiry units, which focused on questions that could be explored through access to data collected by remote sensor networks. Based upon analysis of protocol

Wednesday, March 28, 2012

observations and teacher interviews, as well as video-based interaction analysis, the authors find that the two teachers vary in their enactment of unit activities in three ways: their general approach to adapting curricular materials, the locus of agency in the classroom during the unit, and the coherence between activities. The findings suggest that teachers' interpretations of educative materials are highly dependent upon their own knowledge of reform teaching, and probably even their perceptions of their students' capabilities.

Cooperative Learning and Intergroup Competition in Biology Education

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 Birgit Jana Neuhaus, University of Munich (LMU)

ABSTRACT: In 2005 National Education Standards became effective. They claim to foster the students' competences, e.g. in inquiry acquisition. To fulfill these claims, new teaching methods, like the Egg Race, have to be developed and evaluated. When working with the teaching method Egg Races students are assigned to cooperative small groups, which are competing against other groups. They work on a problem-oriented task which can be solved with more than one approach. Many teachers have already used this new method, but there are no empirical studies about the intergroup competitions effects compared to pure cooperative learning environments. So in the presented study an Egg Race on the teaching content "food-webs in the forest" has been developed and evaluated with 111 6th graders from secondary school. The surveyed variables were achievement, situational interest and perceived interaction within the group in a pre-post-test-design. Results show that the intergroup competition has a positive effect on achievement and situational interest, but a negative influence on perceived interaction within the group. Subsequent studies should examine the validity of the results for other learning contents and the influence of intergroup competition on social-psychological variables.

Project-Based Teaching: Supporting Students in Making Connections

Heather J. Johnson, Vanderbilt University, heather.j.johnson@vanderbilt.edu

ABSTRACT: Project-based curriculum materials serve as promising vehicles to mobilize progress toward reform-based science teaching and learning. However, success with these materials is not always realized in classrooms. One challenge that permeates a project-based approach is how to support students in making connections between seemingly discrete learning events and the overarching project goal. This study followed four urban classrooms through the first unit of a project-based curriculum. Differences emerged in how deeply teachers supported students in making connections from lessons to the project goal. Findings indicate that the support teachers provide during enactment does help students construct connections. Additionally, when students construct deeper, more substantive connections between lessons and the project goal, they perform better on a content assessment. These results indicate that differences in enactment have an effect on student science learning. For this reason, teachers need to be supported, through professional development or educative curriculum materials, in developing strategies that make connections salient to their students during enactment.

iCoach-Teacher Teams Professional Development: The Influence of Coach led Reflection, Practice Teaching, and Content Instruction on Middle School Teachers' Use of Inquiry Practices

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

ABSTRACT: The purpose of this study was to investigate the influence of an inquiry professional development program that teamed middle school teachers with their school-based math or science instructional coaches on the teachers' understanding and use of inquiry-based practices. Thirty-nine teachers participating in an iCoach-Teacher Teams Inquiry Professional Development Institute were the subjects of this study. The professional development model began with a two-week summer institute and continued with four follow-up sessions during the academic school year. This study focused on several data collection instruments: (a) pre/post-institute and end-of-year (EOY) questionnaires (b) pre/post-institute inquiry lessons, and (c) final reflection papers. All written data sources were coded for themes related to the research questions using a constant comparative method. Through an analysis of teachers' questionnaires and written reflections, we found that teachers gained a better understanding of inquiry-based teaching practices through the program. The participants recorded inquiry lessons were analyzed using the

Wednesday, March 28, 2012

Reformed Teacher Observation Protocol (RTOP) and we found significant increases in their use of inquiry from their pre-tape to their post-tape. The institute also had a positive impact on the coach-teacher relationship. Teachers began working more with their coaches due to a new understanding of the coach's role.

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

Developing Conceptual Understanding in Science

8:30am – 10:00am, Room 304

Presider: Leigh S. Arino De La Rubia, Tennessee State University

Tracking College Students' Growth in Understanding of the Particulate Nature of Matter

James M. Nyachwaya, University of Minnesota, nyach002@umn.edu

Jamie L. Schneider, University of Wisconsin, River Falls

Nathan B. Wood, North Dakota State University

Abdirizak W. Mohammed, University of Minnesota

Anne L. Kern, University of Idaho

Gillian Roehrig, University of Minnesota

ABSTRACT: Research in Chemistry education has shown that students who are successful at solving algorithmic problems in chemistry don't necessarily understand the chemistry concepts involved in the problems. This qualitative study examines the growth of college students' understanding of the particulate nature of matter when instruction is informed by much of the previous research. We present trends, over time, of students' representations of three reactions at the particulate level. Three questions were administered as a pre-test on the first day of class, and subsequently as a series of post-tests throughout the semester. Data in the form of student drawings were collected from 50 freshman chemistry students in the spring semester of 2011. The results point to growth in students' understanding of the particulate nature of matter over the course of the semester, as well as continued struggle with a number of fundamental ideas in chemistry. Looking at the drawings, we track ideas that students seem to be struggling with, identifying those that fade (go away) with instruction, and others that persist despite carefully planned instruction.

Improving College Students' Interdisciplinary Science Understanding

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Ji Shen, The University of Georgia

Kathrin Stanger-Hall, The University of Georgia

ABSTRACT: College students face great challenges in developing interdisciplinary understanding in science as they take introductory science courses housed in individual departments. In this paper, we describe an ongoing project aimed at improving college students' interdisciplinary understanding. We gathered a team of scientists and science educators from multiple disciplines and met regularly to discuss how to develop assessment items eliciting interdisciplinary understanding. We started with the concept of osmosis, one of the most important topics taught in many college science courses. We analyzed and reflected on our meeting conversations. As we realized we were using inconsistent terminologies related to osmosis, we conducted a content analysis of a collection of textbooks and found several issues including inconsistent use of terminologies. We also developed an item on osmosis and implemented it with a biology class (n=441). We coded students' alternative conceptions according to their attributes and related-topics. The results showed students' difficulty in reasoning the underlying mechanism of osmosis might result from their shaky understanding of the state variables used to describe the dynamic process and their incapability of translating terms across disciplines. Our project supports that constant communication and collaboration across disciplines are necessarily to improve students' interdisciplinary understanding in science.

University Students' Informal Reasoning Progression on NDM-1 Socio-scientific Issue: A Preliminary Study

Tzu-Chun Huang, National Taichung University, smy@mail.ntcu.edu.tw

Shu-Mey Yu, National Taichung University

Wednesday, March 28, 2012

Yu-Hsiang Su, National Taichung University

ABSTRACT: The purpose of this study was to investigate the university students' informal reasoning learning progression on a controversial socio-scientific issue (SSI) about NDM-1 (New Delhi Metallo- β -lactamase 1 Enterobacteriaceae). In this qualitative study, subjects were 18 first-year university students. Researchers developed a SSI, questionnaire, online discussion activities, and interview framework about NDM-1, then conducted pretest, online discussion activities, semi-structured interview, posttest. The collection of data were pre-post-test, 1st online informal reasoning activities, 1st interview, 2nd online informal reasoning activities, 2nd interview, the analytical of data were informal reasoning modes, levels, progression of reasoning product and process. Analysis of the data showed those students' reasoning modes from "social-oriented", "medical science-oriented", "medical environment-oriented" increased more such as moral-oriented" and "legal-oriented", and reasoning levels showed students could make appropriate and sufficient claims with reasoning. In informal reasoning progression, students' informal reasoning process and product were more complex from initial. That indicated informal reasoning could help to develop students' abilities and more different aspect of perspective in informal reasoning. The study results could provide evidence to support instructor in progression and SSI for learning and teaching about informal reasoning in future studies which aim to enhance students' abilities of informal reasoning.

Progress Made in the Development of a Conceptual Roadmap for Chemistry and Nanoscience Education

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ABSTRACT: Since the publication of the "big ideas" in nanoscience by Stevens, Sutherland, and Krajcik in 2009, exploratory research in undergraduate chemistry students' understanding of nanoscience had led to a hypothesis. The hypothesis is that the key for someone to develop a fundamental understanding of nanoscience is to hold a consistent conceptual framework based on extending our current knowledge of the relationship between the macroscopic world and the atomic-molecular world to the "nanoworld." In other words, the "nanoworld" is not a "different" world. It is a world sandwiched between two better-known worlds on a size continuum. Semi-structured interviews with undergraduate students also suggested that investigating students' understanding of size-dependent properties of matter would seem to be fruitful future endeavors. Furthermore, extending from the "big ideas" work, a research-based conceptual roadmap is currently in development. Possible "routes" to aid students' exploration of an unfamiliar territory as in nanoscience (and chemistry) as well as "road blocks" are the key features on a conceptual roadmap. The roadmap is compared with the AAAS Project 2061 Science Literacy Maps, and implications of the roadmap for curriculum development, curriculum alignment with national and state standards, assessment, and the teaching and learning of chemistry and nanoscience are discussed.

Strand 6: Science Learning in Informal Contexts

Fostering Complex Learning in Museums

8:30am – 10:00am, Room 305

Presenter: Jennifer DeWitt, King's College London

Re-Imagining Science Museums: Communities of Environmental Lifelong Learners

Kathleen A. Fadigan, Pennsylvania State University, kxf24@psu.edu

ABSTRACT: Predictions of future museum trends indicate that museums will become sites of community discourse. This study focuses on a program evaluation at a science museum that is in the early phases of developing non-traditional programming that reflects this trend. Since 2008, the science museum offered 107 town squares programs during the evenings. The data from registration and evaluation forms were analyzed to determine the program impact on participants' knowledge, engagement and behavior. A total of 12,641 registrations were entered into the registration system. Between October 2010 and June 2011, 4692 registrations were logged into the system by 3089 individuals (52% female, 42% male, and 6% gender-not-listed). Of those individuals that stated their age 624 (46%) are age 35 and under, 412 are between the ages of 36 and 55 (30%), and 331 are over the age of 55 (30%). Almost 20 percent of the participants have attended more than one

Wednesday, March 28, 2012

program. Participants' plans to utilize their new knowledge were classified into five categories: personal, work, community, political, and family. Overall, participants provided positive comments about their engagement and plans to take action regarding an environmental issue indicating an increase in their level of science literacy.

Guiding Play with Technology to Improve Science Affect and Learning

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Sameer Honwad, New York Hall of Science

Cheryl Kwinn, Tufts University

Adiel Fernandez, New York Hall of Science

ABSTRACT: We are interested in if guided play can support students' science inquiry and improved learning coincident with positive affect and fun, not always an outcome of classroom inquiry, but important to keeping students on the path to science careers. To guide play, we designed a technology-enhanced scooter cart game to teach Newton's Second Law. Students pushed a friend along a straight path while a webcam tracked the cart and instantaneously displayed displacement and force profiles. Students tried to get their cart's motion to match their chosen profile. Sixteen middle school students played the game and data was collected: Force Concept Inventory questions to assess learning; interviews to assess learning and reasoning; and video recordings to directly observe affect (behavioral and emotional engagement) and inquiry. Our findings indicate that this guided play experience supported high levels of playfulness and positive affect while supporting high levels of inquiry. As a result, students' learning improved significantly for one of two target physics concepts. While these findings provide preliminary support for the potential of guided play, further study is necessary to determine how the guided play must be redesigned and/or extended into a formal learning context to ensure all target science content is learned.

Learning at the Museum: Spects of Learning in German Natural History Museums from the Museum Educator's Point of View

Jennifer H. Härting, Jennifer.Haerting@uni-vechta.de

ABSTRACT: Dusty, dull, dark and old-fashioned, these are words many visitors still have in mind when they think about natural history museums in Germany. But nowadays, natural history museums are different. They display themselves in modern designs and offer amazing programs for all groups of ages. This development goes back to the museum's education departments and their employees. Especially class trips to a museum are characterized in Germany by guided tours given by the museum's educator. In this analysis we focused on the following research questions: Do museum educators care about the learning goals of their tours? How far do they take into account the relevant aspects of learning during their tours? Is it possible to define different types of intermediation based on their statements to learning aspect during a tour? 71 museum educators from 20 natural history museums in Germany participated in our online survey. The survey contained questions regarding the relevant learning situations with students during a tour. Data analysis revealed three different types of intermediation: 1. Young idealists, 2. anti-authoritarian and 3. pragmatist.

Using Educational Research in the Development of Science Exhibitions

Antti Laherto, University of Helsinki, Finland, antti.laherto@helsinki.fi

ABSTRACT: During past few decades, museums and science centres throughout the world have given increasing emphasis to their educational function. Although exhibitions are the primary means of promoting visitors' learning, educational research is generally not taken into account in a systematic manner when designing those learning environments. Rather, the development of exhibitions in museums and science centres tends to rely on the know-how of the staff. A consistent procedure of carrying out and reviewing science education research would complement that expertise and support the educational role of science exhibitions. This theoretical study therefore suggests such research-based approach by adapting the Model of Educational Reconstruction for the purpose of exhibition development following the idea of the Model for Personal Awareness of Science and Technology. The former model serves as a general framework to involve analytical and empirical research in the development of learning environments, while the latter model provides a specific view of visitors' learning in interaction with exhibits. The study shows how these constructivist models can be interconnected in order to apply

Wednesday, March 28, 2012

educational research for improving the long term learning profit of exhibition visits. The idea is illustrated with an example concerning research-based development of a nanoscience exhibition.

Strand 7: Pre-service Science Teacher Education

Technology in Pre-Service Teacher Education

8:30am – 10:00am, Room 306

Presider: Kristin L. Cook, Indiana University

Investigating Pre-service Science Teachers' Content Knowledge And Perceived TPACK Regarding Genetics

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Ozgul Yilmaz-Tuzun, Middle East Technical University

ABSTRACT: The purposes of this study were to investigate the relationship between genetic knowledge and perceived technological pedagogical content knowledge (TPACK) of pre-service science teachers and explore relationships among the components of TPACK. A total of 1530 pre-service science teachers who are enrolled in elementary science education department of Education Faculties of 8 public universities located in the central part of the country participated to the study. The perceived TPACK questionnaire developed by MaKinster, Boone, and Trautmann, (2010) and genetic concept test developed by Sadler and Zeidler (2005) were used. Results revealed that most of the subscales of TPACK were correlated with genetic concept test and the highest correlation was obtained with perception of content knowledge. Correlations among the TPACK subscales revealed high correlations and the highest correlation was obtained between perceived technological content knowledge and perceived technological pedagogical content knowledge. This study supported that both content knowledge in science and each knowledge sources of TPACK are vital in developing competency in technological pedagogical content knowledge.

Preservice Teachers as eMentors: Using Web 2.0 Learning Tools To Foster Student Inquiry

Gabriela Jonas-Ahrend, University of Dortmund, gabriela.jonas-ahrend@uni-dortmund.de

M. Randall Spaid, Macon State College

Stuart Fleischer, The American International School in Israel

ABSTRACT: This descriptive study of the online interactions of over 60 international teams of middle school students conducting science fair investigations and preservice teachers as their eMentors focused on the functions, frequency, and flow of threaded discussions exchanged in the context of the Near East South Asia Virtual Science Fair (NVSF) and vsf-Germany (virtual science fair Germany). All postings to their individual Blackboard™ and Moodle™ space between eMentors and students during the planning, experimenting, and interpretation phases were captured and analyzed. Categories for message function were based on Rueda's (1992) taxonomy; results indicated that: (1) eMentors "talked" more during the project than their mentees; (2) participants' roles as eMentor or student were associated with different frequencies of certain message function types; and (3) reports related to curriculum content comprised a surprisingly small portion of total message functions identified. The preservice teachers established a mentoring relationship with multicultural middle school students, helped struggling students improve their inquiry skills necessary for successful completion of a science fair project, reflected upon the art of motivating students, and fostering their self-regulation by journaling. This collaborative model between preservice teachers, middle school students and teachers reflects today's reality: the age of international communication and worldwide collaboration.

Using Blogging as a Disruptive Design for Learning in Pre-Service Teacher Education Courses

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Julie E. Justice, University of North Carolina at Chapel Hill

Steven D. Wall, University of North Carolina at Chapel Hill

ABSTRACT: This paper examines the ways in which blogging, and participation in a web 2.0 community of pre-service teachers disrupted students' notions of learning and facilitated the development of a pre-service teacher

Wednesday, March 28, 2012

community (Lave & Wenger, 1991). Building upon Luehmann's (2008) previous work with in-service teachers, this study examines a designed learning context that required the pre-service teachers to use blogging to evidence and critically reflect on learning (Schon, 1987; Loughran, 2002). The intent of the designed context was to disrupt the traditional practices of teacher education courses. This paper begins the exploration of disruption as an analytical concept that allows for the investigation of how individual learning and changes in local practice mutually influence the other within purposefully designed learning contexts. In this study, disruptions are defined as rearrangements, temporary or sustained, of typical practice, meaningfully experienced by participants within the community. We explore the following research question: How do disruptions to typical practice in teacher education courses in terms of interactions, participation structures, perceptions, material and cultural tools, embodiments and modes of learning taken up, adapted or rejected by the pre-service learners and how this, in turn, does this inform design?

Using PhotoVoice to Empower Pre-service Teachers to Connect Science to Their Daily Lives

Kristin L. Cook, Indiana University, kshockey@indiana.edu

Cassie Quigley, Clemson University

ABSTRACT: Can science education research bring out emancipatory processes of learning? PhotoVoice (Wang & Burris, 1994) used in the exploration of socioscientific issues can offer ways to experience emancipation by providing opportunities for scientific inquiry to positively impact and enhance caring for the environment. We asked twenty-four pre-service teachers (PSTs) to document socio-scientific issues through photographing and reflecting on their surroundings, as well as dialouging with local scientists. PSTs came to appreciate the connections of the science that operated in their lives as they reflected on the science content behind social issues of interest to them on campus. This experience empowered PSTs to connect deeply with science, provided a pedagogical tool for teacher educators to use with their PSTs to engage them with relevant science, and has the potential to improve science teaching by fostering PSTs that are more connected to science and the world around them.

Strand 7: Pre-service Science Teacher Education***Field Experiences as a Factor in Pre-service Teacher Development II***

8:30am – 10:00am, Room 312

Presenter: Vanessa Kind, Durham University

Curriculum Materials Analysis as a Boundary Spanning Task: Bridging Science Methods and Field Placement Discourses

Kristin L. Gunckel, University of Arizona, kgunckel@email.arizona.edu

ABSTRACT: Preservice teachers must often negotiate on their own differences in Discourses between science methods courses and field placement classrooms. Discourses define the ways of talking about and enacting practices in different communities. In this project, we designed boundary spanning tasks that were intended to bring different Discourses closer together. We engaged preservice and mentor teachers in co-learning events where they worked together on a curriculum materials analysis task. We examined whether the analysis task functioned as a boundary spanning experience for the preservice and mentor teachers. We learned that the task provided opportunities for preservice teachers to support mentor teachers in learning the language and constructs of the science methods course and for the mentor teachers to help the preservice teachers situate in the field placement classroom the practices they were learning in their methods course. However, not all enactments of the co-learning task functioned as a boundary spanning experience. Sometimes, mentor teachers let the preservice teachers complete the task on their own. In order to be a boundary spanning experience, all participants must feel that they have something to offer or gain from engaging in the task. These findings inform design of other boundary spanning tasks.

Wednesday, March 28, 2012

Examining the Role of School-Based Experiences in Preparing Pre-Service Teachers for Science Teaching

Angela Fitzgerald, Monash University, Melbourne, Australia, angela.fitzgerald@monash.edu

Katrin Schneider, Monash University, Melbourne, Australia

ABSTRACT: It is widely acknowledged that “there is no single model of teacher education that is clearly the most effective way of preparing teachers” (Dow, 2003, p. 34). While this may be the case, research suggests that knowledge of content and skills in teaching are associated with effective teaching. Therefore, teachers’ knowledge of a content area is augmented by their knowledge of how to teach that content to students. Internationally, some teacher education programs have incorporated school-based experiences into their approach to developing content and pedagogical knowledge that relate specifically to science teaching. This is the context in which this study was situated. Through documenting the experiences of pre-service teachers participating in this science education unit, this study examines the role of school-based experiences in contributing to the development of primary school pre-service teachers confidence and competence in teaching science. 96 pre-service teachers, enrolled in a science education unit, completed a pre- and post-questionnaire with 11 participants contributing to focus group discussions. Their experiences suggest that the incorporation of a school-based experience was beneficial as it was identified as a key contributing factor to the development of their confidence and competence to not only teach science, but to teach more generally.

Science Educator Identity Formation: The Impact of Place-Based Teaching Opportunities

Jennifer H. Forrester, The University of Wyoming, jforres5@uwyo.edu

Jason M. Katzmann, The University of Wyoming

ABSTRACT: There is an increasing shortage of science teachers in the United States. According to the U.S. Department of Education (2000) 20% of math, science, and technology undergraduates considered teaching, with only 5% completing their teacher preparation programs and accepting teaching jobs. Current data reveals that 33% of those students, who accept teaching positions, leave the profession within their first three years (National Center for Education Statistics, 2009). Despite these dismal statistics, researchers have documented avenues for increasing the number of science teachers in our nation’s schools. Moin, Dorfield, and Schunn (2005) found that undergraduates majoring in science, engineering, and mathematics during their junior years are promising recruits for K-12 teacher preparation programs. They also found that career intent may be influenced through undergraduate education experiences (Moin et al., 2005). For students to alter their academic major choices and career trajectories, they must be able to “see” themselves as science educators. In order for this to occur, these students must develop a science teacher identity. The current study documented the impact of teaching in a place-based residential science school, on a non-education major’s identity formation as a science teacher.

Strand 8: In-service Science Teacher Education

Symposium - Different Ways to Investigate Teachers' Pedagogical Content Knowledge

8:30am – 10:00am, Room 206

President: Andreas Borowski, RWTH Aachen University

Presenters:

Sophie Kirschner, University Duisburg-Essen

Janet Carlson, BSCS

Ineke Henze, Radboud University, Nymegen

Julie Gess-Newsome, Willamette University

Hans E. Fischer, University Duisburg-Essen

Jan H. Van Driel, Leiden University

ABSTRACT: This symposium will explore the theoretical underpinnings of the construct of PCK as re-searchers are currently using it. Five speakers will provide perspectives on the overall problem; the theoretical conceptions, measurements, and results used within specific research groups; and provide a synthesis of the research while engaging the audience in discussion. To consolidate different point of views on PCK, we have selected researchers who use more qualitative methods such as interviews and open-ended questionnaires as well as researchers using

Wednesday, March 28, 2012

more quantitative methods, such as open-ended and multiple-choice items for large-scale paper-and-pencil-tests. This symposium will also be interdisciplinary, connecting biology, chemistry, and physics PCK research, thus shining a rare spotlight on PCK in the natural sciences

Strand 10: Curriculum, Evaluation, and Assessment

Middle School Curriculum and Evaluation

8:30am – 10:00am, Room 308

Presider: Gayle A. Buck, Indiana University

Assessing NOS Knowledge using Network Analysis: An Examination of Students' Growth in a Contextualized Environment

Erin E. Peters-Burton, George Mason University, epeters1@gmu.edu

ABSTRACT: An understanding of how science is enacted and how scientific knowledge is generated, also known as the nature of science (NOS), is a major goal of science education. This study used a network analysis to examine the growth of student learning of NOS in a year-long middle school environmental issues class taught explicitly and reflectively with aspects of NOS. Network analysis, chosen to capture the students' beliefs about science before and after the class, was developed in two parts: an open-ended writing sample and a card sort where the statements on the cards are derived from the open codes given in the writing sample. A network analysis of NOS understanding displays the original, verbatim ideas of the students and the interconnections among the ideas. The pre-test map indicated loosely connected ideas that centered around 4 ideas. The post-test map displays 11 central ideas that are more tightly clustered than the 4 central ideas on the pre-test map. These statements are indicative of science being iterative and collaborative rather than a linear, singular method. The method of network analysis has promise in complementing other measures of NOS because it can document the connections among ideas.

The Effects of Coherent Curriculum on Middle School Students' Understanding of Key Chemistry Ideas

Joseph S. Krajcik, University of Michigan, krajcik@umich.edu

LeeAnn M. Sutherland, University of Michigan

Sung-Youn Choi, University of Michigan

Joi Merritt, Michigan State University

Kathryn F. Drago, University of Michigan

ABSTRACT: Curriculum coherence, where interrelated ideas build upon each other over time, is a critical predictor of learning. However, most science textbooks and instruction in the U.S. do not focus on building ideas over time. We developed a full middle school science curriculum for grades 6 through 8 that focuses on coherence. One purpose of this research and development project was to determine the effectiveness of the chemistry units in building understanding of core chemistry ideas. Because the units were designed to build on each other, learners should develop greater and more sophisticated understanding of the core ideas over time. The following questions guided our work: 1) How do the three chemistry units, as taught in the specified sequence, affect middle school students' understanding? 2) How does coherence affect student understanding of chemistry both within and across the middle grades? 3) Do student outcomes designed to measure their understanding of chemistry concepts vary by gender, school, or teacher? Unfortunately, although the findings across grades six and seven support the claim that coherence should promote student learning, the findings from grades seven to eight do not. Student attrition, teacher teaching experience and school effects might account for these results.

Students' Errors Using Geographically Variable Data to Support Scientific Predictions

Sarah J. Fick, University of Michigan, sfick@umich.edu

ABSTRACT: There is growing need for students to be able to interpret and analyze large-scale datasets. Students have been shown to have difficulty interpreting large-scale climatic datasets, though it has as of yet been unclear which skills and knowledge students have difficulty with. This study looks at the types of errors that eighth grade

Wednesday, March 28, 2012

students made in the interpretation and analysis of average temperature and precipitation data. Three types of students were described, ranging in the extent of the difficulties they had. These characterizations of students' errors can be used to mold instruction that scaffolds students' abilities in these areas.

