Sunday, March 21, 2010

Pre Conference Workshop—Equity and Ethics Committee Sponsored

W1 Research into Practice: Practice Informing Research for Equity Scholarship and Teaching 1:00pm – 5:00pm, Conference Rooms 407 – 408 Felicia M. Moore-Mensah, Columbia University, moorefe@exchange.tc.columbia.edu Melody Russell, Auburn University Jomo Mutegi, Sankore Institute Blakely K. Tsurusaki, Washington State University Gillian U. Bayne, Lehman College Rowhea Elmesky, Washington University-St. Louis Wilbert Butler, Tallahassee Community College Nate Carnes, University of South Carolina Mary M. Atwater, University of Georgia Sumi Hagiwara, Montclair State University

ABSTRACT: The pre-conference workshop will emphasize opportunities available to scholars of color and scholars who do research involving issues of equity and how to develop relationships so that equity research that influences practice can be accomplished. Each panelist may offer some specific advice about teaching and conducting equity research , how to make connections in order to conduct research, how their research informs practice, or what particular practices are outgrowths of their research and vice versa. The panel will field questions from the audience relevant to the challenges and opportunities as equity scholars and scholars of color for doing research in science education. Attendees will work in small groups to outline personal or individual plans of research that they may continue to develop after the NARST conference. Breakout groups and work sessions will be lead by facilitators and panelists representing a range of expertise.

Pre Conference Workshop—Research Committee Sponsored

W2 Writing a Competitive Proposal for the National Science Foundation's (NSF) Division of Research on Learning in formal and Informal Settings (DRL): Strategies and Tips for Novice and Seasoned Proposers

1:00pm - 5:00pm, Conference Rooms 411 - 412

Janice Earle, National Science Foundation, jearle@nsf.gov

Sharon J. Lynch, National Science Foundation

Gavin Fulmer, National Science Foundation

Charles W. Anderson, Michigan State University

Heidi Carlone, The University of North Carolina at Greensboro

Okhee Lee, University of Miami

ABSTRACT: This pre-conference workshop is designed for experienced and new researchers who are interested in developing competitive proposals for NSF funding. Its specific focus is on the the program solicitations for REESE, DR-K12, and CAREER awards within the Division of Research on Learning, but the workshop may also be useful for researchers who are interested in other NSF solicitations. The first part of the workshop will be led by NSF Program Directors and focus on NSF's context for research and provide information on expectations for competitive proposals and the merit review process. The second part of the workshop will be led by researchers who have had successful NSF proposals and who will provide their insights into the organization and grant-writing process, supplying their own "sanitized" proposals as exemplars. The last portion of the workshop will provide some time for participants to talk about their own research ideas. The entire workshop is intended to be informative and interactive.

Pre Conference Workshop—Research Committee Sponsored

W3 Developing High Quality Reviews for the Journal of Research in Science Teaching

1:00pm – 5:00pm, Conference Rooms 414 – 415

Joseph S. Krajcik, University of Michigan, krajcik@umich.edu

Angela Calabrese Barton, Michigan State University

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.

Sunday, March 21, 2010

Pre Conference Workshop—Research Committee Sponsored

W4 "It's Electric!"- E-Portfolios as Evidence of Teacher Growth: Examining a Growing Trend in Both Research and Practice in Science Teacher Education

1:00pm – 5:00pm, Off Site. Transportation will be provided.

Sonya N. Martin, Drexel University, Sonya.Martin@Drexel.Edu

Christina A. Siry, University of Luxembourg

Rachel Ruggirello, Washington University

Constance Blasie, University of Pennsylvania

Jane Horowitz, University of Pennsylvania

Yushaneen Wilson, University of Pennsylvania

ABSTRACT: This workshop invites participants to learn about and share experiences, as well as theoretical and methodological lenses for developing and assessing e-portfolios with pre- and in-service science teachers. Participants will discuss challenges and benefits of engaging teachers in developing e-portfolios, including practical issues, such as technological requirements/challenges, as well as pedagogical concerns about how to support teachers to engage in research on their own practice and learn to document and reflect on evidence of their growth. Participants will be asked to engage in discussion around how to assess growth in areas such as science content knowledge, pedagogical practice, and social interactions with peers, students, and the community. Participants are encouraged to bring examples of rubrics, course syllabi, sample portfolios, and suggestions for continued research on e-portfolios. Stemming from their own research on the implementation of e-portfolios with pre- and in-service teachers in three different programs, facilitators will engage participants in discussions around how research into practice, as documented via e-portfolios, informs learning about teaching for both science teacher educators and the science teachers in their programs.

Plenary Session

PL1 Policy in Practice: Instruction & the School Administrative Infrastructure

5:30pm – 7:00pm, Liberty Ballroom

Presider: Richard A. Duschl, Penn State University

Presenter: James Spillane, Northwestern University

ABSTRACT: School leadership and management are critical in efforts to improve classroom teaching and learning. The success of even the best classroom-centered designs or high stakes accountability policy will depend in good measure on the schoolhouse administrative infrastructure. Spillane argues for re-conceptualizing how we think about the work of leading and managing schools using a distributed perspective. Getting beyond the nearly exclusive focus on the school principal, we must take account of how the work of leading and managing is distributed across other schoolhouse actors. We need to focus on the practice of leading and managing instruction in a way that considers interactions, not just actions. Understanding practice necessitates close attention to aspects of the school infrastructure such as organizational routines that enable and constrain interactions among staff.

Strand 1: Science Learning, Understanding and Conceptual Change

S1.1 SC-Paper Set: New Ideas about Learning Progressions

8:30am – 10:00am, Conference Room 401

S1.1.1 Towards a Learning Progression Addressing the Seasons: A Comparison of Two Learning Trajectories with Middle School Students

Julia D. Plummer, Arcadia University, plummerj@arcadia.edu

Lori Agan, Expeditionary Learning School

ABSTRACT: This study explored two proposed learning trajectories towards understanding the cause of the seasons. In the "local-first" trajectory students began by moving through major concepts from their own local perspective and in the "global-first" trajectory students worked through the same concepts but focused on comparing locations across the globe. Each group eventually worked through the same concepts and activities, just in different orders. We analyzed pre/post assessments for eighth grade students (taught by the same teacher) who participated in the "local-first" curriculum (two classrooms; N=18) and the "global-first" curriculum (three classrooms; N=20). The data were analyzed by first creating a 4-level construct map describing increasing proficiency of understanding the seasons. Student responses to items were aligned to levels on the construct map through a scoring guide. While students showed significant improvement in their understanding of the seasons across both conditions, no differences were found between conditions. Through the testing of standards-based hypotheses, we describe how our findings provide an empirical basis for extending our learning progressions for celestial motion towards improving students understanding of the seasons.

S1.1.2 Fifth and Eighth Grade Students' Conceptions about the Nature of Technology

Nicole DiGironimo, University of Delaware, digirn@udel.edu

ABSTRACT: The science education literature clearly shows that knowledge of the Nature of Technology is an educational goal; however, there is a distinct lack of research on student conceptions about the Nature of Technology in the United States. This research study used an interview protocol developed from a newly conceived definition for the Nature of Technology to interview fifth and eighth grade students about the Nature of Technology. The findings suggest that although student conceptions of the Nature of Technology become more coherent and more accurate with age, there are distinct alternative conceptions present in the thinking of young people. Additionally, both of the student groups expressed views of the Nature of Technology that were less advanced than anticipated when compared to the National and State standards for science and technology. This suggests the need for improved science and technology education – an issue of great importance in a society dependent on information and communication technology.

S1.1.3 Progression in Student Understanding of Matter from Middle School to College: Implementation of the Structure and Motion of Matter (SAMM) Survey

Marilyne Stains, University of Massachusetts Boston, marilyne.stains@umb.edu

Marta Escriu-Sune, University of Massachusetts Boston

Hannah Sevian, University of Massachusetts Boston

ABSTRACT: The development of learning progressions has been at the forefront of science education for several years. While understanding students' conceptual development of key science concepts is extremely valuable for researchers, science teachers can also benefit from assessment tools that evaluate their students' understanding along these progressions. In this paper, we describe the development and validation of a teacher-friendly survey (the Structure and Motion of Matter – SAMM - survey) designed to measure students' progress along a research-based learning progression on the particulate nature of matter (PNM). Following field-testing, SAMM was administered with students from middle school through college levels in order to explore a) differences in the ranges of understanding between students with different levels of schooling, and b) the influence of the domain of science (chemistry, physics or biology) that students have most recently been exposed to on their understanding of the PNM. We found that middle school students outperformed high school and college students in nearly all measures, but that student understanding improved from high school to college. Our analysis also shows no statistically significant relationship between the domain of science (biology, chemistry or physics) students were currently studying and their level of understanding of the PNM.