Results from a Pilot Study of a Curriculum Unit Designed to Help Middle School Students Understand Chemical Reactions in Living Systems

Cari F. Herrmann Abell, AAAS/Project 2061, cabell@aaas.org

Jean C. Flanagan, AAAS Project 2061

Jo Ellen Roseman, AAAS Project 2061

ABSTRACT: Students often have trouble understanding key biology ideas because they lack an understanding of foundational chemistry ideas. We are collaborating in the development a four-week curriculum unit that connects core chemistry and biochemistry ideas in order to help eighth grade students build the conceptual foundation needed for high school biology. The unit is designed to engage students in (a) observing phenomena that are explicitly aligned to the targeted ideas and selected to address common learning difficulties and (b) using models to help them interpret the phenomena in light of the targeted ideas. The unit was pilot tested with students from an urban school and a suburban school in the mid-Atlantic region of the U.S. at the end of or just after eighth grade. A multiple choice pre-/posttest was used to measure the change in students' understanding. Overall, the students at both schools made statistically significant gains in their performance on the items testing for the targeted chemistry and biochemistry ideas and appeared to hold fewer misconceptions, suggesting that the unit being developed has promise.

Strand 10: Curriculum, Evaluation, and Assessment

Science Assessment: Approaches and Issues

8:30am – 10:00am, Room 314

President: David F. Treagust, Curtin University

How Stable are Students' Understanding of Light Propagation and Visibility of Objects in Different Contexts?

Hye-Eun Chu, Nanyang Technological University, hyeeun.chu@gmail.com

David F. Treagust, Curtin University

ABSTRACT: This study focuses on elucidating and explaining reasons for the stability of and interrelationships between students' conceptions about light propagation and visibility of objects in different contexts across three years of secondary schooling from Years 7 to 9. It is a large scale quantitative study involving 1,233 Korean students and 1,149 Singapore students. Data were collected with the Light Propagation Diagnostic Instrument (LPDI) consisting of four pairs of items, each of which evaluated the same concept in two different contexts. Findings show that students generally could not apply their conceptions of basic optics in different contexts giving rise to several context-dependent alternative conceptions. Also, students' understanding of Light Propagation concepts was less context-dependent than Visibility of Objects concepts due to the need to understand the behaviour of light in different contexts. The concepts of light Propagation and visibility of objects were only moderately correlated. School grade was not strongly effective variable but students' school achievement influenced their conceptual understanding in optics strongly. The research findings indicated that for the topic of optics teachers should provide students with opportunities to compare concepts in different contexts.

Development and Validation of Instrument for Exploring High School Students' Conceptions of Science Assessment in Taiwan

Min-Hsien Lee, National Central University, Taiwan, lee.minhsien@gmail.com

Tzung-Jin Lin, National Taiwan University of Science and Technology, Taiwan

Chin-Chung Tsai, National Taiwan University of Science and Technology, Taiwan

ABSTRACT: Since the goals of science learning have kept changing, several issues regarding assessment have arisen, such as how students conceptualize assessment during learning. For obtaining a better understanding of

Wednesday, March 28, 2012

students' conceptions of science assessment, this study aimed to develop and validate the Conceptions of Science Assessment (COSA) instrument, based on Author's (2010) qualitative work, and consists of six conceptions as "Reproducing knowledge," "Rehearsing," "Accountability," "Improving learning," "Problem solving" and "Critical judgment." This study further hypothesized a higher-order categorization (i.e., surface, summative, and formative) among the six conceptions. To establish the reliability and validity of COSA and confirm the second-order structure hypothesized in this study, exploratory factor analysis, second-order confirmatory factor analysis, and criteria-related correlation analysis were conducted. A total of 1138 tenth graders from thirteen high schools in Taiwan, which were spilt into three subsets for each analysis, participated in this study. The results support our hypothesized second-order structure of COSA and indicate the instrument items have good reliability, convergent, construct, and criteria-related validity. The newly developed COSA could provide science educators a valid instrument for evaluating what assessment means to student and to reflect their assessment activities through surface, summative, and formative perspectives of assessment

Children's Perceptions on Primary Science Assessment

Colette Murphy, Queen's University Belfast, c.a.murphy@qub.ac.uk

ABSTRACT: This study builds on and contributes to work in assessment of children in primary school, particularly in science. Although studies in this area have examined primary science and its assessment from several different standpoints, there has not been a study which specifically addresses children's perspectives. As such, this study provides additional insight into the issues surrounding children's assessment in primary school. The analytic focus on engaging children as co-researchers to assist in the process of gathering informed views and interpreting findings from a large sample of children views enables another contribution. Many studies have identified ways to improve assessment of science at primary level, but little analytic attention has been paid to the perspective of those for whom assessment policies and practices have been developed. The current study reveals that despite being assessed under two markedly different regimes, children's views of science assessment, 'what works' and their ideas for how science should be assessed at the end of primary school are remarkably consistent. The proposal demonstrates that children provide an important perspective on assessment and that including their views can improve policy making in relation to primary science assessment.

Assessment of Student Reasoning in Control of Variables

Lei Bao, The Ohio State University, bao.15@osu.edu

Shaona Zhou, China Central Normal University

Jing Han, The Ohio State University

Amy Raplinger, The Ohio State University

Kathleen M. Koenig, University of Cincinnati

ABSTRACT: Scientific reasoning skills are becoming a necessity in modern society. As a result, such skills are being emphasized in science curricula. This study focuses on the particular skill of control of variables. Two forms of an assessment instrument (providing and not providing experimental data) were developed to analyze how students handle data and how context affects performance. This instrument will allow us to identify common student difficulties and reasoning patterns at a finer grain size as well as determine levels of learning progression from naïve to expert use of control of variables. Results from this study show that (1) students perform better when no experimental data is provided and (2) students perform better in physics contexts than in real-life contexts. The new form of assessment instrument developed in this study provides a practical tool for researchers and teachers to evaluate student learning on control of variables.

Strand 10: Curriculum, Evaluation, and Assessment

Symposium - Argument Focused Instruction and Science Proficiency

8:30am – 10:00am, Grand Ballroom VI-A

President: Victor D. Sampson, Florida State University

Presenters:

Wednesday, March 28, 2012

Patrick J. Enderle, Florida State University, pje07@fsu.edu
 Barry Golden, University of Tennessee
 Jonathon Grooms, Florida State University
 Joi P. Walker, Florida State University

ABSTRACT: Continued efforts to enhance science education are focusing attention on learning goals embodying not only science understanding, but also sets of skills concerning students' application and evaluation of that knowledge. Science education must endeavor to not only produce students literate in science, but also proficient in science, capable of designing scientific investigations, engaging in scientific discourse, and constructing and analyzing scientific explanations. Science teaching must make a similar shift in its approaches to teaching such a multifaceted assemblage of constructs. Argumentation research suggests that teaching emphasizing scientific arguments and argumentation processes can improve students' abilities in a multitude of desired ways. This symposium focuses on the learning outcomes that can result from implementing an argument focused instructional model in a variety of contexts. Presenters will provide evidence of several learning gains resulting from an argument focused instruction model and further group discussion will explore the dynamics of addressing and assessing the complex learning goals that comprise science proficiency.

Strand 11: Cultural, Social, and Gender Issues

Poster Symposium - Identity and Science Education Research: Topics, Issues, and Trends

8:30am – 10:00am, Grand Ballroom V-A

President: Maria Varelas, University of Illinois at Chicago

Presenters:

Megan Bang, University of Washington
 Angela Calabrese Barton, Michigan State University
 Philip L. Bell, University of Washington
 Leah A. Bricker, University of Washington
 Heidi Carlone, University of North Carolina at Greensboro
 Alice Carvalho, Université de Montréal
 Allison J. Gonsalves, Université de Montréal
 Juanita Bautista Guerra, Michigan State University
 Jennifer Hope, University of Missouri-St. Louis
 Angela Johnson, St. Mary's College of Maryland
 Justine M. Kane, Wayne State University
 Hosun Kang, University of Washington
 Audrey Lachaine, Université de Montréal
 Amanda Marin, Northwestern University,
 Maria S. Rivera Maulucci, Barnard College
 Elizabeth Rita Menig, University of Illinois at Chicago
 Felicia M. Mensah, Teachers College Columbia University
 Carole P. Mitchener, University of Illinois at Chicago
 Tara B. O'Neil, University of Hawaii at Manoa
 Eileen C. Parsons, University of North Carolina at Chapel Hill
 Joe Polman, University of Missouri-St. Louis
 Jrene Rahm, Université de Montréal
 Gale A. Seiler, McGill University
 Daniela Stellino, University of Illinois at Chicago,
 Edna Tan, University of North Carolina at Greensboro
 Katie Van Horne, University of Washington

ABSTRACT: The symposium will bring together science education scholars who study identity and identity construction of students, youth, and teachers in various settings, in and out of schools/classrooms, in order to

Wednesday, March 28, 2012

identify ways in which these constructs are inextricably related to learning, engaging with, science. The studies presented and discussed are grounded on collaborative program development work with teachers, scientists, community members, children, young adults, and university-based education researchers and educators. They span disciplinary domains, educational settings, grade levels, and conceptualizations and methods of studying identity. Moreover, the research presented focuses on students, youth, or teachers of color and/or economically disadvantaged, helping us better understand how non-whites, girls/women, non-native-English speakers, less-economically affluent children and adults identify with science and science education (teaching, learning, curriculum, and engagement). The symposium will start with a brief introduction of all the studies organized in clusters, will offer attendees an opportunity to visit individual posters of the studies and interact with author teams, and will conclude with a brief synthesis and conversation among presenters and attendees on how identity-related research is helpful (or limiting) in the field of science education, and how it can be / is related to research on developing scientific knowledge.

Strand 11: Cultural, Social, and Gender Issues

Symposium - Perspectives from the Frontline: Examining African-American Students Matriculation into Science

8:30am – 10:00am, Grand Ballroom V-B

Presenters:

Bryan A. Brown, Stanford University, brbrown@stanford.edu

Christopher Emdin, Teachers College Columbia University

Andre M. Green, University of South Alabama

Christopher G. Wright, T.E.R.C

ABSTRACT: Contemporary research on African-American students involves a number of constituent perspectives. These perspectives include both the “emic” (cultural insider) and the “etic” (cultural outsider) interpretations of the African-American experience in science education. As meaning is constructed in cultural spaces, both lens are equally valuable. However, science education has very few research perspectives from the emic perspective of the African-American Males. As one of the most significantly under represented communities in the science education research, this symposium offers a collaboration of research from an emic lens of African-American male science educators. As a demographic of individuals who reflect the emic perspective, African-American males have the potential to shed an intriguing perspective on teaching, learning, and social experiences of African-American students. This symposium involves explorations of teaching and learning at the K-12 level and higher education from the lens of a rarely heard perspective -- that of the African-American male scholar.

Wednesday, March 28, 2012

Publications Advisory Committee Sponsored Session

Symposium - The Anatomy of a Good Article: Publishing in the Journal of Research in Science Teaching

10:15am – 11:45am, Grand Ballroom V-A

Presiders:

Angela Calabrese Barton, JRST Editor; Michigan State University

Joseph S. Krajcik, JRST Editor; Michigan State University

Bob Geier, Assistant JRST Editor, University of Michigan

ABSTRACT: The purpose of this session is to engage potential authors in dialog about what constitutes a high quality article that aligns with the scope and focus of JRST. The session will offer perspectives on the anatomy of a high quality article from multiple perspectives: Editors, published authors, and reviewers. The editorial team will first present their model for how manuscripts are reviewed, including the publication guidelines that reviewers of the Journal of Research in Science Teaching use when reviewing submitted manuscripts. Their presentation will be followed by comments from three panelists who represent the author and/or reviewer position. The panelists will reflect a range of expertise in research approaches. A substantial portion of time will be devoted to open discussion. This session welcomes 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.

Strand 1: Science Learning, Understanding and Conceptual Change

New Foundations for the Contribution of Prior Knowledge to Learning

10:15am – 11:45am, Room 314

President: Michelle P. Cook, Clemson University

The Use of Construct Maps to Explore Student Understanding of the Chemical Reaction Big Idea

Nirit Glazer, University of Michigan, nirit@umich.edu

ABSTRACT: This study examines how students' understandings of early concepts relate to their understanding of later concepts and investigates the understanding of separate sub-ideas in relationship to their contribution to the understanding of a big idea. The study characterizes 7th grade students' learning of chemical reaction, which is a core idea in scientific literacy, as they participate in a coherent curriculum, exploring the prior knowledge, new knowledge, challenges, and development of the students' understanding of chemical reactions. Specifically, I developed construct maps to guide the development and analysis of assessment items aimed at finding evidence for learning at specific points in the unit's instruction. The main findings show that students' understanding of chemical reaction comprises many components and that each alone is important for student growth and further learning. Beyond the difficulties in understanding, this study highlights what students can learn and at different stages of the learning process as opposed to what they can do only after the instruction. Thus, the proposed nuanced construct maps and the related findings provide input for curriculum development and can help instructors to break down the concept of chemical reactions into the elements that contribute to this big idea.

Exploring the Relationship between Integrated Understanding of Energy and Preparation for Future Learning

Jeffrey Nordine, Trinity University, jnordine@trinity.edu

Abigail Drake, Trinity University

ABSTRACT: Energy is a central concept in every branch of science, and it plays an increasingly important role in people's everyday lives and decision making, yet students often have difficulty understanding and applying the energy concept to make sense of real-world phenomena (Driver, Squires, Rushworth, & Wood-Robinson, 1994; Duit, 1984; Solomon, 1983). While many studies have documented students' difficulty in applying their existing knowledge of energy to novel situations (Driver & Warrington, 1985; Trumper, 1993), we explore the impact of different types of prior knowledge – declarative (knowledge of facts) and integrated (knowledge of how facts are connected) – on students' ability to learn efficiently about energy in the future. By assessing students declarative knowledge of energy and integrated knowledge of energy, then asking them to engage in a task that requires them to seek out and use new information about energy, we explore the relative importance of declarative knowledge

Wednesday, March 28, 2012

and integrated knowledge on students' preparation for future energy-related learning. Results of this study have implications for instruction and assessment design, since understanding the type of prior knowledge most critical for future learning will help to identify instructional and testing practices that must be emphasized in order to promote lifelong learning.

Attending to Individual Differences in the Instruction of Physics: The Role of Prior Knowledge
 Shulamit Kapon, Tel Aviv University, ISRAEL, kaponsh@post.tau.ac.il

ABSTRACT: This theoretical paper examines, compares and contrasts two models that illustrate the role of prior knowledge in students' responses to instruction in physics. The first model (Hunt & Minstrell, 1994) employs a pragmatic applied approach and focuses on instruction. The second (Author et al., 2010, 2011) employs a theoretical approach and focuses on learning. Both models aim to explicitly address differences between individual learners in terms of prior knowledge. The discussion highlights similarities and differences between these models and points to a powerful synergy between them.

Eighth-grade Students' Mental Models of Magnetism: Modes of Agency and Mechanisms of Interaction
 David Sederberg, Purdue University, dsederbe@purdue.edu

ABSTRACT: This study is a synthesis of the ways in which multiple related concepts are represented in students' mental models of magnetism. In a design-based approach, we investigated trajectories by which students in traditional eighth-grade science classes (N = 71; 29 male, 42 female) constructed, critiqued, and revised their mental models of magnetism using instruction that encouraged students to systematically and frequently reflect on their learning. Our goal was to construct an in-depth analysis of the dynamic nature, coherence, and explanatory power of students' mental models of related concepts of magnetic phenomena, in the context of agency and mechanisms of magnetic interactions. Elements of instruction and assessment focused on answering the following questions (1) What is the structural nature of ferromagnetic materials?, (2) What does it mean to "be magnetized?", and (3) What mechanisms are involved with magnetic interactions? Our results indicate that the majority of students were progressively able to articulate mental models of magnetic interactions in which their understanding of abstract elements associated with magnetic phenomena fostered continued learning and understanding.

Strand 2: Science Learning: Contexts, Characteristics and Interactions

Elementary Science

10:15am – 11:45am, Room 302

President: Bhaskar Upadhyay, University of Minnesota

On Learning Ecology in Elementary Grades by Designing Robotic Animals and Their Habitats

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

Pratim Sengupta, Vanderbilt University

Amanda C. Dicks, Vanderbilt University

Amy Farris, Vanderbilt University

ABSTRACT: Although educational robotics has been widely used in K12 education, there exists no systematic study of how it can be used by elementary students to learn about ecology. The study reported here is a significant step in that direction. In this design-based research study (Cobb et al., 2000) we present a novel educational robotics-based learning environment where elementary grade students used LEGO Mindstorms to learn about ecology by engaging in iterative design-based learning activities (Papert, 1980; Kolodner et al., 2003; Kafai & Ching, 2008). Students in our study engaged in two kinds of design tasks: construction and iterative refinement of robot-animals, and construction and refinement of the habitats in which these animals had to operate and survive by foraging for food and communicating with other animals. We show that it is indeed possible to design a learning environment based on design-based learning activities where elementary students can develop a deep and

Wednesday, March 28, 2012

nanced understanding of structure-function and interrelationships among different elements in complex ecosystems by iteratively designing robotic animals and their habitats.

The Use of Drawings to Evaluate the Impact of an Out of School Environmental Education Experience

Michael W. Dentzau, Florida State University, mwd09c@my.fsu.edu

Alejandro J. Gallard, Florida State University

ABSTRACT: Prior to and after attending either a 2 day or 5 day out of school environmental education experience 406 4th grade students were asked to draw what they believed a longleaf pine forest looked like in north Florida, to include the plants, animals and processes that occur in the ecosystem. The review of the drawings was completed through a modified Content Analysis where emerging themes were developed and assessed. Comparisons of pre and post drawings suggest equal gain was obtained in the 2 day and 5 day interventions. Post instruction drawings reflected significantly higher mean number of species per drawing than the pre, and showed a shift away from common mega-fauna to a focus on more unique and unassuming species. The context of the experience was reflected in 27.8% of the post drawings. Prior to and after attending either a 2 day or 5 day out of school environmental education experience 406 4th grade students were asked to draw what they believed a longleaf pine forest looked like in north Florida, to include the plants, animals and processes that occur in the ecosystem. The review of the drawings was completed through a modified Content Analysis where emerging themes were developed and assessed. Comparisons of pre and post drawings suggest equal gain was obtained in the 2 day and 5 day interventions. Post instruction drawings reflected significantly higher mean number of species per drawing than the pre, and showed a shift away from common mega-fauna to a focus on more unique and unassuming species. The context of the experience was reflected in 27.8% of the post drawings.

The Effect of Instructional Framing on Learning and Transfer of Experimental Design Skills

Stephanie Siler, Carnegie Mellon University, siler@cmu.edu

David Klahr

Kevin Willows

Cressida Magaro

ABSTRACT: Although the ability to reason scientifically is critical to developing valid knowledge about the world, prior research has shown that students have a poor understanding of one of the central aspects of science: the design and evaluation of simple experiments. Providing explicit, interactive, instruction focused on the logic of experimental design significantly improves this understanding; however, students from lower-SES populations benefit at much lower rates than their higher-SES counterparts. In the study discussed in this paper, we tested whether low-SES 5th-grade students' understanding of the Control of Variables Strategy (CVS)—the strategy of only varying the variable of interest—can be improved via re-framing the instructional context. Three types of initial framing were compared: the traditional "Science" framing, an intuitive "Fairness" framing, and a "Brain Teaser" framing. As predicted, students with more incoming knowledge of CVS benefited more in the Science than other framing conditions and students with less incoming knowledge benefited more in the Brain Teaser condition. However, these advantages appear to be due to improvements in the ability to recognize good and bad designs rather than improvements in the ability to design unconfounded experiments.

An Investigation of How Cogenerative Dialogues Affect the Culture of Learning in a Pre-Service Elementary Science Learning Environment

Natan Samuels, Florida International University, nsamu002@fiu.edu

Renee Michelle Goertzen, Florida International University

Eric Brewé, Florida International University

Laird Kramer, Florida International University

ABSTRACT: Using Cultural-Historical Activity Theory (CHAT), we discuss how cogenerative dialogues in a learning environment can affect participants' learning preferences. For this ethnographic case study, we examine pre-service elementary teachers' (and their instructors') use of the Cogenerative Mediation Process for Learning Environments (CMPLE) in a science content and teaching methods course. CMPLE is designed to help students and

Wednesday, March 28, 2012

teachers reflect on their learning preferences, and then take part in the responsibility for changing their shared environment. Our analysis of the artifacts from the CMPLE activities, as well as student and instructor reflections, indicates that adapting the learning environment to meet the preferences of a cogenerative culture of learning affects that culture in multiple and complex ways. By comparing the week #4 and week #12 preferences of the class, we were able to see an increase in student agency, development of teacher identities, and a changed culture of learning. In terms of CHAT, the participants' community expanded from people in a college class to include in-service teachers, their motivation moved from following instructions towards a focus on self-directed learning, and the outcome changed from merely passing the class towards the learning of science content and teaching methods.

Strand 2: Science Learning: Contexts, Characteristics and Interactions

Middle Grades Science

10:15am – 11:45am, Room 311

Presider: Noemi Waight, University at Buffalo

Can Science Inquiry Instruction Really Enhance 8th Graders' Inquiry Competency and Self-efficacy?

Ching-Wei Tung, Lu-Kang Junior High School, Taiwan, snailms@gmail.com

Hsiao-Lin Tuan, National Changhua University of Education

Chi-Chin Chin, National Taichung University of Education

ABSTRACT: The purpose of this study is to investigate inquiry teaching outcome on 8th graders' inquiry competence and science self-efficacy. One regular class of 34 8th graders was involved in the study. The instructor taught four units of inquiry instructions: electrolyte test, acid-base, static and fruit cell. The combination of qualitative and quantitative research method was applied in the study. In the beginning of study science inquiry scoring rubric (Oregon Department of Education, 2007) and science self-efficacy instrument (Hung, 1999) were implemented, during the study process three more times of same tests were carried out after finish each inquiry instruction to these students. For the qualitative research data, classroom video-taping, students' inquiry worksheets, interview transcripts, and teachers' diary were also collected to confirm the quantitative data. After repeated measure, four aspects of students' inquiry competency—forming questions or hypothesis, designing an investigation, collecting and presenting data, analyzing and interpretation results were improved significantly, especially in forming questions or hypothesis. Students' science self-efficacy has also improved significantly from pre to post test. In addition, students with high, and middle self-efficacy students gain significantly on their science self-efficacy from pre- post comparison. Keywords: science inquiry teaching, science self-efficacy, science competency

Personal and Contextual Factors as Predictors of Homework Management and Procrastination in Science Courses

Yasemin Tas, Ataturk University, tasyase@gmail.com

Semra Sungur, Middle East Technical University

Ceren Tekkaya, Middle East Technical University

ABSTRACT: This study explored middle school students' homework management and homework procrastination in relation to both personal factors (approach and avoidance goal orientations in doing homework) and contextual factors (quality of homework and feedback on homework) in Science and Technology courses. Self-report instruments were administered to 1266 seventh grade students enrolling in 48 public middle schools in Ankara, Turkey. Results indicated that students' perceptions of homework quality and feedback were positively linked to their homework management. Additionally, students adopting approach goals while doing their homework were found to use homework management strategies more effectively. On the other hand, a negative association was found between avoidance goals and homework management. Concerning homework procrastination, although students' perceptions of homework quality and feedback were not significant predictors, students' goal orientations significantly predicted their homework procrastination. More specifically, while approach goals were

Wednesday, March 28, 2012

found to be negative predictors of homework procrastination, avoidance goals were positively linked to the procrastination.

Measuring Students' Continuing Motivation

David L. Fortus, Weizmann Institute of Science, david.fortus@weizmann.ac.il
 Dana Vedder Weiss, Weizmann Institute of Science

ABSTRACT: Continuing motivation is the term traditionally used to describe the process by which students engage in extra-curricular activities, although these activities may not be perceived by them as learning activities. Very few articles have appeared in the last decade on this important topic. This presentation will present a Rasch-based instrument for measuring students' continuing motivation in science and describes how it was developed and tested. The instrument is based on seven Likert-type items. Data on the continuing motivation of over 2600 Israeli students from traditional and democratic schools was collected and analyzed using Hierarchical Linear modeling. The results indicate in both types of schools adolescent girls have lower continuing motivation in science than boys, and that while the continuing motivation of both boys and girls in traditional schools decreases between 5th and 8th grade, the continuing motivation of students in democratic schools slightly increase during this period.

Background Demographic Characteristics: Predictors of Parent Attitudes Toward and Expectations of Middle School Science?

Leigh K. Smith, Brigham Young University, leigh_smith@byu.edu
 Erika Feinauer, Brigham Young University
 Erin F. Whiting, Brigham Young University
 Pamela Cantrell, Brigham Young University

ABSTRACT: Research regarding adolescent students' attitudes toward school science has explored various cultural and environmental factors to better understand the sources of these attitudes and how they impact students' science achievement, persistence with science in school, and career choices. Studies indicate that parents have significant direct and indirect influence on adolescents' attitudes toward science and learning science in school and describes a variety of ways parents impact the beliefs and attitudes of their children. Although parental behaviors and attitudes significantly influence adolescents' attitudes toward school science, little is known about what shapes parents' attitudes toward school science. This study examined how commonly used parent demographic characteristics relate to parent attitudes toward and expectations of science education in middle school. Ordinary least squares multiple regression models were constructed for seven subscales, predicting parent scores on each subscale by demographic background variables. Five of the seven final multiple regression models reached significance; the remaining two models were significant at the .10 level. Findings suggest that while demographic variables seem to matter, they matter differentially depending on the outcome variable. Socio-economic status, parent ethnicity, parent gender, and child gender were important in predicting different attitudes and expectations. Implications are discussed.

Strand 2: Science Learning: Contexts, Characteristics and Interactions

Symposium - Models in Science Education: Providing Foundation, Structure & Substance for Content Knowledge, Practice & Epistemology

10:15am – 11:45am, Grand Ballroom VI-A

President: Julia Svoboda, University of California, Davis

Discussant: Brian J. Reiser, Northwestern University

Presenters:

Julia Svoboda, University of California, Davis, jmsvoboda@ucdavis.edu

Cynthia Passmore, University of California-Davis

Michael Ford, University of Pittsburgh

Melissa Braaten, University of Wisconsin

Leema Berland, University of Texas, Austin

Wednesday, March 28, 2012

ABSTRACT: Our primary aim in hosting this symposium is to initiate a discussion with the science education community about the potential for models and modeling to unify and organize science education theory, practice and research. To this end, we have constructed the Models Pyramid, which synthesizes our theoretical stance on modeling with our empirical work. Our position is that modeling, broadly conceived as a sense-making endeavor, is foundational to scientific practice, that models provide organization and coherence to scientific knowledge, and that together models and modeling reflect the core epistemological commitments of the scientific community. Our central claim is that paying explicit attention to the centrality of models and modeling in science productively informs how science educators understand and design science learning environments in ways that can lead to productive outcomes for science learners. This symposium will include a general overview of the Models Pyramid and invited reactions to it. Our hope is that this symposium will provide an opportunity for scholars to interact around a set of ideas about how models and modeling provide a foundation, structure and substance to science education.

Strand 4: Science Teaching--Middle and High School (Grades 5-12): Characteristics and Strategies
Enhancing the Understanding of NOS

10:15am – 11:45am, Room 303

Presenter: Tamara H. Nelson, Washington State University Vancouver

The Effect of Educational Fieldtrips to Professional Research Labs on Students' NOS Understanding

Dina Tsybul'skaya, The Hebrew University of Jerusalem, dina.tsybul'sky@mail.huji.ac.il

Jeff Dodick, The Hebrew University of Jerusalem

Jeff Camhi, The Hebrew University of Jerusalem

ABSTRACT: U.S. standards documents repeatedly call for high school students to understand the nature of science (NOS). An excellent way of exposing students to NOS is via explicit inquiry experiences that usually mean hands-on "science by inquiry" investigations. However, in this paper we evaluate an explicit, "science as inquiry" learning unit in which students visit Professional University Biology Labs. Our results show that after exposure to this unit students significantly improved ($p = .05$) their understanding of five core NOS elements: science is a complex social activity, social cultural embeddings, tentativeness, research aims, and methodological diversity when compared to a control group that did not participate in the unit's implementation. To more deeply understand this change we probed the students with (pre-post) open questionnaire sections and (post) interviews where the students explained their understanding of these NOS elements. Post-program, their explanations showed a more subtle understanding of these elements, in which they sometimes drew upon episodes from the actual visits showing that the unit was an effective, memorable learning experience. We believe that this unit could be modeled for other sciences giving other students the chance to experience the excitement of scientific research and the deeper elements of NOS.

The Effect of Explicit-Embedded-Reflective Instruction on Understandings of Advanced Students about Nature of Science

Mustafa S. Koks'al, Inonu University, bioeducator@gmail.com

Jale Cakiroglu, Middle East Technical University

Omer Geban, Middle East Technical University

ABSTRACT: The purpose of this study is to investigate the effectiveness of explicit-embedded-reflective (EER) instruction on nature of science (NOS) understandings of ninth grade advanced science students. This study was conducted with 71 students using non-equivalent quasi-experimental design with three groups. In the treatment groups, the EER teaching was conducted while NOS instruction in the comparison group for the same time interval was carried out using lecture, demonstration and questioning strategies. Views on Nature of Science Questionnaire-Form C and follow-up interviews were used for data collection. Categorization of the participants' profiles on the NOS aspects and chi-square analysis were used for data analysis. The results showed that participants had misunderstandings about such concepts as "one method in science", "no hierarchy between law

Wednesday, March 28, 2012

and theory” and “difference between observation and inference” while they had informed views on “role of creativity and imagination” at the beginning of the study. The EER approach was found to be effective as a means of changing naïve views into informed ones. NOS understandings of the participants in the treatment groups improved more than those of the comparison group participants.

Exploring the Nature of Science through an Online Digital Game

Isha DeCoito, York University, idecoito@edu.yorku.ca

Maurice DiGiuseppe, University of Ontario Institute of Technology

ABSTRACT: Improving students’ scientific and technological literacy and the development of 21st century skills is becoming a goal of education systems worldwide. Rapid advances in information communication technology are reshaping the learning styles of students; hence, it is imperative that teachers adapt their teaching styles accordingly. Recently, researchers have found that computer-based games have significant educational value and may help students learn elements of NOS, including the principles, laws, and theories of science. The History of Biology, an online digital game designed to guide grades 7-12 science students through concepts about the history of biology, including the lives of scientists and their discoveries is the basis for this mixed-methods study, which explores teacher candidates’ a) demonstration of learning about NOS as a result of playing the History of Biology game; b) views on the role of the History of Biology game in teaching and learning NOS; and c) views on effective instructional practices for addressing the NOS components of Ontario Science curricula. Results indicate that participants made substantial gains in their understandings of the target aspects of NOS, which can be attributed to a number of factors including explicit-reflective NOS instruction, playing the History of Biology, and practicum teaching experiences.

A Comparative Case Study of Two High School Biology Teachers' Evolution and Nature of Science Teaching Practices

Lisa A. Donnelly, Kent State University, ldonnell@kent.edu

ABSTRACT: Although evolution is the central organizing principle in biology, biology teachers sometimes have concerns about teaching this controversial topic. Nature of science (NOS) instructional strategies have been widely advocated as a means by which to mitigate student concerns and accomplish content learning objectives for evolution. The present research project investigates the NOS and-evolution teaching practices of two high school biology teachers who were committed to embedding NOS into their evolution instruction. This study employed a multi-case study approach. Data collection consisted of participant observation during evolution instruction supplemented by two formal and several informal interviews with the teachers and document collection. The two observed teachers embedded NOS instruction in their evolution instruction using two key approaches: using evolution to teach NOS and using NOS to teach evolution. This comparative case study project can further the current line of evolution education research by exemplifying at least two ways that evolution and NOS instruction can be interwoven in a secondary biology curriculum.

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

Exploring Different Types of Science Learning and Teaching

10:15am – 11:45am, Room 304

Presenter: Janelle M. Bailey, University of Nevada, Las Vegas

Teaching Experiences for Researchers

Anne W. Collins, University of California, Santa Barbara, anne.wrigley@gmail.com

ABSTRACT: Modern science education reform recommends that teachers provide K-12 science students access to the processes and culture of scientists. This study investigated a program that allowed eleven graduate students, engaged in research full-time, to design and implement a short-duration course for secondary students; the “researcher” became “teacher.” Analyses revealed participants’ sophisticated views of the nature of science that clearly resonated with the tenets of nature of science (NOS) recommended for K-12 education. This study also highlighted key factors graduate students considered when designing lessons. Instructors took great care to move

Wednesday, March 28, 2012

away from models of traditional, "lecture"-based, science teaching. Nonetheless, instruction lacked opportunities for students to engage in scientific inquiry or learn about NOS. Graduate students did, however, offer high school students access to their own science or engineering research communities. Findings have significant implications for K-12 classroom reform. Universities continue to be a valuable resource for K-12 given access to scientists, equipment, and funding. Nonetheless, scientists may need explicit training on effective science teaching methodologies just as classroom teachers need this training. In other words, despite membership in the science research community -- thus sound understanding of scientific practice -- university scientists may not be prepared to or understand the importance of translating this for K-12 partners.

Connections to the K-12 Community that Shape the Career of Future Science Educators: A Longitudinal Study of Former Participants in a GK-12 Program

Molly S. Bolger, University of Arizona, mbolger@email.arizona.edu

Susan Kuner, Topaz Canyon Group, LLC

Doug Robinson, Topaz Canyon Group, LLC

Robert Crouch, Vanderbilt University

John A. Willis, The Brooks Besor Consultants, Inc.

Martha J. Willis, The Brooks Besor Consultants, Inc.

Jennifer A. Ufnar, Vanderbilt University

Virginia L. Shepherd, Vanderbilt University

ABSTRACT: A recent influx of new Ph.D.s in the sciences has important implications for teaching and learning of science at all levels. Much attention has been focused on how these graduates are being prepared to meet calls for reform in science education. Several programs have been funded with the aim of better preparing graduate students for their future careers as STEM faculty, but few studies have examined long-term implications for participants. We report on a longitudinal study of former participants in a GK-12 program that partnered graduate students with teachers. This program has been sustained for a total of twelve years and is now funded by a partnership between a public school system and a university. To understand how participation in this program impacted the professional lives of the graduate students who participated, we collected data from participants who were a part of the program over a ten year period (including surveys, focus groups, classroom observations, narratives and reflections). Qualitative analysis has revealed a number of robust themes including the impact on development of participants' teaching skills; partnerships with K-12 professionals as a shaping influence on participants' professional development; and participants as role models for the next generation of scientists.

College Students' Perceptions of Inquiry Experiences in Science Laboratories

Saed A. Sabah, saed_sabah@yahoo.com

Akram Al Basheer, Hashemite University, Jordan

Areej Barham, Hashemite University, Jordan

Merfat Fayez, Hashemite University, Jordan

ABSTRACT: The purpose of present research was to investigate to what extent the college students at the public universities in Jordan were offered the opportunities to engage in the scientific inquiry in introductory science laboratories. The participants, N = 244, were randomly selected from students who were taking general physics, general chemistry, or general biology laboratories in the summer of 2011. To collect data, this research utilized a translated and validated version of PSI-S instrument (Campbell, Abu- Hamid, & Chapman, 2010). The current research used SPSS to conduct the descriptive and inferential statistics and utilized WINSTEPS to check on the quality of items based on the Rasch model. It could be concluded that the opportunities students were offered varied across the dimensions of scientific inquiry aligned with reformed calls for engaging students in scientific inquiry. Students were given better opportunities for conducting investigations and collecting data than framing research questions and designing investigation. The less emphasis on framing question and designing investigations might result from the poor preparation of teachers and providing students with step by step procedure. Students' perceptions of inquiry experiences across science labs were similar. Some implications and suggestions of further research were introduced.

Wednesday, March 28, 2012

Review of Laboratory Learning in Undergraduate Chemistry Courses

Hannah Sevian, University of Massachusetts Boston, hannah.sevian@umb.edu

Gavin W. Fulmer, National Science Foundation

ABSTRACT: Much of the research on implementation of novel curriculum, instruction, and assessment in undergraduate science laboratory courses has been funded by public funding agencies. Recently, we have undertaken review and analysis of all awards between 2000 and 2011 from one funding agency that have focused on laboratory learning in undergraduate chemistry. This paper reports on the findings from this effort. Our study is concerned with characterizing the types of interventions that have occurred and are occurring, and what is being studied and learned related to student learning in undergraduate chemistry laboratory environments. For projects that were completed in this eleven-year timeframe, an overview is presented of the current 'state of the art' of the empirical knowledge base, in the interest of suggesting gaps and opportunities for further study. The findings are also contrasted with a recent summary of the state of chemistry education research, which is largely focused at undergraduate level teaching and learning, presented in a review paper commissioned by the National Academies of Science in the U.S. as part of a consensus study of discipline-based education research.

Strand 6: Science Learning in Informal Contexts

Innovations Cultivating STEM Disciplinary Knowledge

10:15am – 11:45am, Room 305

Presider: James F. Kisiel, California State University, Long Beach

Organizational Schemes as Aids for Understanding Astronomical Content

Sandra T. Martell, National Science Foundation, smartell@uwm.edu

Jean Creighton, UWM Planetarium

ABSTRACT: This study was concerned with providing visible organization schemes to visitors (Tulving, 1962; Kahana & Wingfield, 2000) to see if these schemes helped visitors correctly identify at least three constellations on a star map measure. The authors hypothesized that the treatment group would come away with a better understanding of where the Big Dipper is as well as understand the scale of what they were seeing on the star map, meaning they would identify more constellations overall. The authors found statistically significant correlations between the treatment and control groups and ability to identify the North Star and the Little Dipper. While most first time visitors may arrive at the planetarium with some familiarity regarding what the Big Dipper is and what it looks like, the authors found they are less familiar with objects and constellations that are not as popular or easy to find, including the Little Dipper and the North Star. Introducing them to an organizational scheme such as that utilized as part of this study does, in fact, help visitors with identification of objects in the sky.

Adults' Perception of Learning as Inspired by Awe in Nature

Tamara C. Coleman, Western Michigan University, tcoleman@lowellschools.com

ABSTRACT: This study was designed to promote understanding of awe experiences in nature and learning that may take place due to these awe experiences. This phenomenological research used qualitative methods to provide empirical evidence that those experiencing nature have awe experiences and learn from them. Face to face interviews were conducted with 71 adult individuals who had experiences in nature. Two follow up interviews were conducted with response rates of 73% and 93%. These participants described their most awe-inspiring nature experience and discussed what was learned as a result of that experience. Data segments were categorized using the constant comparative method. Based on the accounts of the informants of the study, recurring elements that make up the awe experience in nature such as; authenticity/intangible becomes tangible, beauty/pristine, challenge, connecting to nature, divine/spiritual, exclusivity, grandeur, novel/different/surreal, processes of nature, senses, solitude, peacefulness, power and wildlife were determined. In addition to elements of awe, learning was determined to occur in 98.6% of participants due to awe experiences in nature. The elements and

Wednesday, March 28, 2012

patterns formed by the experience and learning extend the current research on interpretation, natural resource management, experiential education and the study of emotions as experienced in nature.

Museum Theater as a Learning Environment for Introducing Evolution

Ayelet Baram-Tsabari, Technion

Ran Peleg, Technion - Israel Institute of Technology

ABSTRACT: Informal learning environments can provide children with positive exposure to science which may increase children's interest, create positive attitudes and influence choice to learn science in later life. Theatre within science museums is such an environment. Previous research focused on viewers. This study adopts a broader view by investigating the intentions of the creators of the play, the play's script, the learning outcomes of the viewers and the interactions between the three. Hall's model of encoding/decoding was adopted as a theoretical framework and an analogy is drawn to different levels of curricula in the educational context. A theatre play on Darwin and evolution in a major science museum was investigated. Data collection included an interview with the creators of the play, the written script, and questionnaires and interviews with visitors to the museum (viewers and non-viewers). Seven aims intended to be encoded by the creators were identified. These were categorized into general museum theatre aims, general aims of the play and specific learning objectives. Evidence was found for each in the script. Evidence for the specific learning objectives was found in viewers' responses. There was less clear-cut evidence for the more general learning objectives, possibly because these require multiple exposure.

STEM integration: Integrating Engineering to Enhance Science Learning

Misun Park, University of Minnesota, parkx598@umn.edu

Younkyeong Nam, University of Minnesota

Tamara Moore, University of Minnesota

Gillian Roehrig, University of Minnesota

ABSTRACT: Science, Mathematics, Engineering, and Technology (STEM) integrated education has been spotlighted as a new approach for promoting students' conceptual understanding and supporting their future career in STEM field. There is increasing evidence of the positive impact of using a whole design process that can be an example of STEM integrated activities to improve students' conceptual understanding and problem solving skills. However, there is a lack of information on how teachers should accomplish science and engineering integration activities in their classroom and what process they should pay attention. To answer this question, we research the relationship between an design process and students' conceptual understanding using an engineering design activity, called 'Save the Penguins', and study on how each step in an engineering design process in this activity enhance students' conceptual knowledge in science. We found that testing their prototypes and discussing with their peers were the most important process for students to understand and apply science concept for their design, even though the whole engineering design process (demonstration about radiation, discussion about examples in our lives, and testing and reviewing their prototypes, and making final design) helps the students understand the scientific concepts.

Strand 7: Pre-service Science Teacher Education

Field Experiences as a Factor in Pre-service Teacher Development I

10:15am – 11:45am, Room 306

Presenter: J. Steve Oliver, The University of Georgia

A Hidden Factor? Investigating the Impact Field Experience Hours on Science Teacher Attrition

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

Julie A. Luft, The University of Georgia

Wednesday, March 28, 2012

ABSTRACT: Studies investigating the factors related to why teachers move between schools or leave teaching entirely abound in the research literature. However few investigations have investigated the influence student teaching hours have on new teacher mobility nor have they examined teacher mobility over time as a function of student teaching hours. This study examines 130 beginning secondary science teachers over 5 years in order to understand if the student teaching component of their preservice program impacted their attrition from teaching. This multiple methods study used correlation and regression, and interviews to explore teacher attrition as a function of hours spent student teaching. The quantitative data analysis revealed no significant results, but a slight negative correlation between teacher attrition and student teaching hours is seen. The qualitative data reveals that the amount of time student teaching may influence teacher attrition. Both implications support further investigation into the role student teaching plays in teacher attrition decisions.

Re-imagining Inquiry-Based Field-Experiences for Preservice Science Teachers

Julie Angle, Oklahoma State University, julie.angle@okstate.edu

Donald P. French, Oklahoma State University

ABSTRACT: Preservice science teachers often lack experience teaching through an inquiry approach, a teaching approach recommend by the National Research Council. Therefore, with teaching through inquiry as a teaching expectation, it stands to reason that encouraging novice teachers to adopt and implement inquiry teaching practices effectively requires offering opportunities for preservice teachers to not only observe model classrooms but to actively engage in the teaching practice. This presentation describes the results of a collaborative between a biology professor and a science education professor. Together they have created a model for a low-threat inquiry-learning environment that affords preservice science teachers an opportunity to practice teaching through an inquiry approach before embarking on their student teaching internship. Reflective writings and class discussions are used to understand the extent to which preservice teachers' ability to design inquiry lessons and to teach through an inquiry approach was impacted by facilitating a freshmen level college biology lab. The experimental design and results of this study can serve as a model, for science teacher education programs, as a way to create inquiry-teaching opportunities for preservice secondary science teachers prior to their student teaching internship.

A Comparison of Field and University Based Science Methods Courses' Impact on Preservice Teacher's Belief and Abilities to Design Instruction for Diverse Learners

Anne P. Gatling, Merrimack College, gatlinga@merrimack.edu

ABSTRACT: Preparing preservice teachers to be more effective at teaching science once in their elementary classroom is a great concern for our field. This mixed-method study explored two different approaches to elementary methods for preparing preservice teachers to teach elementary science, a university-based and a field-based methods course. The purpose of this study is to determine the strengths and weaknesses that both courses have on preservice teachers' preparedness for teaching science in a diverse elementary classroom. I investigated whether preservice teachers' beliefs about science instruction and student learning changed over the semester and whether or not that growth varied depending on which methods section they were in. I collected multiple data sources to assess the impact of the two different types of methods courses including: pre and post surveys, pre and post-interviews and various assignments collected throughout the semester. Analyses of the data suggest that preservice teachers in the field-based section developed a more inquiry view of science, a greater application of diverse student strategies, yet smaller growth in confidence to teach a range of science content. The university based preservice teachers finished the course with less inquiry-based views, but more confidence in other science content areas.

Strand 7: Pre-service Science Teacher Education

Identity formation and Self Efficacy in the Context of Reform

10:15am – 11:45am, Room 312

President: Andrew W. Shouse, University of Washington

Wednesday, March 28, 2012

Persistence of a Culture of Inquiry: Professional Development Schools and Preparation of Reform-based Science Teachers

Jeffrey J. Rozelle, Syracuse University, jrozelle@syr.edu
 Gail Richmond, Michigan State University

ABSTRACT: The creation of Professional Development Schools (PDS) has been an effort to “rethink the connection” between schools and teacher education institutions. In this study, we describe the longitudinal influences of one such PDS initiative on the preparation of reform-based science teachers through a local university. We focus on the development and evolution of one instructional unit over a twenty-year period—a cholera case study developed by teachers and teacher educators. Despite the collapse of the PDS model over ten years ago, lingering effects can be seen including the following: 1) The cholera case study embodies what it means to “do inquiry” though the process of development may have been lost, 2) the cholera case study shapes how student teachers teach, alters their beliefs about good science teaching, and influences how they later teach, and 3) the cholera case study continues to serve as an anchoring point between university-based teacher education and the field in ways that aren’t present for interns in other school placements. The analysis also raises questions about the degree to which knowledge that is developed locally and embedded in tools can be transported to another place without the same institutionalized supports and tools.

Looking through Different Lenses: How Preservice Science Teachers Use Practice-Oriented Reflections to Negotiate Reform-Minded Identities

Robert Danielowich, Adelphi University (Garden City/New York, NY), rdanielowich@adelphi.edu

ABSTRACT: Recent research suggests teachers’ core conceptions about teaching play crucial roles in how they enact science education reform initiatives such as NOS, inquiry, and STS(E)/SSI. This multiple case study used identity as a framework to both encourage and understand how six secondary science teachers developed the reform-minded ideas about teaching associated with these reforms. In a methods and concurrent field course, teachers wrote, taught, and reflected about five lessons focused on reform agendas and two field lessons of their choice, and during student teaching wrote, taught, and reflected about five field lessons of their choice. A subset of their reflections revealed different lenses they used to propose changes to their practices and negotiate dissonances they encountered with their core conceptions about the aims of teaching, structure for learning, and relationships with students, which was described by another subset of their reflections and their interview responses. The extent to which teachers developed reform-minded ideas and enacted science-specific reforms was associated with how they used these lenses to resolve different levels of dissonances. The findings suggest how situating science teachers’ identity negotiations around both their science-specific and general practices can support their development of the reform-minded thinking required to enact science-specific reforms.

Enhance Preservice Teacher Self-efficacy through a Reform-based Science Methods Course

Sanghee Choi, North Georgia College & State University, sc1122@att.net

ABSTRACT: Regarding recent science reforms, improving teaching effectiveness and student scientific literacy, it is important to consider what types of adaptations in teacher education courses help teachers to develop strong self-efficacy in order to provide quality science learning. The purpose of this study was to examine effectiveness of a reform-based science methods course enhancing preservice teacher self-efficacy. The reform-based science methods course, which was based on a constructivist idea of teaching and learning and was a model for inquiry, problem-based learning (PBL), and teacher observation, was provided to 32 preservice teachers. The study employed one-group, pretest-posttest design and used a mixed-methods design. The preservice teachers had a significant increase in their science teaching efficacy and this indicated that significant improvement in their science teaching. Based on these teachers’ teaching self-efficacy, it may be concluded that the reform-based science methods course had a positive impact on participants’ self-efficacy. It is suggested that higher efficacy in science teaching has a positive impact on preservice teachers’ future teaching practices. The findings of this study provide teacher educators and teacher preparation programs important information to better prepare future elementary teachers.

Wednesday, March 28, 2012

Strand 8: In-service Science Teacher Education

Conceptions of Inquiry and the Nature of Science

10:15am – 11:45am, Room 206

Presenter: Carla C. Johnson, University of Cincinnati

Elementary Education Teachers' interest in and Conceptual Knowledge of Science Process Skills

Frackson Mimba, Southern Illinois University Carbondale, frackson@siu.edu

Erin Miles, Southern Illinois University Carbondale

Vivien M. Chabalengula, Southern Illinois University Carbondale

ABSTRACT: Research studies on inquiry-based science teaching rarely discuss elementary teachers' interest in science process skills. This study examined in-service elementary teachers' interest in science process skills and their conceptual knowledge of basic and integrated science process skills. A sample comprised 24 in-service elementary school teachers enrolled in a masters degree program at a research university. The main objective of the master's degree program is to increase elementary school teachers' mathematics and science content and pedagogical knowledge, instructional leadership and technology integration. Data were collected through a questionnaire and Science Process skills Knowledge Survey. Data were analyzed using statistical tests. Results show that teachers were mostly interested in learning more about integrated process skills. In contrast, teachers were less interested in learning more about the basic skills. Teachers displayed poor conceptual knowledge of both basic and integrated science process skills. These findings have implications on science teaching and learning.

Changing Identities and Evolving Conceptions of Inquiry through Teacher-Driven Professional Development

Ben Van Dusen, University of Colorado Boulder, benvandusen@colorado.edu

Mike Ross, University of Colorado Boulder

Valerie Otero, University of Colorado Boulder

ABSTRACT: In a climate where teachers too often feel de-professionalized, it is vital that teachers become empowered. This STEM education study investigates a new professional development program in which teachers work in partnership with university researchers to design professional development opportunities for themselves and for fellow teachers. Our research describes the process of teacher professional growth both through changes in agency and through a shared pursuit of an improved understanding of classroom scientific inquiry. Videos, emails, lesson reflections, survey responses, and interviews were analyzed to glean insight into changes in conceptions of inquiry and into participation shifts as these STEM teachers and university researchers formed a community unified in the pursuit of more effective classroom practice. Implications for professional development in STEM education are discussed.

Making Room for Play in the World of Kit-Based Science

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

ABSTRACT: In the scripted world of kit-based or text-book bounded science programs in many elementary schools, in-service teachers struggle to find ways to explore students' interests, engage them in open-ended, student-driven inquiries, or just let them play with the ideas of science. In this paper, I provide a rationale for building science education reforms around the idea of play, and present a case study of two third-grade, dual language, collaborative team teachers (CTT) and their attempts to interject play into the kit-based science education reform adopted by their school. In addition to describing the play model, the paper explores the benefits of play, as well as the constraints related to the environment, materials, persons, and freedom that undermined teachers' efforts to incorporate play. I also share teachers' perspectives on the trade-offs between making time for play and the value play added to the ensuing lesson. I argue that in our efforts to foster scientific literacy for and with all, play presents a crucial passageway towards re-imagining how we might get there and what science might look like and sound like when we do.

Examining the Progress Made on the Nature of Science Conceptions of Science and Elementary Teachers Exposed to an Astronomy Science Summer Camp

Wednesday, March 28, 2012

Ayhan Karaman, Canakkale Onsekiz Mart University, akaraman@comu.edu.tr
 Sezen Apaydin, Canakkale Onsekiz Mart University

ABSTRACT: The objective of this research study was to examine the improvement made on the nature of science (NOS) conceptions of practicing science and elementary teachers who participated in a week long astronomy science summer camp. Thirty science teachers and twenty elementary teachers who attended the camp program were instructed the specific aspects of NOS in an explicit reflective fashion. An adapted version of VNOS-C (Lederman et al., 2002) questionnaire was the instrument used in the study as a pretest and posttest to measure the progress made by the participant teachers. The responses given by teachers to the open-ended questions in VNOS-C questionnaire were scored using a rubric developed by McDonald (2008). The scored teacher responses in ten specific aspects of NOS were analyzed utilizing repeated measures MANOVA statistics. The results of the analysis indicated a statistically significant improvement between the pretest and posttest mean scores of the participant teachers in some aspects of NOS. Each aspect of NOS specified in VNOS-C questionnaire is discussed in the paper supported with the sample excerpts from the pretest and posttest responses of the teachers.