S1.1.4 What Progresses in a Learning Progression: A Longitudinal Ground-Truth Study of One Students Understanding of Energy in Ecosystems

Elisabeth Roberts, The University of Arizona, enr@u.arizona.edu

Bruce Johnson, University of Arizona

ABSTRACT: This paper will present a preliminary and explorational analysis of changes in one young woman's thinking about energy and interactions in food chains over the course of five years, from age 9 to age 13. This work builds on a six-year research program investigating children's knowledge and perceptions of ecological systems (Authors, 2005, 2006a, 2006b, 2007). Just as detailed "ground-truth" studies of ecosystems are needed to verify and calibrate data from satellites and remote sensing instruments, longitudinal and ethnographic studies of children's thinking as it develops over time and in interaction with curriculum are needed to temper methodological assumptions of neatness and progress that are embedded in the current learning progressions discourse. As research and policy moves forward in the thought collective (Fleck, 1935/1979) forming around learning progressions, it

will be important to balance the "one size fits most" approach with the diversity and richness of actual students' development. This study contributes an example of that diversity, and raises questions about the assumed progression of learning and levels in large-scale models.

Strand 2: Science Learning: Contexts, Characteristics and Interactions

S1.2 Poster Symposium: Applying New Mechanisms and Conceptualizations of the "Transfer-of-Learning" to Science Classrooms: The Dynamic Role of Contexts and Interactions

8:30am – 10:00am, Salon C

ABSTRACT: This interactive poster symposium showcases new perspectives on the transfer-of-learning and related constructs that have implications for transforming how we think about and practice science education. The symposium is organized around four NSF-funded projects that represent the range of possibilities of this work within different disciplines, age groups, and timescales. Together, they show that the process of learners using what they have learned is more dynamic, context-dependent and interactive than usually portrayed. "Preparation for future learning' in physics" shows that students are more likely to use past learning during future learning after designing their own labs rather than following cookbook labs. "Appropriating conceptual representations" demonstrates how discussions around a broadly-framed computer tool helped mediate transfer for middle school teachers, not just for their students. "Expansive framing and transfer in a high school biology class" illustrates how teachers can frame their science classes expansively in order to foster transfer. "Individual and group-level dynamics of framing and resource activation" argues that framing can occur individually or collectively, which affects how students tacitly "select" which knowledge to use. Our presenters, who include both teachers and researchers, look forward to interacting with attendees and our discussant Andy Anderson around these ideas and their implications. See individual poster presentations and corresponding authors below.

S1.2.1 "Preparation for Future Learning" in Physics

Eugenia Etkina, Rutgers University Anna Karelina, Rutgers University Maria Ruibal-Villasenor, Rutgers University Gregory Suran, Rutgers University

S1.2.2 Approaching Conceptual Representations: A Case of Transfer among Middle School Science Teachers

Cindy E. Hmelo-Silver, Rutgers University Suparna Sinha, Rutgers University Steven Gray, Rutgers University Sameer Honwad, Rutgers University Catherine Eberbach, Rutgers University Rebecca Jordan, Rutgers University Spencer Rugaber, Georgia Tech University Swaroop Vattam, Georgia Tech University Ashok Goel, Georgia Tech University Wendy Ford, Linwood Middle School Casey Schmidt, Linwood Middle School

S1.2.3 Expansive Framing and Transfer in High School Biology Class: Hybridizing Settings and Promoting Connections within a Larger Learning Community

Randi A. Engle, University of California, Berkely Xenia S. Meyer, Cornell University Jim Clark, Arroyo High School Jillann White, University of California, Berkely Adam Mendelson, University of California, Berkely