Strand 9: Reflective Practice

Curriculum Development, Teacher Beliefs, and Communities of Practice

10:15am – 11:45am, Room 301

Factors that Influence the Translation of Teachers' Self-efficacy in Teaching Science as Inquiry into Practice

Nattida Promyod, University of Iowa, nattida-promyod@uiowa.edu

Soonhye Park, University of Iowa

ABSTRACT: This study was conducted with 3 female physics high school teachers in Thailand. The sensible system framework was employed, aiming to explore the influential factors that translated teachers' self-efficacy in teaching science as inquiry into their practices and explain how teachers makes sense along this factors to be harmonizing with their practice. Series of data collection approaches including: interview, survey, and classroom observations; they were analyzed qualitatively by the constant comparative method. The result revealed that students, teachers themselves, and contextual issue were significant factors that translated teachers' high self-efficacy into the low implementation. Through the investigation, the consistent relationship between teacher's self-efficacy and their practices was revealed in the way that makes sense to each teacher. Teachers are confident in their teaching but as several factors emerged they considerably influenced the teachers to translate their practice into ways that make sense to them. In the case of this study, low implementation while having high self-efficacy towards inquiry instruction make sense to each teacher. In this light, the study implicates the innovative aspect explained by Leatham's framework in looking through the relationship between teachers' self-efficacy and practice in the consistent way also reflects factors that influenced the teachers' translating practice.

Using Reflective Inquiry to Uncover Perceptions and Beliefs about Transforming Instructional Practice

Robbie L. Higdon, Clemson University, rhigdon@clemson.edu

ABSTRACT: Teaching is complex process that requires its practitioners extended time to fully develop one's practice. However, as one's professional practice becomes more repetitive and routine, it is difficult for the practitioner to recognize opportunities in which to contemplate one's habitual actions. For significant change to occur, teachers, must engage with their prior experiences and understandings about their instructional practice before successfully achieving changes in their practice towards inquiry-based instruction. The first step in transforming one's practice is to recognize there is a problem in current practice (Marshall & Horton, 2010). Therefore, many teachers have difficulty promoting their own growth without the support and assistance to create the cognitive dissonance to assist in the identification of those problems. This study explored the use of a reflective dialogue model and its impacts on stimulating cognitive dissonance in advancing conceptual understanding about teacher practice in the use of inquiry-based methods. A preliminary analysis of the reflective dialogues indicates that these teachers varied greatly in their understandings about how to implement inquiry-based methods as well

Wednesday, March 28, 2012

as in their perceptions about the level of implementation within their own practice. These findings indicate a need to identify additional methods to assist teachers in transforming their practice.

Pathways to Science Teaching and Curriculum Development: A Self-Study of Two Teachers' Experiences

Megan Leider, Loyola University Chicago/St. Rita HS, meganleider@gmail.com

Elizabeth Coleman, Loyola University Chicago

ABSTRACT: In this self-study, we examine our own pathways to science teaching and to developing our own environmental science curriculum for an urban high school classroom. In particular, we focus on identifying the beliefs, values and experiences that lead us to become science educators and to undertake the development and implementation of a novel curriculum. In addition, we highlight how we came to a deeper understanding of our own learning as teachers and researchers through this process. In this session, we present a model for how two science educators researched their beliefs, values and experiences in order to strengthen their practice. We argue for self-study as a viable way for science educators to examine themselves in practice and to ensure that their beliefs, values, and experiences are realized in their teaching.

Developing Reflective Practitioners in Video Centered Communities of Practice (VCCOP)

Kimberly Lebak, Richard Stockton College of New Jersey, kimberly.lebak@stockton.edu

Ron Tinsley, Richard Stockton College of New Jersey

ABSTRACT: Video Centered Communities of Practice (VCCOP) help preservice science teachers develop as reflective practitioners. Through VCCOP preservice teachers work in collaborative groups to create, teach, and reflect upon inquiry-based lessons. This paper demonstrates how the VCCOP model leads preservice science teachers to significantly increase levels of reflective capacity in comparison to traditional teacher preparation models. Analysis of written reflections of preservice teachers following the VCCOP model revealed significantly higher proportions of analysis of practice and plans for improvement over those following a traditional model. Excerpts from transcriptions and video clips demonstrate the development of reflective capacity.

Strand 10: Curriculum, Evaluation, and Assessment

Studies on Assessment Forms and Item Sequencing Effects

10:15am – 11:45am, Room 308

Presider: Min Li, University of Washington

Comparing Student Performances, Anxieties, and Preferences between Situated, Virtual Environment Assessments and Multiple-Choice Assessments

Angela Shelton, Temple University, angi@temple.edu

Diane J. Ketelhut, University of Maryland

ABSTRACT: In Education, the tension between learning and accountability manifests itself in the form of assessments. This paper used a mixed-methods approach to compare student performances, anxieties, and preferences between situated, immersive virtual environment (IVE) assessments and multiple-choice questions (MCQs). Using data from the Situated Assessment using Virtual Environments for Science Content and Inquiry (SAVE Science) project, researchers compared performance on a contextualized question and a district MCQ, finding that students only differed significantly when frequency of computer game play was considered. Students who played frequently were more likely to answer both types of questions correctly than those who played occasionally or rarely. In terms of science anxiety, students who only answered the contextualized question correctly had a much higher science anxiety than those who answered both types correctly. Overwhelmingly, in focus groups, students asserted their preference to IVE assessment over traditional testing due to its interactivity, lowered reliance on memorization, and association with fun rather than anxiety. Though students appear to prefer this method, the most interesting finding is that almost 25% of students were only able to answer the contextualized question correctly, signifying that some students may understand science but not be able to convey it in decontextualized MCQs.

Wednesday, March 28, 2012

The Impact of Blended Cyberlearning about Climate Change on Students and Teachers

Cindy L. Kern, University of Nevada, Las Vegas, kernc2@unlv.nevada.edu

Kent J. Crippen, University of Florida

Heather J. Skaza, University of Nevada-Las Vegas

Peter G. Schrader, University of Nevada, Las Vegas

Nya Berry, Clark County School District

Jake Rollans, Clark County School District

ABSTRACT: This paper describes a design study of a blended cyberlearning instructional unit about climate change created with a new inquiry-based design framework, the 5-featured Dynamic Inquiry Enterprise (5-DIE). The 5-DIE design framework was created to address the need for authentic science inquiry experiences in cyberlearning environments that leverage existing tools and resources that are common to learning management software systems. Because 5-DIE is relatively new, research was needed to establish the effectiveness of the basic design and to inform future innovation. This paper describes an implementation for high school students in the southwestern U.S. in classes with a large number of students with special needs and focuses on achievement and barriers to teacher implementation. The results show significant student improvement for general and special populations. Three themes associated with the teachers' experience included: anxiety associated with technology issues, modifications for special education students, and the emergence of student autonomy. Implications for further development of the framework are discussed as well as future research related to science cyberlearning environments.

Item Sequencing Effects on the Measurement of Students' Biological Knowledge

Meghan A. Rector, The Ohio State University, rector.43@buckeyemail.osu.edu

Dennis Pearl, The Ohio State University

Ross H. Nehm, The Ohio State University

ABSTRACT: Recent research in evolution assessment has documented how item features may bias the measurement of students' evolutionary knowledge. An additional issue that has not been critically examined in the literature is whether the sequencing (or order) of assessment items has a meaningful impact on the measurement of evolutionary knowledge. The focus of this study is to examine order effects as a potential constraint on knowledge measurement using open-response items. Our data consisted of student responses from an introductory non-majors biology course (n=309) and a majors evolution course (n=126). Item order and context were found to have sizable effects on student performance. Student responses to the first item in the assessment sequence were significantly more verbose and contained a greater number of key concepts relative to the last item in the sequence (p<0.01). Additionally, student responses contained more key concepts when presented with easy-to-hard sequences relative to hard-to-easy sequences (p=0.05). Use of naïve ideas was similar across groups, suggesting that the impact of item order may be more significant for key concepts. Overall, our results indicate that item order effects are a significant constraint on the measurement of students' biological knowledge using open-response items.

Strand 11: Cultural, Social, and Gender Issues

Symposium - Promoting Science among English Language Learners (P-SELL) Efficacy Study

10:15am – 11:45am, Grand Ballroom V-B

President: Okhee Lee, University of Miami

Discussant: Sherry A. Southerland, Florida State University

Presenters:

Jaime Maerten-Rivera, University of Miami

Kimberly S. Lanier, University of Miami

Brandon S. Diamond, University of Miami

Rose Elizabeth Rohrer, University of Miami

Georgina O. Lindskoog, University of Miami

Wednesday, March 28, 2012

Soyeon Ahn, University of Miami

ABSTRACT: This symposium presents the first-year results of a three-year teacher professional development intervention to improve science achievement of English language learners (ELLs) in urban elementary schools within the context of high-stakes assessment and accountability policy in science. The project involved 64 elementary schools that were randomly selected from a large district and then randomly assigned to (1) a treatment group of 32 schools participating in the intervention for the first two years and sustaining the intervention for the final year and (2) a control group of 32 schools using the district science curriculum. The intervention consists of: (1) curriculum for students and teachers along with supplies, (2) teacher workshops, and (3) implementation support at the school sites. The intervention is grounded in three areas of literature: (a) reform-oriented practices in science, (b) science instruction with ELLs, and (c) high-stakes assessment and accountability policy in science with ELLs. Teacher practices were measured using a questionnaire, a science knowledge test, and classroom observations. Student science achievement was measured using the state science test administered at fifth grade. The symposium consists of six presentations on a range of topics addressing the impact of the intervention on teacher practices and student achievement.

Wednesday, March 28, 2012

Presidential Sponsored Session

Symposium - The PISA Assessment Framework for Science in 2015

1:00pm – 2:30pm, Room 313

President: Sharon Lynch, George Washington University

Presenter: Jonathan F. Osborne, Stanford, osbornej@stanford.edu

ABSTRACT: In this symposium, the draft framework for the assessment of scientific literacy in 2015 will be presented. In 2015, science will be the major focus of this PISA round and this will be the first time the framework has been revised since 2006. This will be an opportunity to hear what the underlying rationale for the framework is, what changes are being suggested and what elements will be sustained. There will be extended opportunity for discussion and feedback from this session will be considered and, where appropriate, used to modify and improve the final framework.

Presidential Sponsored Session

Poster Symposium - Sandra K. Abell Institute for Doctoral Students Poster Symposium

1:00pm – 2:30pm, Grand Ballroom V-A

President: Janet Carlson, BSCS

Students' Learning from Deliberative Communications in Socio-Scientific Issues

Birgitta Berne, University of Gothenburg Sweden, birgitta.berne@ped.gu.se

ABSTRACT: Although research in science education reports that students gain content knowledge and argumentation skills when engaged in discussions about socio scientific issues, not much is known about how this actually happens. This paper reports on a teacher's classroom research in lower secondary school in Sweden, where the goal was to examine how students' deliberative communication contributed to students' content knowledge and argumentation skills. The students (14-15 years old) discussed the desirability of designing children and growing of stem cells. In accordance with Vygotsky's socio-constructivist theory the students were arranged in peer-groups. Before discussing they were triggered with different aspects of the issues and were given time to search for more information themselves, but they were also informed to listen respectfully to each other when discussing. Data was collected through students' own video recordings from these discussions and from students' individually written arguments before and after the discussions. During the discussions students invited each other to talk and they made sure that all peers got time and space to articulate their views. Students thus experienced different aspects, warranted by content knowledge as well as by ethical considerations, aspects reflected on and used in their individually written arguments after the discussion.

Identification of Science Literacy Practices in Pre-Service and Practicing Teachers for Urban Youth

Anna E. Hutchinson, University of Cincinnati, hutchiae@mail.uc.edu

ABSTRACT: Diverse students are learning by rote memorization and are not getting an in-depth understanding of science content. Language, connected to relevant experience, aids in creating such depth. Teachers creating language bridges between student experiences and academic content language is vital for diverse students to engage in science content. It is this classroom discourse that lays the foundation for language acquisition and opportunities to learn for students to become scientifically literate. However if bridges are not built among English Language Learners (ELL) or Secondary Language Acquisition (SLA) students and the content language, diverse students will continue to be excluded from the nature of science. In the study, pre-service and practicing teachers within an urban school district are observed for ten weeks for their pedagogical practices – language of instruction and opportunities to learn - that serve as language bridges. The work intends to inform teacher preparation programs on creating activities that support scientific literacy for urban youth.

From Evaluation to Instructional Support: Changes in Secondary Science Preservice Teachers' Assessment Expertise

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Wednesday, March 28, 2012

ABSTRACT: Developing assessment expertise consistent with the aims of science education reform looms as a daunting task, particularly for preservice science teachers. This study explored the ways in which the assessment expertise of eleven secondary science preservice teachers (SSPTs) changed when exposed to assessment-related instruction during their teacher education program (TEP). I analyzed assessment expertise through three dimensions - Constructing assessments to make inferences about students' scientific thinking, Using assessment to support science learning, and considering Equitable assessment for English Learners. Data sources consisted of responses to an open-ended survey item and semi-structured interviews collected at three different times during the SSPTs' TEP. I employed a mixed-method approach by scoring the open-ended item using a rubric based on the three dimensions and analyzing the content of interviews through several rounds of coding and pattern identification to provide richer descriptions of those changes. On the open-ended item, the SSPTs demonstrated positive changes in their assessment expertise, including a statistically significant change in the use dimension. Content analysis of the interviews was consistent with these positive changes and revealed several assessment expertise "shifts" in each dimension. The findings from the study have implications on how SSPTs are prepared to assess in teacher education programs.

How do Elementary Teachers and Students with Known NOS Views Make Meaning of NOS Messages in Trade Books?

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ABSTRACT: While it is generally accepted that the Nature of Science (NOS) is a major learning objective for students, the question of how teachers can reach this goal still exists. One of the techniques used in elementary classrooms to teach science are science read-alouds. This study examines how science read-alouds can be utilized and how teachers can be supported to teach NOS concepts through science read-alouds. The study will examine elementary teacher NOS views, explicit and implicit NOS message in trade books and elementary student NOS views before and after the read-aloud. Data from 5-8 elementary teachers will be collected over a three-month period that includes a VNOS survey, interviews and video-recorded observations. A grounded theory method of analysis will be used, that includes open, axial and selective coding, to contribute to the literature on how teachers can use read-aloud techniques to teach NOS. While the results from this study will be available in the spring of 2012, preliminary findings suggest the need for elementary teachers to become more aware of the meaning-making affordances in children's science books selected for read-alouds with the help of science education research.

From "Teaching the Textbook" to Focusing on "Big Ideas" in an Introductory Undergraduate Biology Course

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ABSTRACT: This research explores the influence of a novel instructional model in the context of teaching a large-lecture introductory course in biology. The innovative model was implemented in three phases, gradually increasing student-centered instruction. In the advanced phase there were very few lectures and most of the basic content was studied through an on-line tutorial. Students studied complex topics in groups and discussed them in small-group meetings with the TAs and the instructor. Multiple data sources included semi-structured interviews, class observations and teaching surveys. Analysis was interpretative and quantitative. Results demonstrated that the instruction gradually changed from "teaching the textbook", through focusing on the more complex and wide-scope issues, to mentoring. In the third phase, student-centered approach and group discussions were dominant, and evidence for meaningful changes in instructional approach was found. During the meetings with the small groups the instructor had opportunity to ask questions about student presentations, address student misconceptions, and raise issues that deepened and broadened concepts talking about. We believe that this instructional model, based on social-constructivist ideas, made this Biology 1 course more meaningful to the students' current and future learning, and that the model is applicable to other large-lecture introductory science courses.

Wednesday, March 28, 2012

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

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ABSTRACT: Using a framework of the variations of inquiry matrix (NRC, 2000, p. 29), this study explored eight elementary teachers' planning, modification, and enactment of kit-based science curriculum materials. We employed mixed-methods to investigate these questions: 1) In what ways do practicing elementary teachers adapt existing science curriculum materials across the inquiry continuum of teacher-guided to learner-guided? 2) What do their curricular adaptations reveal about their views of the inquiry continuum? 3) How do their views of inquiry teaching & learning and their curriculum adaptation practices change over three consecutive years? Lesson plans and enactments were scored on both the P-SOP and STIR rubrics. The research design includes observing the same three lessons each year for the duration of the study and using semi-structured and stimulated recall interviews with teachers. First year findings indicate that the majority of teachers' enactments fell on the teacher-guided side of the continuum while their definitions fell on the student-guided side. Teachers attempting more learner-directed forms of inquiry failed to scaffold their students to be successful in this scientific practice. Professional development that exposes teachers to the inquiry continuum is needed, as well as curriculum materials that support teachers in adapting existing lessons across the continuum.

Investigating Teacher Beliefs about the Importance of Scientific Models through Professional Development

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ABSTRACT: Incorporating knowledge of scientific models into instruction engages students in a more authentic science experience than when scientific models are not included. This study tracked 15 middle and high school teachers' beliefs and knowledge about the importance of including scientific modeling in their teaching and how these beliefs change as a result of professional development. A mixed methods approach to data collection was used. Quantitative pre-post data on teacher beliefs and knowledge of scientific models was collected before and after the professional development. Qualitative data in the form of surveys, interviews, and daily reflections focused on teachers' beliefs were collected during the institute. Research questions included: (1) How do teacher beliefs about the importance of teaching about scientific models and scientific modeling change in the context of professional development? (2) What characteristics of the professional development played a role in the changes in teachers' beliefs about the importance of modeling? (3) Why did some teachers' beliefs about the importance of modeling not change? Research findings include rich descriptions of both successes and challenges in changing teacher beliefs about the importance of teaching with and about scientific models in the classroom. Implications for the improvement of modeling professional development are discussed.

Cultural Relevance in High School Biology - Exploring Students' Scientific Understandings and Dispositions

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ABSTRACT: One explanation offered for the existing achievement gap is that conventional science classroom practices alienate students from diverse backgrounds due to a cultural discontinuity between the teacher, school system and student. This documented inaccessibility is considered to be a contributing factor to the marginal presence of ethnically diverse individuals in science, technology, engineering, and mathematics (STEM) professions. Educators must look to non-traditional pedagogical approaches that will effectively increase students' access to science. Culturally-relevant pedagogy is one such alternative that has been evidenced to increase student achievement, engagement and scientific literacy. Yet, research has shown that it is not widely implemented in the science classroom. Enrollment in secondary-level biology classes is often mandatory and occurs during a period in students' lives in which they are making decisions about future career aspirations. As a result, this study will examine the degree to which the enactment of a culturally relevant secondary genetics curriculum impacts diverse students' dispositions toward and understanding in science.

Wednesday, March 28, 2012

Teaching Science to English Learners: A Case Study of an Experienced Science Educator

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ABSTRACT: The purpose of this case study was to examine how an experienced seventh grade science teacher implemented science lessons in ways that helped students who were English learners increase both their English language fluency and science content understandings. The participants in the study were a science teacher with over sixteen years teaching experience and one class of 32 seventh grade students in a K-8 school in Northern California. A qualitative case study design guided the collection and analysis of data. This study contributes to the literature on the teaching of science to English learners, and how learning science content can support students' development of English language skills.

Youth Action Research in the Science Classroom: Implications for Youth's Identity Work

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ABSTRACT: This study examines how engaging youth in action research within the science classroom might enable them to author their identities and work as change agents to impact their surrounding communities. Specifically, this study investigates how the use of youth action research as an instructional strategy and curricular framework within science education might promote and/or constrain youth's identity work and their critical science agency. In addition, this work defines a framework that draws on tenets of critical theory and socio-cultural learning theory in order to define youth action research and distinguish it from other forms of inquiry, explain how it might be used in science classrooms, and argue for its potential to address significant problems at work in science education.

Alternatively Certified Science Teachers' Perceptions of their Preparedness to Teach Urban Minority Students

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ABSTRACT: A recent report by the National Commission on Teaching and America's Future has estimated that more than half of today's teacher will be gone in a decade. With the vast number of teachers that are needed, many school districts are now strategizing over how to recruit new teachers. Alternative teacher preparation programs and certification routes are only one source for many struggling school districts. The purpose of this research project is to explore how alternative teacher certification models affect science teachers' perceptions of their level of preparedness to teach urban, minority students within their first year of teaching. For this case study, three alternatively prepared teachers, from urban minority school districts were interviewed. The alternatively prepared teachers found that they were underprepared in issues of diversity, power relations, and unrealistic demands for "saving" groups of underprepared and underrepresented urban minority students. Although this study briefly sheds light on three teachers perceptions of their preparedness to teach urban minority students, it is evident that more could have been done in pre-service training to make this a more meaningful and authentic experience.

Exploration of Professional Learning Pathways of Senior Years Science Teachers: the Journey toward Science Literacy

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ABSTRACT: The purpose of this research is to develop a deeper understanding of those professional learning pathways and opportunities that meaningfully support teachers in addressing their personal professional goals as science educators as well as the curricular goal of science literacy. In contrast to research studies that address the state of science teacher preparedness in fostering learning environments that support science literacy or various strategies for professional learning in teaching science (Schneider and Krajcik, 2002; Clough, 2007), this research focuses on the personal experiences and perceptions of teachers in their continued individual journeys through the process of developing professionally as science educators. Given the complexity and individuality of what it means for a teacher to develop as a professional, this study will explore the specific pathways that selected senior years science teachers have followed and continue to follow to meet their own perceived professional learning needs.

Wednesday, March 28, 2012

Leveraging Students' Lived Experiences and Science Ideas

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ABSTRACT: Research in science education has begun to address how teachers use students' funds of knowledge to support science learning, but specific practices for building bridges between secondary science classroom learning and students' funds of knowledge have not been fully described. This study examined how two novice teachers, who taught in urban, diverse schools in the northwest learned about and used students' funds of knowledge in classroom conversations. Primary data sources included classroom observations during practicum and their first year of teaching, informal interviews following each lesson observed, and three formal interviews. The teachers for this study were selected because of their equitable and ambitious teaching practices demonstrated throughout their practicum. Analysis of the classroom discourse episodes led to a map of specific practices on how they used funds as an engagement piece in learning. By focusing on secondary science teachers and these practices, a beginning vision of how teachers can incorporate the socially just pedagogical moves of connecting rigorous science concepts with their students' lives was mapped out.

Teacher Candidates' Stories Identities and Their Learning to Become a Science Teacher

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ABSTRACT: There is a growing corpus of literature that reveals the relationships among teachers' identity work and their developing instructional practices in the classroom. While many of these studies have focused on experienced and beginning teachers, few have honed in on teacher candidates. In this study, I examine how teacher candidates engage in identity work as they learn to teach. I use a storied identity framework to call attention to the critical events that shape their journey to becoming a science teacher. I use 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.

Pre-service High School Science Teachers' Selection and Implementation of Formative Assessment Tasks (FATs)

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ABSTRACT: The understanding of how to assess students' knowledge and progress forms one part of the knowledge that teachers should possess to be successful in their profession. The purpose of this study is to understand pre-service secondary science teachers' experience with selection and implementation of formative assessment tasks (FATs). FATs are the activities, techniques, and tools used by teachers to assess students' prior knowledge, progress, and learning to improve their instruction. We used the preservice teachers' lesson plans, reflections, interviews, and observation as data, which we collected during prospective teachers' field teaching experience. Three main trends emerged from the data and they are identified as selection of FATs, implementation of FATs, and reflection on implementation. Related to these main sections, four themes emerged for selection of FATs: a) the instructional reason for selection, b) the characteristic of FATs, c) the factors that affect selection process, and d) source of FATs. The second main section is implementation of FATs and it consists of types of formative assessment tasks used by participants and challenges participants faced during implementation. The last main section that emerged from the data is the prospective teachers' reflections on their implementation that includes benefits of FATs and modification for future usage. We will discuss the implication for teacher educators and teacher preparation programs based on these findings.

What Meanings do Rural Students Place on STEM Careers when Exploring and Creating Career Videos?

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Margaret R. Blanchard, North Carolina State University

ABSTRACT: National efforts to interest students in STEM careers are intensifying in the United States, due to shortages of professionals to fill the growing demands in these fields. Minorities are greatly underrepresented in STEM careers, yet often show interest and excel in science. Little is known about rural students and promoting their STEM career interest. Minority students in rural areas must confront how gender, race, ethnicity, and class structure play a role in their science identity. Research suggests promise in activities that help minority students experience the process of science. This study proposes that there is potential in having diverse rural middle school

Wednesday, March 28, 2012

students explore and create STEM career videos. This mixed methods exploratory study asks, What are students' interests in STEM careers? What criteria guide their exploration of STEM careers? What meanings do rural students place on STEM careers when exploring and creating career videos? Data will be collected using pre and post STEM career interest surveys, classroom and STEM career video data, audio recordings of group work, interviews, and focus groups. Expected implications will help the STEM community understand ways for minority students to better identify with STEM careers and what pedagogical aspects might be explored in science classrooms.

Pedagogical Content Knowledge and Content Knowledge of Pre-Service and In-Service Secondary Physics Teachers

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ABSTRACT: Teachers' professional knowledge is assumed to significantly influence teaching and student outcomes, but little research explains how teachers gain this knowledge. In this study, we are trying to bridge this gap by assessing the content knowledge and pedagogical content knowledge of 41 pre-service and 167 in-service physics teachers, and will present our findings. For in-service teachers the correlation between content knowledge and pedagogical content knowledge is $r=.497$, $p<.001$; for pre-service teachers $r=.429$, $p<.001$. This indicates that content knowledge and pedagogical content knowledge develop concurrently and should be taught concurrently at university. In-service teachers' pedagogical content knowledge in this sample does not increase with their experience, but there is a positive relationship between increases in content knowledge and length of time teaching physics. We are currently working to understand the development of physics teachers' professional knowledge to identify ways to best support them. Avenues for this support could be universities, pre-service and in-service training.

Modeling Instruction: Success in Dissemination through Teacher Empowerment

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ABSTRACT: Although certain key research-based reforms in physics have been documented to have positive impacts on the conceptual understanding of high school students, few of those reforms are enacted in classrooms in the United States. One of the more successfully disseminated and enacted reform in physics is Modeling Instruction. To identify aspects of Modeling Instruction that have promoted its widespread dissemination and sustainable enactment by teachers in their schools, we interviewed five people who were extensively involved with the development of this reform. Our analysis of the interviews linked our findings to three theoretical perspectives: diffusion of innovation, communities of practice, and leadership. The diffusion of innovation focuses on the structure of the reform, the community of practice describes how adopters learn to use the reform, and the leadership perspective describes the distribution of power in the interactions between leaders and followers of the reform. These three perspectives, which define our conceptual framework, contribute to our efforts at describing the successfulness in dissemination of Modeling Instruction.

Open Inquiry in the Urban Science Classroom

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ABSTRACT: Science education is currently failing our students, especially those from low-income urban areas. Traditionally, science has been centered on the idea that there is one way of knowing science. This has left many students to feel marginalized in the science classroom. In addition, these students are left with misconceptions regarding the nature of science. By using open inquiry and positioning students as researchers, these misconceptions can be challenged. The purpose of this study is to determine how students' knowledge of the nature of science is impacted by conducting open inquiry based research. Using a critical theory lens, I will conduct research in my own classroom with the hopes of uncovering how issues of power, race, and economics impact the

Wednesday, March 28, 2012

students' knowledge of the nature of science. This poster outlines the theoretical framework and methodology behind a case study involving four of my students as their knowledge of the nature of science changes. I will also make a case for teachers to assume dual roles as teacher and researcher as a means to investigate their own class, students, beliefs, values and pedagogy; to strengthen their practice; and to improve the state of science education.

Insights about Students' Knowledge of Natural Selection Concepts from Three High School Biology Teachers' Classes
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ABSTRACT: mechanism through which evolution works, but many of its components are not well understood by many individuals. Various studies have explained why natural selection concepts are difficult to understand, but little research exists regarding how the daily demands and practices of a group of high school teachers with the same relative knowledge base and average experience level impact their students' understanding of natural selection concepts. This study focused on explaining why a specific group of high school students experienced ease or difficulty in learning natural selection concepts. After identifying which natural selection concepts posed more or less difficulty by a group of high school students, teachers' lesson plans and key classroom events were used to explain the students' understanding. Findings indicated that despite acceptance and expertise in knowledge of natural selection concepts, the teachers were not thoroughly capitalizing on the prior knowledge of their students, nor were they completely familiar with the natural selection alternative conceptions students often possess.

The Fundamentals of Literacy in Science: Teachers' Implementation of Literacy Practices in the Science Classroom
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ABSTRACT: The National Research Council's new framework for K-12 science education specifically focuses on the importance of incorporating scientific practice into the science curriculum. An inherent part of the scientific practice includes specialized literacy practices that are used to evaluate, communicate, and generate scientific knowledge. Previously the integration of literacy into the science curriculum has been taken up by the literacy community. However with a shift of importance from inquiry to practice by the new science framework, the issue of literacy in science will become an important area of research for the science education community. This study proposes to investigate science teachers' implementation of literacy practices in science with the intention of learning how teachers are integrating literacy practices in the science classroom. I use disciplinary literacy theory to understand the literacy practices science teacher implement in the classroom and how those activities engage students in literacy practices integral to scientific practice. Observing science teachers using these literacy practices in their classrooms provides the science education community an opportunity to understand the role of literacy practices in science teaching and learning.

Understanding the Co-Development of Modeling Practice and Ecological Knowledge

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ABSTRACT: Scientific knowledge and practice are deeply intertwined and develop together in community activity (Lave & Wenger, 1991; Latour, 1999). Despite science educators' recent focus on engaging students in epistemic practices, there is little research on how learning environments might support the co-development of concept and practice. I use a design study method to understand how, and under what conditions of support, modeling practice and ecological knowledge co-develop in a classroom community. Instruction engaged third grade students in modeling to develop explanations of a backyard ecosystem. Qualitative analysis of classroom activity focused on understanding how concepts became visible and useful, in turn shaping students' modeling practice. I report on how one concept, reproductive success, was positioned and repositioned in students' activity over the course of a year of instruction. The concept became visible and interesting to students, then the subject of their scientific activity, and finally was adopted as a measure for a new investigation. This analysis suggests that the purposeful positioning of concepts in relation to students' scientific practice is a potentially powerful design tool.

Studying a Reconceptualized Instructional Model for Secondary Physics Education

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Wednesday, March 28, 2012

ABSTRACT: For years, research has shown that “traditional” physics instruction is insufficient for a large fraction of students. While many alternative models have been proposed, researched, and championed by numerous physics education groups, they have not been as influential in secondary physics education as in higher education. This proposal describes a pilot case study which will utilize an alternative instructional model to traditional secondary physics instruction that emphasizes: (1) Developing students’ conceptual understanding; (2) Covering the breadth of content required by many state curricula; and (3) Using teacher-generated, instructional podcasts as the primary source of content presentation. In this alternative model, traditional in-class lectures will be replaced by a online collection of highly-focused, teacher-generated podcasts that can be easily accessed by students anywhere, anytime via internet connection.

Figured Worlds as a Lens of Understanding Girls’ Identity in a Kindergarten Science Classroom

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ABSTRACT: This dissertation study examines the authoring of and positioning on girls as science learners in a kindergarten classroom. My study will take place in a classroom where practices of providing evidence in connection with explanation building are central to science instruction. I will use this setting to view the figured worlds that afford and/or constrain the girls authoring as science learners and position the girls within this environment. Ultimately, I am trying to understand the impact evidence-based early science education might have on our next generation of female science citizens.

Barriers to Developing Science Faculty Knowledge for Teaching: Identifying Gaps through Critical Review of the Literature

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ABSTRACT: In light of bringing reforms in teaching, The National Research Council (1999, 2003) reported that undergraduate faculties should shift from traditional teaching to learner-centered instruction, which positively impacts student learning. Despite the call for encouraging faculty to bring changes in their instruction, they seldom teach in ways that “promote student construction of knowledge” (Walczyk, et al., 2007, p. 85). The situation is even worse in physics, where most physics instructors felt the need to change, but continue teaching with traditional approaches (Henderson & Dancy, 2008). This study attempts to identify the barriers and challenges for physics faculties (in particular) to change existing teaching practices through reviewing literature on science faculties’ views of teaching. The findings are presented as five themes: a) mismatch between the thought processes of educational researchers and science faculty; b) dilemma to balance the time between research and teaching; c) personal beliefs about teaching and learning; d) graduate students preparation for the professoriate in science departments; and e) lack of pedagogical content knowledge (PCK) (Shulman, 1987). The synthesis provides motivation for future research to bridge the gap in the research on science faculties’ PCK. Implications of the study are discussed in terms of both research and practice.

What do Second Graders Notice? Examining Student Notebooks from a Problem-Based Learning Unit

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ABSTRACT: Scientific process skills such as observing, measuring, and making inferences are foundational aspects of science learning; however, process skills are more challenging to assess than content knowledge. Examining student class work can provide information on what is happening in primary grade science classrooms, and help educators see strengths that students bring to class that may not be evident on standardized tests. In this study, we examined student notebooks from eight rural second grade science classrooms. We addressed the following

Wednesday, March 28, 2012

research questions: 1) What types of observations do second grade students' make when studying tomato plants in the context of a problem-based learning unit? 2) How prevalent are these types of observations in student work from the eight classrooms? After we analyzed the notebooks, the following five themes emerged from the students' work: systematicity, noticing details, accuracy in measurement, change over time, and making inferences. We found differences across classrooms in many aspects of the observations, suggesting that even when using the same curricula, teachers' individual approaches to the lesson may result in great variations in student work

Evolution of a K-5 Teacher Learning Community: Grappling With Ambitious Science Teaching Practices

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ABSTRACT: Teacher learning communities have been offered as a powerful form of sustained professional development that have the potential to transform instruction, however little is known about how they develop. This proposed ethnographic study seeks to describe the evolution of a teacher learning community, specifically a video club community focused on reform-oriented science teaching practice grounded in the construction of evidence-based explanations, as new members join the group. An existing video club has been in place in the school district surrounding our large research university for the past year and multiple new individuals have expressed interest in joining. This work will be grounded in socio-cultural theories of learning as it examines this community of practice of K-5 teachers. By seeking to understand how communities exist as dynamic entities, it is anticipated that this study will provide useful information on how teacher learning communities grow, evolve, and sustain themselves over time. The study also aims to describe how participation in this community shapes the new members' science teaching practice grounded in the construction of evidence-based explanations, with a recognition that the relationship between teacher's experiences in professional development and their classroom practice exists as a coevolution.

Supports for Engaging Students' Argumentation: The Role of Students' Everyday View and Teachers' Questioning Scaffold

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ABSTRACT: Study context refers to all of the variables associated with where the study will be conducted. We meant for you to describe the setting: is it high school, middle school or grade school? What class is it? Is it physics, biology, etc.? It is an after school program? It is an informal setting like a museum? What is it designed for: gifted, average or struggling students? Is this a setting that has lots of resources or one that is poor in resources? What type of instruction do the students typically receive? Does this make sense? Let me know and if it doesn't I will try and explain it further.

Above the Fold: Headlining the Engagement of Teen Science News Journalists

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ABSTRACT: A key tenet of science education is to contribute to the scientific literacy of future participants in society. The Science Literacy through Science Journalism (SciJourn) project involves high school science and English teachers and their students in the process of writing science news toward the goal of improving high school student science literacy. As teachers and students become more critical consumers of, and producers of, science news articles, it was also expected that participants would make connections to topics of interest to them personally, leading to possible changes in engagement with science and technology. The Youth Engagement with Science and Technology (YEST) survey was developed around a framework of science and technology engagement based on interest, action, and identity and considers the interplay between those components. In this study, conducted within the larger context of the SciJourn project, case studies and survey research were used to gain insight into high school student engagement with science and technology. This poster will present the engagement stories of three students in an environmental science class where SciJourn was implemented at a high level.

Wednesday, March 28, 2012

Engaging in Pedagogical Reasoning through the Work of Mentoring: A Case Study

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ABSTRACT: Mentoring is an important way in which novices learn to teach and it has become a wide spread practice in teacher preparation. Cooperating teachers are mentors that work within the context of their own classrooms and thus have a unique opportunity for learning. While research has shown that cooperating teachers are highly influential in determining the practices that preservice teachers will ultimately adopt, little attention has been paid to the impact of the mentoring process on these mentors. This case study investigates the ways that mentoring mediates the pedagogical reasoning of cooperating science teachers. The data collected for this study includes interviews, field observations, recorded lesson debriefs, and written feedback forms provided by the cooperating teachers. Findings demonstrate that 1) observations of preservice teachers is a vicarious experience for many cooperating teachers, 2) these experiences motivate cooperating teachers to evaluate and reflect on their own teaching, 3) this process leads to new comprehensions and the transformation of science teaching practices, and 4) observations of preservice teachers within the classroom context may be more powerful in stimulating pedagogical reasoning than the act of teaching alone. This study highlights a relatively untapped source of learning for cooperating science teachers.

Desegregating Evolution within the Curriculum: Exploring Changes in Students' Epistemology and Evolutionary Reasoning

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ABSTRACT: The purpose of this research is to investigate the epistemological and conceptual development of 10th-grade, high-school biology students when evolutionary concepts are explicitly embedded within topics outside formal evolution units. The embedding of evolutionary concepts and the addressing of alternative conceptions throughout the biology curriculum may help support student science learning by building conceptual and epistemic connections between what students may perceive as ostensibly, disparate, unrelated topics. The focus question for research is: How does explicit emphasis of evolution concepts within an ecology unit influence students' epistemic beliefs and evolutionary reasoning? This qualitative study will explore how explicit emphasis on selected evolutionary ideas concurrently within ecology influences students' learning. Student data will be gathered in two general biology classes in a small mid-western, public-high school receiving instruction in a traditional ecology unit where the teacher is the researcher. The ten-week ecology unit will be taught using reflective, student-centered pedagogy with guided inquiry. Student data will include pre and post-test open-response questions focusing on students' epistemologies in science and selected evolution ideas, semi-structured interviews and video-taped instruction, in addition to student artifacts.

Youth Participatory Action Research in Science through a Critical Race Theory Lens

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ABSTRACT: This study uses critical race theory as a lens to understand how two female participants in an informal science program speak back to White privilege and a system of marginalization of youth of color. The youth are participants in a program designed to explore green energy issues and places a heavy emphasis on digital technology. The youth have participated in the program for three years during their middle grade years and were transitioning into high school at the time of this study. They wanted to go beyond the regular program activities and take action on pressing green energy issues in their community creating an opportunity to engage them in youth participatory action research. Their participation and counterstories form a stark contrast to the discourse around the persistent achievement gap particularly in science between groups of students often reported as differences between racialized groups. The stories of both participants and their efforts to engage in science serve as an important reminder that policy by itself cannot overcome achievement gaps. These initiatives often fall short when they do not address the institutionalized racism that persists in both science learning spaces and in society.

Argumentation as Collaborative Discourse: Productive Argumentation Moves in Elementary Classrooms

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Wednesday, March 28, 2012

ABSTRACT: Though a critical component of authentic scientific inquiry, scientific argumentation is notably absent from many elementary school science classrooms. This is especially problematic in the early elementary grades, when it is often assumed that young children are incapable of this form of scientific reasoning. This study will address the following research questions: 1) What types and patterns of productive argumentation moves do early elementary students engage in during collaborative experimental design work, and 2) When given the opportunity to work collaboratively on experimental design, how do productive argumentation moves compare between early and upper elementary students? A total of four teachers, two in 2nd grade and two in 5th grade, and their students will participate in the study. The primary data source will be video recordings obtained during small group discussions. Findings are forthcoming.

Changes in Teachers' Culturally Congruent Instruction Over Three Years in a Professional Development Project

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 Joan Lafrance, Mekinak Consulting
 Rod Brod, University of Montana-Missoula

ABSTRACT: American Indian students as a group consistently underachieve compared to their White peers on standard measures of science achievement (e.g., Rampey, Dion & Donahue, 2009). One factor believed to hinder achievement is the cultural incongruity that commonly exists between American schools and ethnically diverse students' home cultures. A small body of research provides evidence of the efficacy of culturally congruent instruction in improving Indigenous students' achievement in science and math (e.g., Lipka & Adams, 2004; Gilbert, 2005). This poster displays three years of findings on changes in teachers' culturally congruent instruction (CCI) during their participation in a professional development project designed to improve culturally congruent practice in teaching American Indian students. In this study we assessed the impact of participation on teachers' CCI through multiple administrations of the Culturally Congruent Instruction Survey (CCIS) to treatment and matched comparison teachers. Data analyses indicate that treatment teachers made statistically significant larger gains in their culturally congruent practice versus the comparison teachers, providing evidence of the efficacy of the project's professional development model in improving teachers' cultural congruence. These results give the project's model currency as a model for others interested in developing and/or researching teachers' cultural competency.

Revealing Undergraduates Conceptions of the Nature of Science in Ill-Structured Media Domains

Michele Snyder, University at Albany, michele.snyder@clinton.edu

ABSTRACT: The proposed research study will explore college level students' understanding of nature of science (NOS) as it is revealed through the journaling process when attending to scientific information presented in the media. This research draws upon cognitive flexibility theory as a framework to support understanding of the NOS and the cognitive ways in which students negotiate scientific information as it is presented to them in the media. The proposed study of research uses a mixed methods approach in its study design. The research explores writing as a heuristic for conceptualization of the nature of science; writing as methodological research strategy to uncover students' understanding of the conceptual NOS and how students' conceptions of the nature of science are used to negotiate ill-structured scientific information; and the relationship between cognitive flexibility theory and use of media as a way to contextualize scientific learning. The study is therefore guided by the following research questions: 1) What influence, if any, does NOS prompted journal writing have on students' conceptualization of the nature of science? 2) How do students use their conceptualization of NOS to negotiate scientific information presented in the media?

It's (Not) Elementary: Experiences of Pre-Service Teachers in Science Classrooms

Jessica Stephenson, Virginia Tech, Jesteph3@vt.edu
 George Glasson, Virginia Tech

ABSTRACT: In this ethnographic study, pre-service teachers describe their experiences of learning and teaching in elementary classrooms. From self-described management concerns and operationalized definitions of "Science", to the dichotomy of novice and expert and the invisible "benign community of neglect" pervasive in schooling

Wednesday, March 28, 2012

culture, pre-service teachers give a voice to their experiences of indoctrination into the profession. As science teacher educators, we have a responsibility to address the concerns of pre-service teachers in their field placements, beyond rudimentary planning and instructional design questions. This study indicates that while the university and teaching schools offer increasing instructional support for pre-service teachers, our students do not take full advantage of our collective expertise. By focusing on the vocalized concerns of pre-service teachers, rather than their quantitative field observations or survey studies, we gain greater insight into the culture that transforms our students into professional members of this field.

Using Technology to Transform the Social Structure of the High School Physics Classroom

Ben Van Dusen, University of Colorado, Boulder, Benjamin.VanDusen@Colorado.EDU

ABSTRACT: Social networking services have permeated our social, political, and work lives, but in our schools it has largely been seen as an impediment to learning. Many school districts block these services from being provided in schools. These networking tools are designed to provide people additional avenues of communication and collaboration, the exact activities we need to learn. Rather than turn our backs on these resources; we must investigate how their inclusion in the schools and at home affects the social structures of the class. If these resources allow students to create more effective communities of learners and increase student empowerment as scientists then our current policies on and uses of social media will need to be reexamined.

Influence of PCK for Teaching Evolution on Student Outcomes In A Non-Majors' College Course

Emily Walter, University of Missouri, emw2n4@mail.missouri.edu

Patricia Friedrichsen, University of Missouri

ABSTRACT: This study investigates the influence of pedagogical content knowledge (PCK) for teaching evolution on knowledge of macroevolution and acceptance of evolution 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 will be described by pre-instruction and stimulated recall interview, a reflective lesson planning document (CoRe; Loughran, Berry, & Mulhall, 2006), and by classroom observation and then coded using the Magnusson et al. (1999) PCK model. Student learning will be examined through a constructivist lens, considering the experiences and previous knowledge of participants to understand their perspectives. Three data sources will 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 with students of interest (matrix of high-high to low-low on the MuM and MATE). Using the student outcome data, the relationship between knowledge of macroevolution and acceptance of evolution for non-science majors will also be explored.

Examining Student Collaboration when Using Web 2.0 Tools to Construct a Group Knowledge Artifact

Jennifer Weible, Pennsylvania State University, jweible@gmail.com

ABSTRACT: This study examines students' collaboration facilitated by the use of web 2.0 tools (social bookmarking and wiki) when constructing a knowledge artifact. The students in a high school science classroom used Web 2.0 tools to research alternative energy resources in small groups and then constructed a wiki page about the energy resources. Students were grouped both within the physical classroom and with students in another classroom. This arrangement facilitated examination of collaboration of students in close physical proximity to each other while working online on a group project, as well as how students collaborated asynchronously with others who had little to no physical contact. In my study, I propose a method of analysis of Web 2.0 artifacts (delicious.com links, tags, and networks and wiki) as well as video data (approximately 40 hours) from learners (N=36) to examine the student collaboration when creating a knowledge artifact when using Web 2.0 tools. The analysis is conducted on multiple levels in order to understand how students work together in class and online when constructing artifacts in a web 2.0 environment. The goal of this poster is to add to our understanding of how students make use of the affordances of the tools as they communicate and collaborate during knowledge construction.

Wednesday, March 28, 2012

How School Environments Impact Elementary Science Instruction

Julianne A. Wenner, University of Georgia, jakent@uga.edu

ABSTRACT: Elementary science is often characterized as falling by the wayside due to in-service teachers' lack of in-depth content knowledge. However, content knowledge is just one component of the larger construct widely known as pedagogical content knowledge (PCK). It seems to improve elementary science, one must first improve elementary teachers' science PCK. Mentoring preservice teachers has been shown to benefit mentor teachers in a variety of ways that could potentially improve science PCK. Research investigating the impact of mentorship on elementary mentor teachers' science PCK will be conducted using a multiple-case study design and studied through a symbolic interactionist lens. Data concerning the interactions within the mentorship relationships will be collected through a variety of interviews and observations. This data will then be analyzed using the constant comparative method. Preliminary findings from this study will be presented at the poster session. Findings from this study could impact how universities and schools view the internship phase of teacher education.

Supporting Secondary Biology Teachers in Their Use of Technology to Teach Genetics

Regina Wragg, University of South Carolina wragg@biol.sc.edu

ABSTRACT: This study seeks to identify what teachers believe to be enabling and inhibiting in using technology-rich curriculum to instruct their students. This study also explores how these teachers' beliefs change over time with support through a university partnership professional development program. Four veteran high school biology teachers completed a professional development workshop on the genetics curriculum. In the following two years, teachers implemented the curriculum with the aid of enactment modeling, equipment provision, and in-class instructional support from the university partnership. With a design grounded in the interpretivist paradigm, teachers' enactments of the curriculum were video-recorded and teachers' perceptions about the curriculum were measured through interviews, surveys, focus groups and reflections. Through case analysis, these four teachers will be compared to another teacher who has been supported through the university partnership for an additional year. Initial findings indicate how extended scaffolding experience in the form of support with the use of the technology in the classroom setting is influential in teachers enacting the curriculum on their own. This study informs professional development programs and curriculum developers who plan to identify teacher participants and support them with implementation of technology as a way to engage students in the Nature of Science.

Strand 1: Science Learning, Understanding and Conceptual Change

Conceptual Understanding and Conceptual Change

1:00pm – 2:30pm, Room 311

Presider: Shulamit Kapon, Tel Aviv University

The Impact of using a Scaffolded Written Framework on Students' Conceptual Understanding

Jeong-yoon Jang, University of Iowa, jeongyoon-jang@uiowa.edu

Brian M. Hand, University of Iowa

ABSTRACT: This study investigated the impact of the using a scaffolded written framework on students' conceptual understanding. A quasi-experimental design with 6th and 7th grade students taught by two teachers was used. A total of 170 students participated in the study, with 87 in the control group (four classes) and 83 in the treatment group (four classes). All students used the SWH templates to guide their written work and completed these templates during the SWH investigations of each unit. After completing the SWH investigations, both groups of students were asked to complete the summary writing task at the end of each unit. All student writing samples were scored using analytical frameworks developed for the study. Results indicated that the treatment group using the Structured Reading Framework performed significantly better on the Summary Writing task than the control group. The results suggest that the using of the Structured Reading Framework in prompting and guiding the reading activities within the SWH approach have an impact on the development of conceptual understanding. In addition, it appears that the Structured Reading Framework impacted the development of conceptual understanding in the Summary Writing task by providing a scaffold to assist students' knowledge construction.

Wednesday, March 28, 2012

Epistemic Network Analysis: An Alternative Analysis Technique for Complex STEM Thinking

Cynthia M. D'Angelo, University of Wisconsin – Madison, cmdangelo@wisc.edu

Douglas B. Clark, ASU / Vanderbilt

David Williamson Shaffer, University of Wisconsin – Madison

ABSTRACT: This paper re-examines a set of qualitatively coded data on students' ideas about force using a technique called epistemic network analysis (ENA). This technique allow us to look at patterns of student discourse about complex STEM thinking and make quantitative comparisons across students or between research groups, and see how patterns change over time. ENA focuses on looking at the linkages or connections between the different parts of complex STEM thinking (such as related concepts, elements of understanding, or relevant pieces of knowledge or skills). Using ENA over other previously used methods for this data set simplifies the discussion about the differences among age groups and reveals new information about student understanding of a complex idea like force. ENA allows us to look more closely at the data and use a larger amount of the available data about each student to visualize patterns and differences among groups.

The Role of Metacognition in Students' Development of Explanatory Ideas of Magnetism

Meng-Fei Cheng, University of Illinois at Urbana-Champaign, mcheng2@illinois.edu

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

ABSTRACT: We conducted a video-taped, multi-session teaching experiment with a small number of fifth grade students in order to study in detail the interactions between students' metacognition and their development of explanatory ideas to account for magnetic phenomena. Two small groups received full scaffolding, and two small groups received partial scaffolding. Students in both fully and partially scaffolded groups were asked to make their own predictions and explanations before observing the phenomena and to make individual explanations and modification after their observations. Then, they were asked to elaborate individual ideas and discuss with others in order to select or develop the best group consensus model. In later activities, they were required to compare their current group model with their previous group models. Only fully scaffolded groups were explicitly asked to consider the metaconceptual modeling criteria of visualization and explanatory power. Through reflection on their explanations using these metaconceptual modeling criteria, most students in the fully scaffolded groups gradually developed, evaluated, and revised their explanations to coherent and sophisticated explanations. By contrast, none of the students in the partially scaffolded groups, who relied only on self-generated model evaluation criteria, revised their original fragmented ideas toward more coherent and sophisticated explanations.

Strand 2: Science Learning: Contexts, Characteristics and Interactions

Strategies in Secondary Science

1:00pm – 2:30pm, Room 302

President: Phillip Herman, University of Pittsburgh

Supporting Reading in High School Science: Evidence that Explicit Strategy Instruction Increases Science Achievement

Phillip Herman, University of Pittsburgh, pherman@pitt.edu

Kristen Perkins, Northwestern University

Peter S. Wardrip, University of Pittsburgh

ABSTRACT: To be successful science learners and to eventually become scientifically literate citizens, high school students need to independently read, understand, and learn from a variety of science texts. Science teachers are challenged by the large number of students in their classrooms who have not acquired the essential reading-to-learn skills that allow students to integrate new learning from texts with prior knowledge of a domain. The adolescent literacy research community argues that only science teachers can model and explicitly support expert science reading. We report on the efforts of Biology and Chemistry teachers and students who worked to learn, practice, and apply strategic reading strategies that are intended to help students increase science achievement and reading-to-learn competencies. We administered an assessment that had students independently use the

Wednesday, March 28, 2012

strategies and then complete a science achievement measure. Proficiency with the strategies predicted science achievement, even controlling for on-entry reading proficiency. This study provides evidence that strategy instruction in high school science is feasible and can be effective in increasing science achievement and thus might reasonably be part of a teacher's instructional repertoire.

The Dissonance between Taiwanese High School Students' and Teachers' Conceptions of Learning Science and Conceptions of Science Assessment

Tzung-Jin Lin, National Taiwan University of Science and Technology, tzungjinlin@gmail.com

Min-Hsien Lee, National Central University

ABSTRACT: The harmony between students' and teachers' conceptions is essential in order to achieve a better quality of learning environments. However, when the dissonance occurred between students' and teachers' conceptions, it may cause problems in students' learning processes and their learning outcomes. The main purpose of the current study were to compare and discover the gap, if any, between Taiwanese high school students' and teachers' conceptions of learning science and those of science assessment. 1084 high school students and 59 teachers filled out two questionnaires assessing participants' conceptions of science assessment (COSA) and conceptions of learning science (COLS). The results showed that students' conceptions did not align with teachers' in certain aspects. Students regard science learning and assessment at a superficial level (COLS as "Memorizing," "Testing," and "Calculating and practicing" and COSA as "Reproducing knowledge"), while teachers view these conceptions at a more sophisticated level (COLS as "Application" and "Understanding and seeing in a new way" and COSA as "Improving learning"). It is evident that the dissonance exists between students' and teachers' COLS and COSA. It is encouraged that science educators should mitigate the gap between students' and teachers' conceptions based on the suggestions provided in this study.

Exploring the Link between the Framing of Activity and the Conceptual Trajectory of an Idea

Brett A. Criswell, Georgia State University, bcriswell@gsu.edu

ABSTRACT: In a high-school chemistry classroom, a group of students develops a proposal to a problem posed by the teacher. This study follows the conceptual trajectory of that proposal through five event clips which present the communicative acts involved in the development, presentation and evaluation of that proposal. The theoretical lens used in that process integrates Goffman's notion of framing and the roles / characters available within a frame / key, Goodwin's construct of the contextual configuration and the semiotic fields comprising it, and Givrey and Roth's unit of gesture-speech-situational structure. We were able to examine the interactions between these elements at different levels of analysis and to therefore understand the interplay between the cognitive and social factors that influenced the trajectory of the proposal. Through our analysis, we were able to show the different framing conventions employed by the teacher and their affordances and constraints relative to meaning-making actions. In particular, by foreshadowing participants' gestures as they were associated with other semiotic resources, we can account for conceptual advancement and stagnation. Additionally, we were able to show that the pragmatic information expressed in these gestures – largely overlooked in research in science education – contributed significantly to the thinking around this proposal.

Co-Teaching and Co-Generative for Transforming Teacher Interpersonal Behaviour and Teacher-Students Interactions in Secondary Schools

Yuli Rahmawati, yuli.chem@gmail.com

Rekha Koul

Darrell Fisher

ABSTRACT: The paper reports on part of a longitudinal study which aimed to investigate the effectiveness of co-teaching and co-generative dialogue in the science learning and teaching in lower secondary science classes. The idea of co-teaching and co-generative dialogue was first proposed by two leading educationists, Roth and Tobin in early 2000, making an international impact in educational research. In the context of the research, co-teaching and co-generative dialogue are applied for transforming teacher-students interactions. This multiple case studies research was conducted in three year-9 science classrooms from different secondary schools. Multiple research

Wednesday, March 28, 2012

methods (interview, students' reflective journals, and Questionnaire on Teacher Interaction (QTI) questionnaire) were used to develop in-depth understanding of the participants. The results show that co-teaching and co-generative dialogue helped in transforming teacher interpersonal behaviour and teacher-students interactions after co-teaching and co-generative dialogue is embedded in classroom practices. It also had implications on developing teachers' pedagogical praxis, transforming teaching behaviour, and improving students' engagement, achievement, and behaviour.

Strand 2: Science Learning: Contexts, Characteristics and Interactions

Symposium - Re-imagining Context: Student-Generated Representations as Tools for Reasoning in Science

1:00pm – 2:30pm, Grand Ballroom VI-A

Discussant: Megan Bang, University of Washington

Presenters:

Brian Gravel, Tufts University, brian.gravel@tufts.edu
 Kristen B. Wendell, University of Massachusetts Boston
 Christopher G. Wright, TERC
 Joshua A. Danish, Indiana University
 Asmalina Saleh, Indiana University

ABSTRACT: In this symposium, we offer four perspectives to examine the claim that external representations are central aspects of the contexts in which students engage in science, and have a profound impact upon reasoning and learning. In our first re-examination of the relationship between learning contexts and student-generated representations, we describe a study where first and second grade students were asked to work with reference materials to create drawings depicting their understanding of the life-cycle of the sea turtles. The findings highlight the relationship between students' representational practices and the features included in students' final products. In the second perspective, we examine middle-schoolers' spontaneous drawings of sound transmission and reflection. We highlight how students' conceptualizations of sound were impacted by the context in which they explored the phenomenon. In the third perspective, we consider a case study of two fifth graders' efforts to make sense of air through multiple representation systems. We describe the embodiment of students' resources in the multiple representations they produce, and we explain how these same representations amplify cognition. Finally, in the fourth perspective, we demonstrate how children's musical instrument engineering constructions can function as external representations of their ideas about sound.

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

Using Technology for Science Learning

1:00pm – 2:30pm, Room 303

President: Josephine Shireen Desouza, Ball State University

Edison Didn't Work Alone: A Case for Collaboration among Rural Middle School Science Students Using Digital Backpacks

Jennifer J. Mohler-Geary, University of Cincinnati, mogy2001@yahoo.com
 Maya Israel, University of Cincinnati

ABSTRACT: This qualitative research presents a case study of a rural 7th grade science teacher who, through initiative, resiliency, and collaboration overcame obstacles typically encountered in rural settings to provide a rich learning experience that met the needs of her diverse students. In this case, collaboration was integral. By collaborating with many stakeholders and applying STEM research to her classroom project, the teacher created an authentic, collaborative, problem-based project that gave ownership of learning to students. Digital backpacks house instructional technologies such as hardware, software and instructional support materials in a mobile technology unit and served as the main collaborative tool in this project. In sharing the research findings of the project, research with digital backpacks and collaboration in rural settings can be further advanced.

Wednesday, March 28, 2012

Inquiry-Based Science and Technology Program for Female Middle School Students

Hanna Kim, hkim13@depaul.edu

ABSTRACT: This study investigated the effects of an intensive, one-week Inquiry-Based Science and Technology Enrichment Program (InSTEP) designed for middle-school-age female students. The study was to test the effectiveness of InSTEP on students' attitudes toward science/science careers and content knowledge in terms of selected science concepts (e.g., DNA, Force & Motion, Latitude & Longitude, and Water Quality). We used pre- and post-attitudes surveys, drawings of a scientist/scientists, pre- and post-content knowledge tests, and selective interviews to collect data and measure change in 123 female students' attitudes and content knowledge in reference to science. A within-group, repeated-measure design was conducted, the results of which indicated that InSTEP, which used guided inquiry integrated with technology, affected participants' positive attitudes toward science, science-related careers, and content knowledge of selected science concepts.

What Makes for Effective Multimedia Simulations in Science Education? Outcomes from an Effectiveness Study

Catherine E. Milne, New York University, cem4@nyu.edu

Jan Plass, New York University

Bruce Homer, Graduate Center, City University of New York

Trace Jordan, New York University

Ruth Schwartz, New York University

Elizabeth Hayward, New York University

ABSTRACT: We report on a study investigating the effectiveness of a series of simulations for high school chemistry learning the design of which was based on a theoretical framework emphasizing active learning, contextualizing of the content, and the use of visualization in science education, as well as a cognitive approach to multimedia learning. A unique feature of the simulation design process was that high school science teachers and students were included as partners in the research, design, and evaluation of simulations. All four simulations were embedded in a two-week curriculum plan on Kinetic Molecular Theory and associated topics, and lesson plans for each simulation were developed. These simulations were first tested for usability, and their efficacy verified in experimental research that manipulated the level of guidance and the representation format of the information. An effectiveness study was then completed with a total of 718 high school students (357 rural and 361 urban students in a total of 25 classrooms). Results supported the effectiveness of this sequence as classroom teaching tools, and highlighted the importance of factors such as characteristics of the student population, school culture, and fidelity of implementation in determining the specific environments in which these materials were most effective.

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

Visual Representation and Science Learning

1:00pm – 2:30pm, Room 304

Presider: Allison Ritchie, University of Toronto

Subject Matter Content Knowledge and Representation Strategies of Physics Teachers: Biot-Savart Law and Ampère's Law

Sharareh Majidi, University of Helsinki, Sharareh.majidi@helsinki.fi

Terhi Mäntylä, University of Helsinki

ABSTRACT: The purposes of this study are to answer (a) what are the building blocks of teacher's subject matter content knowledge (SMK) concerning two specific topics of Biot-Savart law and Ampère's law and how teachers portray and organize their SMK regarding these topics; (b) what strategies teachers use in order to represent SMK. Therefore, four experienced university teachers are interviewed and interviews are analysed through qualitative categorization of certain elements. The results reveal (1) the types of concepts, entities, laws, theories, and principles teachers hold; (2) that teachers organize their knowledge slightly different. First, they start by describing Biot-Savart law and explaining the examples of this law. Second, they describe Ampère's law, and then they explain

Wednesday, March 28, 2012

the examples of this law. Finally, they express how these two laws are related to each other. However, teachers employ different concepts for describing the studied topics. (3) Teacher's representation strategies consist of eight categories: reasoning, interpretations, and explanations; statement of facts; analogies; mathematical models (descriptive and explanatory), experiments, visual models, didactical aspects, and level of description. This study identifies and describes experienced teachers' SMK and its representation strategies and thereby makes explicit the representational elements of experienced teachers' pedagogical content knowledge.

Comparing Physical and Virtual Manipulatives for Retention and Preparation for Future Learning of Science Concepts

Amy Rouinfar, Kansas State University, rouinfar@phys.ksu.edu
 Adrian C. Madsen, Kansas State University
 N. Sanjay Rebello, Kansas State University
 Sadhana Puntambekar, University of Wisconsin

ABSTRACT: Previous research on the effects of physical and virtual experimentation has focused on comparing the two manipulatives for learning. In this study we focus on which of the two manipulatives better support retention of knowledge learned and preparation for future learning. Our research is conducted in the context of a conceptual physics course for non-science majors at a large Midwestern university. Students completed activities in two two-hour laboratory sessions over two consecutive weeks. Some students completed the physical activity before the virtual activity, while others completed the virtual activity before the physical activity. The activities were spaced one week apart. We present the results of student performance on a conceptual test and implications for retention and preparation for future learning. Our results seem to indicate that physical manipulative better supports retention than the virtual manipulative. Further, learning with the physical manipulative better prepares students for future learning with the virtual manipulative.

Categorizing Students' Kinds of Mental Representations during Problem Solving of Different Representational Task Formats

Bashirah Ibrahim, Kansas State University, bibrahim@phys.ksu.edu
 N. Sanjay Rebello, Kansas State University

ABSTRACT: The study investigates the kinds of cognitive structures that engineering students, taking a calculus-based physics course, construct during problem solving. A cohort of 19 students completed five non-directed tasks, individually, in the context of work. The tasks were presented in symbolic, linguistic or graphical forms requesting either quantitative or qualitative solutions. Individual interviews were conducted immediately after completing the tasks. Johnson-Laird (1983) cognitive framework underpins this study. The framework highlights three types of mental representations namely propositional representations, mental model and mental image. Profiles were designed based on the students' problem solving strategies. They were then related to the cognitive framework to infer about the kinds of mental representation. Two main profiles emerged from the data. Only four students construct a mental model while 15 of the 19 students work with propositional representation. None of the students in the sample was found to generate a mental image.

Using Student Learning Preferences to Specifically Augment Student Performance in an Introductory Biology Laboratory Course

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ABSTRACT: The Index of Learning Styles (ILS) generates reliable data; its ability to evaluate learning preferences has been validated. In 2009, 67 students in an introductory biology laboratory completed the ILS. I found that overall academic performance was negatively associated with a student's learning preference in two ways, as student preference to: 1) perceive information intuitively increased, overall lab grades tended to decrease; and 2) to understand information globally increased, overall lab grades tended to decrease. Since student preference in processing information was positively related with the student preference in how that information is presented, I sought a way to promote greater academic performance in intuitive students by creating more opportunities to understand information globally. In Fall 2010, biology laboratory students completed two mini-journal lab

Wednesday, March 28, 2012

activities. The mini-journal approach to student laboratories models how scientists work: Students read a mini-journal article as the relevant literature, identified follow-up questions, designed a simple experiment to answer one question, collected and interpreted their data, and presented their work in the form of a scientific paper. Without any change in the average laboratory score, the negative association between student lab grades and student preferences to perceive information intuitively or to understand information globally was removed.

Strand 6: Science Learning in Informal Contexts

Community Involvement in Science: Youth and Adults Participating in Scientific Practices

1:00pm – 2:30pm, Room 305

Presider: Rita Hagevik, The University of North Carolina at Pembroke

Community Science Experts: Putting Place at the Center

Daniel Birmingham, Michigan State University, birming2@msu.edu

Angela Calabrese Barton, Michigan State University

ABSTRACT: Socioscientific issues in connection to energy use, production or influence on climate change continue to be at the forefront of local, national and global debates. These issues are complex, requiring individuals to engage with knowledge and experiences from multiple sources when making decisions or taking action. The role of place can be a powerful influence on the ways in which an individual engages with environmental issues (Umphrey, 2007, Gruenwald & Smith 2008, Noddings, 2005). A person's sense of place plays a vital role in determining what knowledge is considered and what expertise is leveraged when deciding on a course of action. This paper examines how place influences the actions taken by middle grades youths in an informal after school science program when investigating socioscientific issues. Our findings indicate youths' critical connection to place allows youth to position themselves as insiders and influences their motivation to both defend their place and take action to make a positive impact on their community. In addition, this critical connection to place serves as a lens for youth to leverage their expertise of place and science simultaneously to engage multiple audiences in a convincing way.

Getting Participants to Participate: Stimulating Interest and Involvement among Participants in a Citizen Science Initiative

Jennifer Borland, Rockman Et Al, jennifer@rockman.com

Aaron Price, AAVSO

ABSTRACT: There are ever-increasing numbers of community-based informal science education (ISE) initiatives, including citizen science projects and open-source initiatives. This paper presents findings from the evaluation the Citizen Sky project (<http://www.citizensky.org>), a citizen science initiative that invites professional and lay astronomers to collaboratively gather and analyze data and disseminate findings related to the eclipse of a variable star. Additionally, there is much known about successful strategies for promoting community-based informal science education initiatives, but somewhat less known about the strategies for successfully leading would-be participants to more fully engage themselves in the experience. This paper/presentation explores characteristics of more fully engaged participants and strategies for successfully promoting participation among diverse groups of would-be participants in a citizen science project. The authors discuss similarities between strategies for encouraging and supporting participation among a diverse group of citizen participants and diverse groups of students.

Community Youth as Socioscientific Activists: Visions for School Science Reform

John L. Bencze, OISE, University of Toronto, larry.bencze@utoronto.ca

G. Michael Bowen, Mount Saint Vincent University

Shaun Chen, University of Toronto

Allison Ritchie, University of Toronto

Erin R. Sperling, OISE, University of Toronto

Wednesday, March 28, 2012

ABSTRACT: Given the potential seriousness of socioscientific issues, such as debates about potential climate change, many jurisdictions have urged educators to engage students in decision making regarding such issues. Scholars and others argue, however, that students also need to take sociopolitical actions — such as lobbying of power-brokers — to address issues. Experience indicates, however, that such a tack in formal schooling often meets structural barriers. School science systems tend, for various and complex reasons, to orient instruction towards students’ passive acceptance of conclusions of fields of science and technology. Such an orientation appears not conducive to challenges to the authority of professional science and technology or their financiers. In the study reported here, we concluded — based on constant comparative analyses of qualitative data in light of actor network theory — that community youth were, after particular apprenticeship activities, able to enact complex and effective research-informed activism projects that, in effect, situated them as co-producers and users of knowledge in negotiation with powerful others. With such results, youth can serve as agents of change — providing science educators, and possibly power-brokers, with visions of the possible.

Scientific Competencies and Learning in Online Discourse of a Citizen Science Project

Aaron Price, AAVSO, aaronp@aavso.org
 Hee-Sun Lee, University of California, Berkeley
 Jennifer Borland, Rockman Et Al

ABSTRACT: Online forums have been a staple of science education for decades. Citizen science projects, research collaborations between scientists and volunteers (Cornell, 2009), often use such forums as a way to build a social aspect into their projects. Modern CMC frameworks for analyzing such forums are based on assumptions common to formal settings that do not exist in informal environments. This study made minor changes to a versatile CMC framework (Garrison, Anderson & Archer, 1999) and used it to analyze 185 messages in an online forum associated with an astronomical citizen science project in light of three scientific elements: cognitive, social and teaching presences. We found a higher cognitive presence in our technical forums than in our theoretical forums. However, the theoretical forums did have the highest teaching presence. We also found a surprisingly low amount of social presence across all forums - including the ones designed with social discussion as their goal. We found no differences according to gender, experience in the project or in the length of messages posted over time. Overall, we found the forums were largely used as a support mechanism for other activities in the project as opposed to a place where scientific knowledge is built on its own.

Strand 7: Pre-service Science Teacher Education

Secondary Science Teacher Preparation

1:00pm – 2:30pm, Room 306

Presider: Christiana Nkechi Omoifo, University of Benin

The Mechanisms of Secondary Science Teacher Candidates’ Learning to Teach

Hosun Kang, University of Washington, hosunk@uw.edu
 Charles W. Anderson, Michigan State University

ABSTRACT: This study investigates the mechanism of beginning teachers’ learning in the context of a university-based teacher preparation program. The purpose is to understand how and why secondary science teacher candidates from the same university-based teacher preparation program develop different kinds of science teaching practices through their responses to deliberately designed occasions for learning. This study focuses on two key science teaching practices—(a) planning and enacting classroom activities, and (b) assessing and responding to students. Fourteen teacher candidates, 14 mentor teachers, and two course instructors participated in this study. Data included written plans and reports of teaching, candidates’ teaching videos, interviews with candidates, mentor teachers, and course instructors, candidates’ vision statements, and other teaching artifacts. The findings show that the candidates’ ways of understanding science for teaching and their designated identities—the kind of teacher they want to be and the kind of practice they want to master—play critical roles in their learning from professional communities and from students by affecting their highlighting and interpretation

Wednesday, March 28, 2012

of practices, resources, and advice from the communities of practices. A mechanism of beginning teacher learning developed from the evidence are presented. The implications for practice and research on science teacher education are discussed.

Preservice Secondary Science Teachers' Approaches to Teaching Inquiry Skills

Byoung Sug Kim, Roosevelt University, bkim@roosevelt.edu

Yeon-A Son, Dankook University

Eun Kyung Ko, National-Louis University

Seok Jun Hong, Dankook University

ABSTRACT: There are two general approaches to teaching inquiry skills: implicit and explicit teaching approaches. The main difference between these two approaches is whether students are given opportunities for inquiry skill practice with or without explicit instructional support. When the effects of different kinds of instruction are compared, it is evident that the effect of explicit instruction is prevailing compared to implicit instruction. To the best of our knowledge, however, few research studies have been done with preservice teachers. The purpose of the present study was to explore 11 preservice secondary biology teachers' approaches to teaching inquiry skills while observing their peer teaching practice during a biology teaching methods course. The analysis of preservice biology teachers' lesson plans, reflective journals and peer teaching lessons revealed that preservice biology teachers' initial attempt to teach inquiry skills was restricted to implicit teaching. After a two-week intervention for explicit teaching of inquiry skills, their teaching approaches improved, but still limited. Preservice biology teachers' teaching mainly focused what a particular inquiry skill means and ignored how, when, and why aspects of inquiry skills. More results and implications will be discussed.

Preservice Secondary Science Teachers' Views on the Value and Role of Student Ideas

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

ABSTRACT: Over the past few decades, an emphasis on the importance of eliciting student ideas regarding scientific phenomena has become a cornerstone feature of science teacher education programs. Though many science teachers recognize the importance of eliciting student ideas, there is less consensus concerning the role that these ideas ought to play in the classroom and in planning instruction. This empirical study examines how fourteen preservice secondary science teachers in four different science teacher preparation programs interpreted messages about working with student ideas over the duration of their programs. The findings indicate that preservice teachers in this study showed evidence of gaining a deeper understanding of what difficulties students might encounter in science learning, yet not all took the same view of student ideas. Conceptions about the role of student ideas in learning appeared to be closely connected to beliefs about how learning takes place, and the findings categorize these as five different orientations to student ideas. Some participants demonstrated a remarkable degree of change in thinking about student ideas and "misconceptions" over the course of their teacher education programs, while others saw a pedagogical role for their students' ideas only for the duration of their science methods courses.

An Investigation of Secondary Science Teacher Candidates Discourse in the Context of Inquiry Investigations

Danielle E. Dani, Ohio University, dani@ohio.edu

Helen M. Meyer, University of Cincinnati

ABSTRACT: Science education reform documents advocate the preparation of teachers who are able to facilitate student learning through authentic inquiry investigations. Such facilitation is predicated on a teachers' ability to facilitate open-ended discourse. However, current research on teacher candidates' understanding and practice of inquiry has identified significant problems with their knowledge of, and ability to implement authentic inquiry. Furthermore, the teacher-dominated nature of classroom discourse has been a persistent theme in the research literature, illustrated by a dependence on the Inquiry-Response-Evaluation triad. The purpose of this study was to investigate secondary science teacher candidates' discourse around authentic inquiry as well as their understanding of inquiry in the context of participation in an open-ended inquiry investigation with asynchronous online support from peers. Teacher candidates exhibited difficulty with engaging in inquiry investigations

Wednesday, March 28, 2012

themselves, and they were more likely to engage in superficial discourse around the conduct and outcomes of their peers' inquiry investigations. The superficial nature of teacher candidates' discourse is reflected in their emphasis on mostly diffuse questions and procedures, as well as the absence of rejections, elaborations, and cues. Findings have implications for teacher education programs seeking to more systematically prepare candidates to facilitate student discussions in the context of inquiry.

Strand 7: Pre-service Science Teacher Education

Topics in Environmental Education

1:00pm – 2:30pm, Room 312

Presenter: Julie Thomas, Oklahoma State University

Cosmologies of Preservice Teachers: A Six-Year Study, With Comparisons to Cosmologies of Children

Alice (Jill) A. Black, Missouri State University, ablack@missouristate.edu

ABSTRACT: This six-year, two part empirical research study investigated 405 preservice elementary/middle teachers' ideas of Earth shape and gravity. It also compared their thinking to that of children. The What Are Your Ideas About the Earth? (WIE) test was lengthened (AWIE) to include questions about Earth shape, far-scale gravity, and near-scale gravity. No previous testing of adult views on these topics was found. AWIE individual item responses were analyzed. Adult responses on the WIE were categorized into Earth shape and gravity levels and their levels were compared to those of children, grades 4–8, tested by previous researchers. Results showed many subjects lacked scientific thinking about Earth shape and gravity, and held views of an absolute down rather than down related to Earth's center of gravity. Many appeared unable to integrate near-scale and far-scale drawings and/or visualizations of Earth, and had particular problems with mixed-scale drawings. Some were distracted by other ideas, such as Earth's rotation, axis, and orbit. Adults were classified slightly higher than children on Earth shape, but were very similar to 7th-8th graders on gravity. Mixed scale drawings, common in textbooks, should be avoided or carefully explained. Addressing scale, beginning in early grades, is recommended

The Western Worldview vs. Environmental Education: Pre-service Teachers' Beliefs

Darren D. Hoeg, University of Toronto, hoeg_darren@hotmail.com

Sarah Barrett, York University

ABSTRACT: This study investigated pre-service teachers enrolled in a teacher education program, to gain some insight into their beliefs about environmental education. We were particularly interested in how dominant cultural assumptions connected to Western worldviews and science might influence their beliefs. The participants demonstrated complex and often conflicting environmental worldviews and beliefs about environmental education. Orientations beneficial to environmental education, such as enthusiasm, intention to teach environmental education, and relatively well-defined approaches were expressed during interviews. However, underlying cultural assumptions, such as an orientation to anthropocentrism, individualism, consumerism, and the exclusive value placed on scientific knowledge were also present, indicating a relatively limited perspective which may be detrimental to teaching in environmental education.

Strand 9: Reflective Practice

Enhancing Students' Understanding and Empowerment

1:00pm – 2:30pm, Room 301

Presenter: Kim Charnatz, Daemen College

Using an Understanding of Children for Science Lesson Design

Jenny D. Ingber, Bank Street College of Education, jingber@bankstreet.edu

Margaret A. McNamara, Bank Street College of Education

Wednesday, March 28, 2012

ABSTRACT: Recently there has been a growing body of literature on the topic of Learning Progressions in Science (Corcoran, Mosher, & Rogat, 2009; National Research Council [NRC], 2011). In these reports and articles researchers are seeking to understand what science content and which science practices are appropriate to introduce to students in order to build their understanding over the course of their science education. Understanding children’s conceptions, experience, and development are critical in order for elementary teachers to understand the importance of Learning Progressions. Reflective practice (Loughran, 2002) was used to examine my students’ understanding and application of child development within the context of my course to determine how I could support them in making this connection. Three claims could be made based on this research: 1) Some students discussed child development in robust ways; however, they did not always reconcile their understanding with their science pedagogy; 2) Some students grounded their rationale for why they were teaching specific science content using certain methods in their practical experience rather than on theories of child development; 3) Some of the students appropriately drew from the child development and/or science education literature, though they employed it using different lenses.

A Self-Study on Reframing Non-Science Majors' Fundamental Understandings about Scientific Inquiry and Scientists

Gayle A. Buck, Indiana University Bloomington, gabuck@indiana.edu

Xinying Yin, Indiana University Bloomington

Pazit Koren, Hebrew University

Varda Bar, Hebrew University

ABSTRACT: Over the past several decades, our understandings of people's beliefs about the nature of scientific inquiry has grown and a greater attention to scientists and the work that they do has been achieved. However, despite a more diverse (and often glamorized) image of scientific inquiry and scientists in venues such as television and video games, research continues to document naive understandings. The non-science majors entering our undergraduate science course were no exception. Although they initially responded that anyone can be a scientist, when their beliefs in this regard were explored, real scientists were limited to Newton and Einstein and real scientific work was a narrowly defined method. Thus, we sought to reframe our practice in regards to fostering our students' understandings about scientists and scientific inquiry. The research questions guiding our inquiry were: To what extent did course re-conceptualization efforts lead to a broader and more specific understanding of scientific inquiry and scientists? and In what ways did the strategies enacted in the re-conceptualized course foster or hinder students' understandings of scientific inquiry and scientists? In this paper, we provide a complete description of our course activities, the findings associated with implementing these activities, and subsequent revisions.

Building Bridges across the Borders: Elementary Student Conceptions of Science

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

ABSTRACT: There is widespread interest in increasing the number of people of color and women in pursuing science careers. Some have begun to look at the issue of underrepresentation through a sociocultural lens. This teacher research study looked at how an elementary science teacher, working in an urban context with predominantly students of color, sought to create bridges across cultural and physical boundaries of the science classroom. The teacher expanded the curriculum to be inclusive of students’ lives and experiences outside of the classroom walls through designating a physical “My Science” space in the classroom exclusively for students to share their own experiences with science outside of class. An interpretive qualitative analysis of what students brought in and wrote about showed that when students build their own conceptions of science, it allows them to see it broadly and inclusive of themselves. The students were able to blur the cultural borders between home, school, and science. When the teacher is able to let go of the power in holding the cultural definition of science, then students’ own ways of understanding and engaging with science could emerge within their own lived experiences.

Environmental Action Projects: Exploring Community Partnerships and College Student Empowerment through Participatory Action Research

Wednesday, March 28, 2012

Kim Charmsat, Daemen College, kcharmsat@daemen.edu

ABSTRACT: The purpose of this study is to understand student empowerment and community connections through a socially critical environmental education perspective. The main research question is: How do participants make sense of their experience developing local environmental action projects in the context of a community partnership between an urban middle school and a college service learning course? The research objectives were to: 1) explore participants' experience developing environmental action projects in their community, 2) examine connections and development of community between intergenerational community partners, including aspects of social change, power, and relationships, 3) explore nature of projects related to college and middle school student interest, and 4) examine individual and group empowerment (locus of control). The research used qualitative methodology from a participatory action research and critical theory perspective as it seeks to examine social change, empowerment, and the nature of relationships. Discussion generally showed: 1) Students demonstrated ownership of service and action in the community. 2) Working with new partners is rewarding and challenging because many people are involved and many logistical details need to be worked out. 3) Much of the first semester has been about planning and learning my role in the process and content of the course.

Strand 10: Curriculum, Evaluation, and Assessment

Inquiry Instruction and Curriculum

1:00pm – 2:30pm, Room 308

Presenter: Mehmet Aydeniz, The University of Tennessee

A Comparative Analysis of K-12 Assessment Instruments of Students' Understandings about Scientific Inquiry

Darin S. Munsell, Illinois Institute of Technology, munsdar@hawk.iit.edu

Norman G. Lederman, Illinois Institute of Technology

ABSTRACT: The focus of this study is to provide a comprehensive review of past and present assessment instruments that address students' understandings about scientific inquiry. This review process provides a comparative analysis of the reliability and validity of these instruments as well as a review of grade level appropriateness. The results of this review highlight a general lack of reliability and validity across the existing instruments in addition to a gap in instruments for the K-8 student population. This study also attempts to draw attention to the existing disconnect between the national standards and benchmarks and existing assessment tools for teachers and researchers alike, and lay a road map for future work in this area.

Comparative Interactions of High School Biology Students Engaging Textbook Accounts and Narratives of Historical Experiments

Matthew Kloser, Stanford University, mkloser@stanford.edu

ABSTRACT: Textbooks play a critical role in high school biology classrooms, but have received heavy criticism for their extensive vocabulary, difficult lexico-grammatical structure, and often incorrect representations of the nature of the discipline. Although an increasing number of studies focus on alternative text types and their effect on student learning and attitudes toward science, more studies in this area are needed. This study uses think aloud protocols and post-hoc interviews to compare how 24 high school biology students engaged traditional textbook accounts and texts containing narratives of historical experiments on the same topics. Results indicated that the constructed texts generated higher students interest and trustworthiness in the claims of the text when compared to the traditional textbook account. Students struggled more often in understanding the historical experiments, but found them to be easier to comprehend because the experiment provided support for the text's claims and the graphical representations of the experiment's results provided an alternative resource for constructing meaning. This study can be used as the basis for larger randomized trials in which measures of student comprehension and learning are employed.

The Inclusion of the Main Features of Inquiry in Saudi 10th Grade Physics Textbooks

Abdulaziz H. Alolah, King Saud University, Saudi Arabia, aalolah2@yahoo.com

Wednesday, March 28, 2012

Fahad S. Alshaya, King Saud University, Saudi Arabia
 Saeed M. Alshamrani, King Saud University, Saudi Arabia

ABSTRACT: The purpose of the study is to investigate the inclusion of inquiry in Saudi tenth grade physics textbooks. To achieve this purpose, the study examine the included features of inquiry, their levels of inclusion, and the types of contexts exists for their inclusion. The sample of the study was four chapters from the two textbooks. The content analysis was used through utilizing an adopted data collection protocol from a previous study. the protocol utilizes the rubric describing the main features of inquiry by National Research Council (2000). six experts reviewed the appropriateness of the instrument and the translation of the rubric to be used for Arabic science textbooks. The reliability was assured through identifying the inter-rater reliability (83.3%) and rate-rerate reliability (72%). The results of the study revealed that most included features are "giving priority for evidence in responding to questions" and "engaging in scientifically oriented questions". Also most of the included features appear in their lower levels which means that most of inquiry is more directed by the textbooks. Moreover, the textbooks seem to utilize some types of contexts such as "a question" and "a question or a step in a laboratory activity".

How do we do Inquiry? Let us Count the Ways

Daniel Z. Meyer, Illinois Institute of Technology, meyerd@iit.edu
 Joy Kubarek-Sandor, Illinois Institute of Technology
 James Kedvesh, Illinois Institute of Technology
 Cheryl Heitzman, Illinois Institute of Technology
 Yaozhen Pan, Illinois Institute of Technology
 Sima Faik, Illinois Institute of Technology

ABSTRACT: Scientific inquiry has become a central focus of science education. Much of the work looking at the specific structure of inquiry activities has consisted of either intended goals or rubrics for assessing the degree of inquiry learning. This paper is intended to illuminate the means for achieving those goals and levels by generating a taxonomy of different pedagogical structures used for inquiry activities. We aim to articulate structures that are more general than individual lessons but more specific than broad goals. By systematically reviewing over 600 activities across a variety of curriculum sources, content areas and grade bands, we have validated a set of inquiry activity structures: protocols, design challenges, product testing, black boxes, discrepant events, intrinsic data spaces, taxonomies, and modeling. We further explore the details of each structure, to guide curriculum developers and science teachers as to the nuances that make each structure type successful.

Strand 10: Curriculum, Evaluation, and Assessment
Teachers' Knowledge and Practices

1:00pm – 2:30pm, Room 314

Presider: Colette Murphy, Queens University Belfast

Escalating the Validity of the Survey-Type Measure of Teachers' Pedagogical Content Knowledge using Think-Aloud Interviews

Soonhye Park, University of Iowa, soonhye-park@uiowa.edu
 Sae Yeol Yoon, Unviersity of Iowa
 Jee Kyung Suh, Unviersity of Iowa

ABSTRACT: This research is an extension of the previous research that aimed to develop a survey-type measure to determine the degree of Pedagogical Content Knowledge (PCK) a teacher possesses for teaching photosynthesis at grades 9 to 10 (Author, 2009). The survey measure constructed from the previous study was a paper-pencil test consisting of 11 multiple choice items. While the previous survey established acceptable content validity, the reliability of the survey estimated by internal consistency calculated by Cronbach's α was not acceptable. Given that, this present study aimed to develop a survey with stronger validity and reliability by modifying previously developed items and adding new items. This paper discusses the procedure through which the second round

Wednesday, March 28, 2012

survey was developed and strategies to enhance its validity and reliability. In particular, it described how the think-aloud interview was used to improve the validity of each item. Several issues and dilemmas that the research team has encountered in developing the measure will be also discussed.

Examining Secondary Science Teachers' Formative Assessment Practices Based on Video Analysis

Min Li, University of Washington, Seattle, minli@uw.edu

Jim Minstrell, Facet Innovations Inc

Ruth A. Anderson, Facet Innovations Inc

Ting Wang, University of Washington, Seattle

Jennifer Quynn, University of Washington, Seattle

ABSTRACT: Recent research has confirmed the positive impacts of formative assessment on promoting student learning and informing the design of instruction (e.g., Black & Wiliam, 1998; Crooks, 1988; Kanjee, 2003; Shepard, 2000; Shepard et al., 2005; Torrance & Pryor, 1998, 2001). In this paper, we analyzed video-taped lessons of ten secondary science teachers to identify and characterize the patterns of their formative assessment practices. The research question is: What are the measureable indicators that can adequately differentiate teachers with high formative assessment skills from the less skillful in their science instruction? With systematic coding of the videotaped lessons for each participating teachers, we found that, compared to the less skillful, teachers with high FA skills: (1) assess more often and focus more on learning objectives than on mechanics; (2) ask more questions related to schematic and strategic knowledge, engaging students in more cognitively demanding assessment activities; (3) share and revisit learning objectives with students; (4) carry out significantly more elaborated conversations with students, tapping into a variety of types of knowledge; (5) are more explicit, responsive and nuanced in their interpretation of student responses and feedback to students; and (6) actively build learner agency and promote metacognition skills.

Translation and Validation of the Epistemological Beliefs Scale with Preservice Teachers

Yusuf Sulun, Mugla University, syusuf@mu.edu.tr

Aylin Cam, Mugla University

Mustafa S. Topcu, Mugla University

Gokhan Guven, Mugla University

Sertac Arabacioglu, Mugla University

ABSTRACT: The purposes of this study were to validate and translate the original version of the Epistemological Beliefs Inventory developed by Schraw, Bendixen ve Dunkle (2002) and to investigate preservice teachers' epistemological beliefs in a different country context. First, the original questionnaire translated from English to other language and then original and translated questionnaires are criticized by language, content, measurement and evaluation experts. The revised questionnaire is administered to 166 preservice teachers. Schraw et. al extracted five factors (Certain Knowledge, Simple Knowledge, Innate Ability, Quick Learning and Omniscient Authority); however, in this study three factors were extracted (Quick Learning, Innate Ability and Certain Knowledge). The reason of these differences could be concerned with the educational system and family structure of the country.

Factors Affecting Primary Science Teachers' Enactment of Formative Assessment: Reality and Professional Decision Making

Poh Hiang Tan, National Institute of Education, pohhiang.tan@nie.edu.sg

ABSTRACT: This study focuses on professional decision making pertaining to formative assessment among 39 elementary school teachers in Singapore. Using three tasks of different natures, these teachers commented upon the tasks that they will select for their classes and explained the reasons for their selection. Thematic coding was carried out on the responses by the teachers using NVivo 9. The four themes that emerge from the coding are (1) nature of task, (2) students' profile, (3) learning outcomes, and (4) implementability of the task. Teachers' relate the nature of task to the students' profile when they decide which task is more suited for formative assessment in elementary science classroom. Teachers also privilege science content as indicated by the curriculum

Wednesday, March 28, 2012

documents when considering the task to be selected. The teachers also dichotomize the act of teaching and learning and assessment. Implications of this study is also discussed.

Strand 11: Cultural, Social, and Gender Issues

Symposium - Science Education for Diversity: An International Perspective

1:00pm – 2:30pm, Grand Ballroom V-B

Discussant: Sibel Erduran, University of Bristol

Presenters:

Saouma B. Boujaoude, American University of Beirut, Lebanon, boujaoud@aub.edu.lb

Rola Khishfe, American University of Beirut, Lebanon

Sugra Chunawala, Homi Bhabha Centre for Science Education, India

SweeChin Ng, Tunku Abdul Rahman College, Malaysia

Ralf van Griethuijsen, Eindhoven University of Technology, The Netherlands

Perry den Brok, Eindhoven University of Technology, The Netherlands

Ayse Savran Gencer, Pamukkale University

Huseyin Bag, Pamukkale University

Alun Morgan, Exeter University, UK

Nasser Mansour, Exeter University, UK

Sahar Alameh, American University of Beirut

Michiel van Eijck, Eindhoven University of Technology, The Netherlands

SiewChee Choy, Tunku Abdul Rahman College, Malaysia

ABSTRACT: The relationship between science education and cultural factors has been proposed as a lens to understand student attitudes toward and interest in science, which have been declining in Europe with possible effects on scientific literacy and students' selection of science-related careers. This symposium aims to elucidate the above issues through familiarizing and engaging the audience with the research project entitled Science Education for Diversity which is a collaborative project between the UK, the Netherlands, Turkey, Lebanon, India and Malaysia. The non-Western countries were selected because science remains a popular career choice in all of them. Through this collaboration, the intention is to (i) understand how the partner countries address the issue of diversity and (ii) use the results to improve science education in terms of responding more effectively to the new cultural diversity of students and benefit students in Western and non-Western countries involved in the Project. The symposium presenters will engage the audience with thought provoking discussions on all these issues by (a) explicating the plan for the research project, and (b) describing the theoretical framework of the Project, and c) presenting the results of two research components of the project.

Strand 14: Environmental Education

Poster Symposium - Climate Change Education for the Twenty-First Century

1:00pm – 2:30pm, Grand Ballroom VI-B

President: Devarati Bhattacharya, University of Minnesota

ABSTRACT: The last decade has seen a growing consensus among scientists, all over the world, about the occurrence and impact of climate change. However, most citizens do not understand and are confused by the great deal of media and (mis)information about climate change being presented today. NASA's Global Climate Change Education (GCCE) program is designed to enhance students' and teachers' literacy about global climate and Earth system change, and to improve the quality of the nation's STEM education. In this poster symposium presentation, eleven GCCE-funded projects will give short presentations detailing how their project aims to increase students' and teachers' climate literacy and provide findings from the research on these projects.

Wednesday, March 28, 2012

Collaborative Development of a climate change curriculum for classrooms in the Intermountain west-The ICE-Net Project

Anne Kern, University of Idaho, akern@uidaho.edu

Global Climate Change Education: Advancing Student Knowledge through Teacher Education-The ASK Florida Project

Anna Lewis, University of South Florida, arlewis@csl.usf.edu

CYCLES: Teachers Discovering Climate Change from a Native Perspective

Gillian Roehrig, University of Minnesota, roehr013@umn.edu

Global Climate Change for Teachers: An Online Professional Development Leading to Civic Engagement

Mary Margaret Small, Clarkson University, mmsmall@clarkson.edu

Date Enhanced Investigations for Climate Change Education-The DICCE Project

Daniel Zalles, SRI International, daniel.zalles@sri.com

NCAR Research Experience for Teachers (RETI)

Lori Reinsvold, University of Northern Colorado, lori.reinsvold@unco.edu

2010-2012 NASA Challenger Center Global Climate Change Award

Annette Brickley, Challenger Center for Space Science Education, abrickley@clcofme.org

Global Climate Change Education: Research Experiences, Teaching and Learning

Mary Margaret Small, Clarkson University, mmsmall@clarkson.edu

Improvements to AMS Pre-college Programs: Results of a Self-study on Datastreme Earth's Climate System

James Brey, American Meteorological Society, brey@ametsoc.org

An Experimental Approach to Climate Change Professional Development

Patricia D. Morrell, University of Portland, morel@up.edu

Kari O'Connell, Oregon State University

Bringing Global Climate Change Education to Alabama Classrooms: The Auburn University GCCE Project

Marllin Simon, Auburn University, msimon@physics.auburn.edu

Climate Change Literacy: Analysis of Learning Gains in Formal Education Setting Using a Normed Evaluation Instrument

Carol Mandryk, George Mason University, cmandry2@gmu.edu

Wednesday, March 28, 2012

Research Committee Sponsored Session

Symposium - Framing Standards: Researching the Development & Implementation of the Next Generation Science Standards

2:45pm – 4:15pm, Grand Ballroom V-A

President: Richard Duschl, Penn State University

Discussants:

Kathryn Scantlebury, University of Delaware

Janice Earle, National Science Foundation

Presenters:

Stephen Pruitt, Achieve, Inc.

Brett Moulding, Utah State, Tidemark Inst.

James Pellegrino, University of Illinois - Chicago

ABSTRACT: The National Research Council July 2011 release of A Framework for K-12 Science Education: Core Ideas, Crosscutting Concepts and Practices provided a conceptual framework to guide the reform of US science education. The next step is the development and implementation of the 'Next Generation Science Standards' (NGSS); an effort being coordinated by Achieve, Inc. The NGSS process is guided by three NRC reports, one on assessment, one on science learning, and the other on the assessment of science learning. The NGSS agenda is to produce learning performance based standards that embrace learning progressions coordinated around core ideas, crosscutting concepts and science/engineering practices. This shift in K-12 science standards design is a radical departure from extant curriculum, instruction, and assessment models. Numerous research and policy challenges abound. The panel symposium participants shall 1) examine the NGSS research and policy challenges and 2) make recommendations for research and development priorities surrounding the development, adoption, and implementation of the NGSS. Three targeted domains will be addressed: R&D around assessment designs for the alignment of curriculum-instruction-assessment; R&D around professional development for implementation of the integrated instructional model; and R&D around assessment and policy practices among adopting States/Districts and partner/test States.

Strand 1: Science Learning, Understanding and Conceptual Change

Symposium - Towards a Learning Progression of Energy Procedures, and Pedagogical Issues to Reposition Literacy in Scientific Literacy

2:45pm – 4:15pm, Room 311

President: Reinders H. Duit, Leibniz Institute for Science Education (IPN) Kiel

Discussant:

Charles W. Anderson, Michigan State University, andya@msu.edu

Presenters:

David L. Fortus, Weizmann Institute of Science

Joseph S. Krajcik, University of Michigan

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

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

ABSTRACT: Energy is a fundamental concept in science. It is hardly possible to overestimate the key significance of this concept in science and in teaching and learning science. It provides the most powerful frame, for instance, for integrating the single sciences as it plays key roles in biology, chemistry, physics, and in earth sciences. Accordingly, the energy concept is among the "big ideas" forming general frameworks in international monitoring studies like TIMSS and PISA as well as in Science Standards around the world. In fact, energy provides a most powerful way of thinking to understand and model processes in nature and technology. In addition, understanding problems of energy supply in modern societies is only possible on a sound understanding of key features of the science energy concept. Research results however reveal that students' understanding of the key basic ideas of energy is rather limited. It seems that a major reason is how energy is taught so far. The contributions of the symposium provide an

Wednesday, March 28, 2012

overview of research that may lead to the de-sign of learning progressions that result in more advanced understanding of energy and its role in science, technology, and society.

Strand 2: Science Learning: Contexts, Characteristics and Interactions

Diverse Learners

2:45pm – 4:15pm, Room 302

Presider: Janell Nicole Catlin, Teachers College, Columbia University

The Construction of Inquiry Questions in Project-based Small-group Scientific Inquiry

Jane J. Lee, Seoul National University, jane8207@gmail.com

Heui-Baik Kim, Seoul National University

ABSTRACT: This research explored how middle school students construct inquiry questions in a project-based small group scientific inquiry. We also analyzed factors influencing the constructing process, as well as the relationship among them. Twelve eighth grade students in a local district science education center for gifted students participated in this research. Multiple data such as videotape and audiotape of classroom and interview data were used. The results indicated students' process of inquiry question construction consisted of three stages: suggestion, selection, and elaboration. In the suggestion stage, students proposed inquiry questions based on their everyday experience and personal interests. The interactions with peers were short and simple. In the selection stage, the students began to gather and judge their suggested inquiry questions within the group. As a result, the 'originality' and 'prosperity' of inquiry question grew. In the elaboration stage, students proposed various solutions and specific ideas for experiments. The inquiry question involved the property of 'variable connection' and 'feasibility' throughout the interaction. The reflective feedback, social mediation, and cognitive support of the small group interaction played an important role in inquiry question development. The small group interaction was closely related to metacognition. This development of metacognition required the teacher's scaffolding.

Factors Affecting whether Students in England Choose to Study Physics once the Subject is Optional

Tamjid Mujtaba, Institute of Education, University of London, t.mujtaba@ioe.ac.uk

Michael J. Reiss, Institute of Education, University of London

ABSTRACT: There is still a shortage of studies in mathematics and science education that examine student engagement over time. We report on a project that aims to identify through research the range of factors (individual, school and out-of-school, including home) and their interactions that influence post-16 (i.e. post-compulsory) participation in mathematics and physics in England and to assess their relative importance among different student populations. In this proposal we concentrate on post-16 participation in physics and draw on surveys undertaken by 1749 students at age 14-15 and then two years later at age 16-17. Our findings indicate the importance of how students see themselves in relation to physics as a key factor in correlating with whether or not students study physics post-16. Physics self-concept, i.e. the psychological construct that indicates how a student sees themselves in relation to the subject physics, had a significant independent relationship with whether or not a student was studying physics post-16. Other factors that were important in correlating with post-16 participation include participation in mathematics, how students see their mathematics and their physics teachers and home support for achievement in physics and advice / pressure to study physics.

Science in the Inclusive Classroom: Addressing Students' Needs through a Multi-Dimensional Instructional Environment

Ornit Spektor-Levy, ornitsl@gmail.com

Yafa Gonda-Keren

Merav Yifrach

ABSTRACT: This study addressed the inclusion of students with Learning Disabilities (LD) in science lessons. A unique science learning program: WOST – The World of Science and Technology was designed as a didactic multi-dimensional teaching and learning environment aimed at providing science teachers with all the materials needed

Wednesday, March 28, 2012

to deal with the diversity of students in their inclusive classrooms and to answer the needs of students with LD. The study aimed to find out whether students consider the WOST program and its unique elements as supportive and useful. Our findings show that the main objectives were realized: Most students in the classes that experienced and learned science in accordance with the WOST program, developed positive attitudes regarding the program, the methods of teaching and the support they received. They also achieved significantly higher scores in comparison with students who did not learn with WOST. Students with LD also improved their grades to a degree similar to non-LD students in the WOST group. Thus, the multifaceted teaching model and the WOST program that was developed according the model show great potential in improving the sense of self efficacy, motivation for learning science, and achievements of students in middle school, in science inclusive classes.

Promoting a Culture of Learning based on Internal Values in an Introductory Undergraduate Biology Course

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Tali Tal, Technion-Israel Institute of Technology

Dan Zilberstein, Technion-Israel Institute of Technology

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ABSTRACT: In recent years there is a growing concern regarding the quality of learning in undergraduate level science education. We developed a framework which describes learning culture as a continuum ranging from learning driven by external values (passing a test) to internal values (the urge to learn). Teaching culture is described as encouraging learning with a similar range of values. We use this framework to explore the effect of an intervention in three levels, which was designed to gradually employ higher levels of internal values of teaching in a large-scale undergraduate Biology course. The study explores how the teaching culture affected the learning culture. We interviewed 30 students and analyzed interviews phenomenographically. Our findings show that students' learning culture represented higher levels of internal values in the interventions that were designed with higher levels of internal values of teaching, indicating a positive effect of teaching culture on learning culture. Moreover, the common assumption that undergraduate students typically hold external values of learning was refuted in this study. These findings have important implications regarding the design of large-scale undergraduate science courses that encourage students to develop "deep" conceptions of learning, intrinsic motivation, and learning-related (rather than performance-related) goals.

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

Measuring and Exploring Teachers' PCK

2:45pm – 4:15pm, Room 303

Presenter: Isha DeCoito, York University

Teacher Knowledge versus Teacher Practice: Reflecting on Classroom Instruction and Interaction through PCK-directed Observation

Erik Barendsen, Radboud University Nijmegen, ILS-RU, e.barendsen@ils.ru.nl

Ineke Henze, Radboud University, Nymegen

ABSTRACT: In the last decades, PCK has been found to be a useful idea for thinking about and exploring aspects of science teachers' professional knowledge. After 25 years of study, however, we still do not know enough about what PCK science teachers have, how they come to have it, or what they do with it. In this study, we aimed to make a contribution to theory on the concept of PCK in science education and instruments that facilitate science teachers' systematical reflection on their knowledge (i.e. PCK) and practice. We developed an instrument to observe the translation of teachers' PCK into classroom practice and carried out a case study to investigate both the feasibility of the procedure and the usefulness of the resulting analysis. We investigated science teachers' PCK and PCK-in-action in the context of the introduction of a new science curriculum in the Dutch educational system. Our observation instrument based on the different knowledge categories of PCK (Grossman,1990; Magnusson,

Wednesday, March 28, 2012

Krajcik and Borko, 1999) and the teachers' representations of the key concepts attached to a specific science topic (i.e. poly lactic acid). The developed observation instrument and the findings of the study will be discussed at the NARST conference.

Further Examination of Interplay between Pedagogical Content Knowledge Components

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

Yezdan Boz, Middle East Technical University

ABSTRACT: Pedagogical content knowledge (PCK) has been identified as knowledge that effective teachers have to make subject matter content accessible to learners. Existing PCK models are not able to inform us about how PCK components interplay. In response to the call for research into examining it, we sought to examine experienced teachers' PCK in electrochemical cells topic. By the use of purposive sampling, three information-rich cases were selected. Data were collected through card-sorting activity, Content Representation, interviews, observation, and field notes. Qualitative analysis indicated teachers may draw on simple and complex interplay between PCK components. Some of the interplays play a role in diagnosing the misconceptions and difficulties whereas some of them play role in remedying it by the use of a particular strategy. In addition to interplays between components of PCK, sub-components of a component are able to inform others. Each interplay is specific to a problem, difficulty, or a case, which requires the teacher to draw on different PCK components. Finally, there may be some missing interplays which may indicate that those components may not be available to the teacher when s/he needs to draw on them. Implications for research and teacher education will be provided.

Comparison of Experienced Chemistry Teachers' Pedagogical Content Knowledge in Electrochemistry and Radioactivity

Yezdan Boz, Middle East Technical University, yezdan@metu.edu.tr

Sevgi Aydin, Yuzuncu Yil University

ABSTRACT: Pedagogical content knowledge (PCK) is an amalgamation of content and pedagogical knowledge for teaching a topic in an understandable way to students. Though topic-specific nature of PCK is assumed by the literature, no empirical study comparing and contrasting participants' PCK in different topics has been conducted. The purpose of the present study was to investigate how experienced high school chemistry teacher(s)' PCK differs for teaching different topics (electrochemistry and radioactivity) in the same discipline, (chemistry). By the use of purposive sampling, information-rich cases were selected. Though three chemistry teachers were selected as participants, this study will reveal the analysis of one chemistry teacher's PCK for both electrochemistry and radioactivity topics. Data were collected by means of card-sorting activity, Content Representation (CoRe), semi-structured interviews, observation, and field notes. Qualitative analysis indicated some similarities and differences in the chemistry teacher's PCK. To clarify, his content knowledge, knowledge of learners' difficulties, knowledge of curriculum, knowledge of assessment and his repertoire of topic-specific strategies were much more adequate for teaching electrochemistry compared to the radioactivity topic. Preliminary analysis indicated that although an experienced teacher may have well-developed PCK in one topic, his PCK may not be adequate to the others.

Examine The Discourse Pattern And Teacher's Pedagogies In Promotion Reasoning In Science Writing Heuristic Classroom

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Brian M. Hand, University of Iowa

ABSTRACT: This mixed method study aimed to explore the discourse pattern and teacher's pedagogy that promote students reasoning and critical thinking skills within a claim and evidence presentation and discussion. Three participants were purposefully selected based on their fidelity of implementing the approach. Each teacher represents high, medium and low level of fidelity. The results showed that a teacher who allowed students to lead a discussion then strategically step in and out from the conversation could control the direction of the conversation and create non-threatening classroom environment in the same time. Students who had been practicing more complex reasoning skills and higher order thinking questioning tend to have higher gain score in their critical thinking test. More importantly, in order to promote students reasoning and critical thinking skills,

Wednesday, March 28, 2012

teachers played an important role during classroom discussion by using questions and strategies that push students to make a position of an argument.

Measuring PCK for Teaching Chemical Equilibrium: A Comparison between Experienced Teachers and Pre-service Teachers

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Elizabeth M. Mavhunga, Wits University

ABSTRACT: As teachers gain experience in teaching a specific topic, their ability to teach the topic effectively improves provided they have the prerequisite knowledge bases which include knowledge of subject matter, learners, general pedagogy, and context. These knowledge bases enable the transformation of subject matter knowledge into teachable form, or pedagogical content knowledge (PCK). This study investigates the role of experience and subject matter knowledge (SMK) in the development of PCK. The study uses an instrument developed to assess the quality of topic specific PCK, related to the teaching of chemical equilibrium. The instrument uses five topic specific components – learners' prior knowledge, what makes a topic difficult to teach, curricular saliency, representations and teaching strategies and was administered to groups of pre-service and experienced teachers, together with a subject matter diagnostic test. Results showed a hierarchy of development of the components of topic specific PCK in the pre-service teachers. Preliminary results also show that experienced teachers perform significantly better on both SMK and PCK tests and that the two constructs are highly correlated in both cases. Possible reasons for this are explored.

Strand 4: Science Teaching--Middle and High School (Grades 5-12): Characteristics and Strategies
Teacher Beliefs and Effects on Practice

2:45pm – 4:15pm, Room 305

President: Catherine E. Milne, New York University

Relationship between Teachers' Beliefs and Practice of Review Lesson and Student Learning

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Jian Wang, University of Nevada, Las Vegas

ABSTRACT: Teaching quality is assumed as important factor in shaping student academic performances while review lesson in teaching process presumably influence the quality of teaching and thus, student learning in the relevant literature. Chinese students showed much higher achievement in science than their US peers in recent PISA study and Chinese teachers are observed to be more likely to use review lesson in their teaching process than their US counterparts. Therefore, it is reasonable to question whether review lessons in Chinese school actually influence Chinese student learning in science and if yes, how such influences occur. This study explores the relationship between science teachers' review lesson and student performance drawing on data from 3 chemistry teachers and 222 students in a Chinese high school. It found that all three teachers developed different understandings of review lessons, which lead to conduct review lesson in different manner and thus, different results of their student achievement in chemistry.

Teachers Views of the Role of Literacy in Science

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Michael Metz, Stanford University

Alexis Patterson, Stanford University

Diego Xavier Roman, Stanford University

ABSTRACT: The new US Common Core Standards for Literacy are for literacy in language arts, history/social studies AND science. Teachers are expected to educate students about how to read informational texts and their major features. Yet, what do teachers of 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 explore language in science? To date, few studies have

Wednesday, March 28, 2012

explored this topic and then only through surveys. In this paper, we report a study conducted using extended interviews with a sample of 25 teachers drawn from the full range of middle 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. As expected, teachers saw a focus on language as subsidiary to empirical work and the major challenge to be one of vocabulary. The implications of these findings are discussed.

Pre-service Science Teachers' Orientations toward Teaching: Evidence for Constancy and Ability across Subject Matter Knowledge Areas

Vanessa Kind, Durham University, UK, vanessa.kind@durham.ac.uk

ABSTRACT: The orientations towards teaching held by 235 pre-service teachers (PSTs) were probed by written response to three classroom-based, misconceptions-oriented vignettes. Four orientations of nine suggested by Magnusson, Krajcik & Borko (1999) were in evidence; conceptual change, activity-driven, inquiry and didactic. Very limited or no evidence for student-centred orientations was apparent. Data suggest that written sources are viable for investigation of orientations. PSTs varied in the extent to which their orientations were consistent or changed across three subject areas and impacted on choice of teaching strategy. Implications arising include that if we regard high quality teachers as important, teacher education needs to decide on desirable orientations and address how best to promote their development.

Science Teachers' Beliefs about the Influence of their Summer Research Experiences on their Pedagogical Strategies

Rommel Miranda, Towson University, Rmiranda@towson.edu

Julie Damico, Towson University

ABSTRACT: This qualitative study sought to determine the beliefs that high school science teachers hold about how their summer research experiences might influence their pedagogical strategies. Qualitative methods were used to explore this study's research questions. Supported with NASA funding, twenty high school science teachers participated in a 6-8 week summer program to conduct research under the mentorship of an experienced STEM researcher. The findings suggest that there are a number of specific learner characteristics that teachers believed helped them to be successful during their summer research experience that center on background content knowledge and laboratory experiences, cognitive skills, and dispositions. Additionally, teachers overwhelmingly responded that their research experiences in a laboratory setting in comparison to their students' learning experiences in their school setting were largely dichotomous. Teachers further believed that the successes they experienced during their summer research experiences largely influenced how they would plan to teach their own students science. The implications of these findings suggest that summer research experiences designed for science teachers might help to influence their pedagogical teaching strategies by allowing them to develop more nurturing, realistic, relevant, and rigorous student-centered learning experiences that can promote student engagement with science.

Secondary Science Teacher Beliefs about Talk during Whole-Class Discussions

Diane Silva Pimentel, Boston College, silvadi@bc.edu

Katherine L. McNeill, Boston College

ABSTRACT: This quantitative study provides insight into secondary teachers' beliefs about their ability to engage in science talk during whole-class discussions and their beliefs about the effectiveness of that type of talk for student learning. A state-wide survey was conducted of Rhode Island science teachers from the comprehensive, public high schools in the state. This study found that secondary science teachers report spending a large part of instructional time in whole-class discussions. Science teachers in this study placed much greater importance on dialogic type talk over authoritative talk in order to develop student understanding. In terms of teacher self-efficacy for conducting dialogic science talk, this study suggests that more opportunities for teachers to participate in coursework or professional development which highlight effective strategies for guiding dialogic science talk in the whole-class discussions in addition to content-focused development is important to change the type of discourse that happens in science classes.

Wednesday, March 28, 2012

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

Science and Graphic Representations

2:45pm – 4:15pm, Room 304

Presider: Linda Keen-Rocha

Investigating the Value of Multi Modal Representation Instruction on Learning Physics Concepts

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Cuneyt Ulu, Marmara University

ABSTRACT: Learning researchers have been studying the value of multi modal representations (MMR) in curricula over the last few years. The findings of their research suggest that when students interact with accurate representations, their classroom performance improves (Ainsworth, 2006) Scholars in the area of science education have investigated by exposing students to various modal representations and recording the resulting effect on overall achievement (Kohl and Finkelstein, 2005). Building onto this research the researchers designed this current study to examine if different multi modal representation instruction combined with writing assignments impacts on students understanding of the physics concepts under investigation. Two hundred twenty eight freshman college students registered in nine sections of an introductory physics course participated in this study. There were three treatment conditions that were exposed to different instruction with respect to introducing MMR and their functions in communicating science. The first group had no MMR instruction and conducted writing to learn assignments at the end of the each unit. The second group had MMR instruction and conducted writing to learn assignment at the end of the each unit. Finally, the last group had MMR instruction and writing assignments with rubric generation to analyze MMR in science based written materials. Results indicated that the third group scored significantly higher than other groups for all three units. Also, the second group was scored significantly higher than the first group on first and second unit posttests.

Understanding the Conventions Undergraduate Students Follow or Break When Constructing Scales for Graphs

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Cesar Delgado, The University of Texas at Austin

ABSTRACT: The construction of scales is a critical but little-studied component of graphing, an essential scientific practice. By employing approaches developed by both socioculturally- and cognitively-based research on graphing, we characterized how a group of undergraduate students constructed scales. More specifically, this line of inquiry examined whether or not students followed standard conventions for creating scales. Standard conventions include using equal lengths to represent an equal number of units, selecting a range that encompasses the data, labeling units, and using tick marks to create intervals. Participants were undergraduate students enrolled in an interdisciplinary Geoscience/History course that focused in part on dimensions of space and time. Using data sources that included constructed-response scale construction tasks for time and size data and individual interviews, findings indicate that conventions were followed to very different degrees. Gaining insight into which conventions students adhere to or break will better inform postsecondary educators as to how to more effectively scaffold their students' understanding of scales.

Students' Use of Covalent Bond Model to Represent Ionic Bonds: Insights from Particulate Drawing Task

Abdi M. Warfa, University of Minnesota, moham489@umn.edu

James M. Nyachwaya, University of Minnesota

Gillian Roehrig, University of Minnesota

Jamie L. Schneider, University of Wisconsin River Falls

ABSTRACT: In this study, we explore students' conceptual understanding of the nature of ionic compounds by looking at how college students ((N = 111) represent binary ionic compounds at the particulate level. We asked college students to draw appropriate particulate representations of chemical reactions that involved both ionic compounds and covalent molecules. Our findings suggest that students use the covalent bond model to represent ionic bonds and struggle with the nature and differences between ionic and covalent bonding. Given the prevalence of covalent molecules in the chemistry representation literature, we argue it is equally important that

Wednesday, March 28, 2012

researchers investigate how students represent ionic compounds at the atomic/molecular level to ascertain their understanding of ionic bond nature. Emergent research from such studies will undoubtedly aid uncovering students' struggles with fundamental chemical concepts, such as chemical bonding theories, as does the present study.

Using Diagrams in Conjunction with Clicker-questions in Large Lecture Biology Courses to Enhance Student Learning

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J.Z. Barlow, UMass-Amherst

Randall Phillis, UMass-Amherst

ABSTRACT: A method of clicker use has been designed to give students practice reasoning like expert biologists that includes an innovative use of diagrams. This project categorized the clicker-questions as model-representation-diagram-questions (MRDQ), authentic-data-diagram-questions (ADDQ), and non-diagram-questions (NDQ), and assessed their impact on class-discussion and student performance. Classroom discussions following MRDQ had significantly more student-comments than those following ADDQ ($p=0.050$) or NDQ ($p=0.007$). In addition, MRD-questions had significantly higher occurrences of student-comments that were coded as reasoning statements than ADD-questions and NonDiagram-questions combined ($p=0.048$). Further, students performed significantly better on exam questions that mirrored in-class MRDQ than exam questions that mirrored NDQs ($p=.005$). Our research suggests MRD-questions might support the quantity and quality of student-comments during large-lecture classroom discussions and student success on exams. We hypothesize that the MRDs support student's ability to reason with the Clicker-questions by reducing cognitive load and supporting mental modeling. As instructors, the MRDs support us in developing Clicker-questions, and we hope to develop guidelines that bridge some of the difficulties in designing and implementing cognitively challenging biology questions for large-lectures.

Strand 7: Pre-service Science Teacher Education***Preservice Teachers' Understandings and Perceptions of the Nature of Science***

2:45pm – 4:15pm, Room 306

Presenter: G. Michael Bowen, Mount Saint Vincent University

A Case Study of a Pre-Service Science Teacher's Practice of NOS Teaching and Argumentation

Yasemin Ozdem, Gaziosmanpasa University, yozdem@metu.edu.tr

Kader Bilican, Ataturk University

ABSTRACT: Research on teaching NOS has demonstrated that explicit reflective approach to teaching of NOS as part of a classroom discourse is an effective mean of instruction. Emerging research suggests that engaging in argumentation and the incorporation of explicit NOS instruction may support learners' understanding of NOS, however the claim that a teacher could be acknowledged and trained in doing an effective argumentation and NOS instruction has very few empirical support. Thus, this exploratory study adapted feedback approach to incorporate both explicit NOS instruction and explicit argumentation instruction in the learning environment with the aim of training a pre-service science teacher to gain improved practice for NOS and argumentation. In this study, we examined the classroom practices of one pre-service elementary science teacher who, through feedback and reflective instruction, tried to facilitate argumentation and incorporation of explicit-and-reflective NOS instruction. The results showed that after he got feedback from his mentors, and has opportunity to reflect on his teaching, his efforts to incorporate NOS and create argumentation has been detected. That is feedback and reflection might be effective tools to trigger teachers to include NOS and argumentation in their science teaching.

Investigating use of Self-efficacy Sources in Improving Preservice Science Teachers' Self-efficacy Beliefs Regarding Teaching Nature of Science

Kader Bilican, Ataturk University

Jale Cakiroglu, Middle East Technical University

Wednesday, March 28, 2012

ABSTRACT: Since self efficacy has been claimed as a significant predictor for performance, teachers' teaching behaviors are closely related with their self-efficacy beliefs. Thus, current study examines the self-efficacy for teaching nature of science of three preservice science teachers during and after participation of science methods course. In science methods course participants were provided instructional activities and course assignments based on mastery and vicarious experiences to increase their self-efficacy beliefs regarding teaching nature of science. Data were collected through pre-post interviews, reflective journals and field notes. Analysis of data revealed that mastery experiences seemed to be important for all preservice science teachers in development of perceived self-efficacy beliefs. Regarding outcome expectancy beliefs, all participants were very positive about teaching NOS. Due to the fact that self efficacy is influential on learning and decisions related teaching performance, the results of the study suggested significant implications for the design of science methods courses and teacher education programs.

Assessing Student Learning from a PBL Approach: Comparing Pre-Service Science Teachers to Undergraduate Science Students

Sharon Schleigh, East Carolina University, schleighs@ecu.edu
 Alex Manda, East Carolina University

ABSTRACT: In this study, we assess the content knowledge and the skills and understanding of the nature of science (NOS) of pre-service science teachers compared to other undergraduates in a science course. Instructional strategies included Project Based Learning (PBL) and a mixed-methods approach was utilized to provide information about their learning and their perceptions of science. Results reveal that pre-service teachers had a better understanding of NOS than other undergraduate students. The pre-service teachers were also more creative but they demonstrated weak skills in written communication. Undergraduate science students were stronger in rote information and were more rigid in their demonstration of conceptual understanding for NOS and their engagement in doing science.

Strand 7: Pre-service Science Teacher Education

Developing Pre-Service Teachers' Content Knowledge

2:45pm – 4:15pm, Room 312

President: Douglas B. Larkin, Montclair State University

Examining the Role of Content Knowledge in Learning to Teach Science: Implications for Teacher Preparation

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

ABSTRACT: There has been little careful examination of ways in which content knowledge per se might open conceptual doors for the acquisition of skills critical for effective teaching, particularly in light of growing numbers of alternative programs, where content knowledge is often privileged. In this study, the extent to which deep content understanding makes it possible to engage in high-leverage practices (HLPs) was examined. These HLPs include the development of plans grounded in significant scientific ideas; the selection of activities addressing core learning objectives; the ability to orchestrate productive scientific discussions; and the ability to identify conceptual difficulties through analysis of student work. Participants included 12 individuals with varying experiences enrolled in a masters-level certification program. Data sources included measures of content knowledge 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 the ability to recognize and design reform-based instruction. Results also suggest an individual's professional identity may shape the enactment of many practices. This work can inform our understanding of the development of HLPs and our design of experiences to better prepare teachers to serve children with the greatest need.

Exploring the Teacher-Researcher Model for Impacts on Pre-service Teachers' Preparation for Science and Math Teaching

Bryan M. Rebar, California Polytechnic State University, brebar@calpoly.edu

Wednesday, March 28, 2012

John M. Keller, California Polytechnic State University
 Collie Conoley, University of California, Santa Barbara

ABSTRACT: The teacher-researcher model holds as a central premise the idea that science and math teachers are better prepared to teach when they have been actively engaged in the process of conducting research. In this study we discuss the ways in which a program providing research experience to pre-service and early career teachers has contributed to better preparation for teaching. Specifically, we present evidence that, following an 8-10 week summer research experience with leading researchers at national laboratories including the support of weekly education workshops, participants demonstrate gains in understanding of the nature of science, commitment to teaching, teaching self-efficacy, and inclusion in the teacher-researcher community. Despite the fact that participants did not have the opportunity to practice teaching in a classroom setting during the program, participants entering science teaching showed gains in science teaching self-efficacy based on pre-/post-program responses to the STEBI-b instrument. Participants also developed understandings of science that more closely resemble the consensus views held by practicing scientists based on pre-/post-responses. Results from an alumni survey including 130 participants from 2007-2010 revealed that 85-89% remain committed to a teaching career. We conclude that the teacher-researcher model offers a transformative experience in the preparation of science and math teachers.

Science Student Teachers' Struggles with and Learning about Classroom Action Research During Their Field Experiences

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 Anthony Clarke, University of British Columbia

ABSTRACT: Action research is a key element in teacher education programs in which pre-service teachers inquire, reflect on and improve their teaching practices. This study sought an understanding of the struggles of 23 fifth-year pre-service science teachers with and learning about action research during their student teaching. This qualitative study drew upon group written reflections, focus group interviews and observations of seminar sessions. Data analysis was inductive involving categorical aggregation, followed by a search for correspondence and patterns. The student teachers held a negative attitude and misunderstanding, which led them to the traditional research methodology. They struggled with time limitations and data gathering. Despite the struggles they experienced, pre-service science teachers learned and broadened their science teaching practices through collaboratively work with cooperating teachers and university supervisors. The recognition of patterns of pre-service science teachers' struggles and learning about action research can be considered a basis for reflecting on and rethinking the components of science teacher preparation programs.

Strand 8: In-service Science Teacher Education

Promoting Project-Based Science Teaching

2:45pm – 4:15pm, Room 206

Presider: Christine R. Lotter, University of South Carolina

The Impact of an Immersion Course on In-Service K-8 Teachers Implementation of Reformed Teaching Practices in the Classroom

Margaret D. Nolan, Boston University, noland@mersd.org
 Peter Garik, Boston University
 Charles Winrich, Boston University
 Nicholas Gross, 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. We find a correlation between the lesson plan rubric that we have designed and the RTOP observation protocol.

Wednesday, March 28, 2012

Developing Science Teacher Leaders to Facilitate the Implementation of Project-Based Science in Schools: Preliminary Findings

Gale A. Mentzer, Grant Fundamentals LLC, gale@grantfundamentals.com
 Janet Struble, The University of Toledo

ABSTRACT: A federally funded project designed to improve science education by making it relevant to students through Project-Based Science linked to the renewable energies industry, utilizes Teacher Leaders (TLs) to provide long term (minimum 3 years) K-12 science teacher professional development to their respective school districts. This study examines whether participation in a professional development program that includes rigorous content, PBS strategies, and leadership development improve a teacher's ability to implement change within the school district. The sample for cohort 1, 12 science teacher leaders (2 districts), are in their second year of a three year program. TLs attended summer institutes and yearlong professional development to increase their science content knowledge, pedagogical content knowledge, and leadership skills. The TLs' development was examined through measures in three major areas: science content knowledge (pre/post tests), science teaching preferences (Science Teacher Ideological Preference Scale and Science Teacher Efficacy Beliefs Instrument), and leadership (Leadership Inventory). This combination provides a comprehensive picture of teacher leader development. The TLs have realized significant gains in two of the three target areas—content knowledge and leadership skills—and have remained constant in their personal teaching beliefs.

Educative Curriculum Materials that Allow for Learned Adaptations: Ensuring Quality of Implementation

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 Tania Jarosewich, Censeo Group LLC

Donna Korol, University of Illinois at Urbana-Champaign

ABSTRACT: As part of a National Institute of Health funded curriculum development and teacher professional development project, we are interested in understanding how to design learning environments that allow teachers the space to use reform oriented curriculum materials to support their own and their students' learning of cutting-edge science and key scientific practices. We build on previous work that examined how teachers create inquiry-oriented classrooms by using reform-oriented curriculum units. In this exploratory study, we examine how teachers use project based science units so that the units fit their understanding of their own and their students' perceived needs. Data analysis focused on classroom observations, classroom audio recordings, teacher interviews and surveys. Analysis of our data allowed us to develop case studies of different enactments. Using these case studies, we identify elements of the unit that teachers saw as critical and the quality of the resulting classroom enactments. In addition, we identify affordances and constraints of using project based science units in the manners that they were used. Implications for the design of materials to facilitate teacher use and adaptation of curriculum materials will be discussed.

Strand 10: Curriculum, Evaluation, and Assessment

Assessment and Evaluation

2:45pm – 4:15pm, Room 308

President: Alan K. Szeto, Purdue University Calumet

Effect of Order of Concept Introduction on Secondary Honors Students' Understanding of Chemistry

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ABSTRACT: This action-research study explored the effect of modifying the order of concept introduction on students' acquisition and retention of chemistry concepts. Students in two Honors year-long chemistry courses, taught by the same instructor, participated in this study. One section was taught using a traditional curriculum where concepts start with the submicroscopic and proceed to macroscopic and a modified curriculum in which concepts were developed from the macroscopic level. The content targeted specific district-determined learning objectives. The instructor used a student-centered instructional approach in both classes. Unit tests were designed to enable comparison of performance on concepts tied to the learning objectives throughout the year across the

Wednesday, March 28, 2012

two classes. Students in both classes took the same final exam. Analysis of unit test items and the final examination show a significant difference in favor of students in the modified section specifically on test items that targeted the upper levels of Bloom's taxonomy. Findings from this study demonstrate that a curriculum intervention focused on changing the sequence of concept introduction can lead to more meaningful learning of chemistry concepts. Implications for research and instruction are discussed.

Research-Based Shift from Algorithmic Teaching to 'HOCS Learning' Science - for a Diverse Global Community

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Naji Kortam, Haifa University

Tami Levy Nahum, Haifa University

Ibtesam Azaiza, Haifa University

David Ben-Chaim, Haifa University

ABSTRACT: Given the current striving for sustainability and the corresponding paradigms shift in science, technology, environment, society (STES), economy and politics; e.g., from unlimited growth-to-sustainable development, correction-to-prevention and passive consumption-to-active participation, the corresponding paradigm shift, at all levels of education, is unavoidable. In these contexts, the need and relevance of the development of students' higher-order cognitive skills (HOCS) such as evaluative thinking (ET), system thinking (ST) and decision-making (DM) capabilities in science education is apparent. Our research objectives were: (1) establishing 'base lines' for these 3 HOCS capabilities of 10th-grade and college students in the Israeli multi-sectorial educational systems; and (2) assessing the pre-post development of these students' capabilities via their HOCS-STES responses to a specially designed questionnaire. Our findings suggest that persistent application of HOCS-promoting teaching and assessment strategies is needed for advancing high-school and college students' ET-ST-DM capabilities. The development of science student's content-generic but context-dependent HOCS capabilities is double. In conclusion: the paradigm shift from teaching to KNOW- to learning to THINK, in the STES context, of science education targeting at ensuring the world sustainability- is an attainable goal.

Where are the People? Understanding Representations of Society-Nature Relationships in State Science Standards in United States

Ajay Sharma, University of Georgia, ajay@uga.edu

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ABSTRACT: Understanding the relationships between social and natural systems is central to understanding the complex underlying causes of climate change. Based on systemic-functional-linguistics based critical discourse analysis of texts, this study focuses on understanding representations of ecological concepts and issues, and the relationship between social and natural systems in state science standards for all 50 states of the United States. Data analysis indicates that state science standards may not be offering adequate frameworks for understanding ecological systems as intrinsically socio-ecological, or collective social action as helpful in addressing ecological crises, such as climate change. The paper explains the implications of these results for science education and their relevance for meeting ecological challenges, and offers recommendations to address this issue.

Designing Effective Science Achievement Measures for Intervention Studies with English Language Learners

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ABSTRACT: A primary goal of science education reform is to promote high levels of science learning for all students. Given that English Language Learners (ELLs) are a sizeable and increasing segment of the United States K-12 student population, more studies are testing the effect of interventions that promote effective science teaching and learning for ELLs (c.f., Lee et al., 2008). However, as stated by Lee and Luykx (2006), "valid and equitable assessment of nonmainstream students remains one of the thorniest difficulties in educational policy and practice" (p. 100). The purpose of this conceptual paper is to shed light on issues involved while measuring science achievement of linguistically diverse students in educational intervention studies. We draw upon a set of guiding

Wednesday, March 28, 2012

assessment design principles – curricular alignment, instructional alignment, and equity considerations – to describe how we composed a science achievement assessment appropriate for our particular intervention study. Our experiences can inform similar studies that seek to measure science achievement in linguistically diverse settings as well as assessment practices by classroom teachers.