S1.2.4 Individual and Group-Level Dynamics of Framing

Luke Conlin, University of Maryland Ayush Gupta, University of Maryland David Hammer, University of Maryland

Strand 2: Science Learning: Contexts, Characteristics and Interactions S1.3 Poster Symposium: Developing the Skills and Practices of Modeling

8:30am - 10:00am, Salon D

Presenters:

Leona Schauble, Peabody College, Vanderbilt University, leona.schauble@vanderbilt.edu Douglas B. Clark, Peabody College, Vanderbilt University Richard Lehrer, Peabody College, Vanderbilt University Eve I. Manz, Peabody College, Vanderbilt University Christina Schwarz, Michigan State University Pratim Sengupta, Vanderbilt University Brian J. Reiser, Northwestern University Uri Wilensky, Northwestern University William Sandoval, University of California at Los Angeles

ABSTRACT: Modeling is a form of explanation that is characteristic—even defining—of science (Giere, 1988). Modeling practices are the signature of research in the sciences, both in the discovery of new scientific ideas and in the application of more familiar ones (Nersessian, 2008). In psychological and philosophical studies, the view of science as a modeling enterprise is gradually superseding the emphasis on experimentation procedures and strategies that typically drives school science (Windschitl, Thompson, & Braaten, 2008). Yet, to the extent that models play a role in education, they typically turn up in texts and classroom demonstrations as illustrations of concepts, rather than as practices for building or interrogating knowledge (Windschitl & Thompson, 2006). This symposium focuses on the development of modeling, emphasizing both opportunities and challenges in accomplishing this goal. We propose, in a poster symposium, to investigate a variety of design questions that are raised when modeling approaches to science education are adopted. These include the pros and cons of adopting domain-general vs. domain-specific approaches to modeling, model sequencing, model types, and pedagogical challenges of modeling approaches. Authors will report on a series of studies, conducted with students from K through graduate level, that investigate these questions by studying learning in modeling contexts.

Strand 2: Science Learning: Contexts, Characteristics and Interactions

S1.4 SC-Paper Set: Representations and Visualizations in Science Learning

8:30am – 10:00am, Conference Room 402

S1.4.1 Applying Science Concepts: Factors That Influence Students' Understandings of Surface Area to Volume

Amy R. Taylor, University of North Carolina Wilmington, taylorar@uncw.edu

Gail Jones, North Carolina State University

ABSTRACT: This study explored the relationships among middle school students' reasoning and visual- spatial abilities with their understanding of the scale concept of surface area to volume. Although reasoning ability and visual-spatial skills have been shown to contribute to learning science the relationships of these factors to applying surface area to volume relationships in science contexts have not been fully explored. This study examined surface area to volume understandings pre and post to an instructional intervention. Correlation and multiple linear regression analyses showed that visual spatial ability is related to understandings of surface area to volume relationships. Discussion of the results is followed by implications for teaching surface area to volume in the science classroom.

S1.4.2 Scale, Magnification, and Zooming: Logical Thinking and Spatial Visualization

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

Grant E. Gardner, NC State University

Amy R. Taylor, University of North Carolina at Wilmington

Eric N. Wiebe, NC State University

Jennifer Forrester, NC State University

ABSTRACT: This study explored factors that contribute to students' concepts of magnification and scale. Spatial visualization, logical thinking, and concepts of magnification and scale were measured for 43 middle school students. Scores on the Zoom Assessment (an assessment of knowledge of magnification and scale) were correlated with the Test of Logical Thinking (TOLT) and a series of four spatial visualization tests. Results showed that TOLT was significantly correlated with the Zoom Assessment. There was also a significant correlation between the TOLT and four measures of spatial visualization (MV1 (Shape Memory), MV2 (Building Memory), the Storage Test, and the Surface Development Test). Implications for teaching magnification and scale are discussed.

S1.4.3 Productive Uses of Representation at the Intersection and Mathematics and Biology

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

ABSTRACT: Reform documents such as the National Research Council's Bio2010 have suggested that incorporating mathematical tools into biology curricula can lead students to a deeper, more coherent conceptual understanding of biology. Such claims depend on the ability of educators to support the productive use of mathematical representations in biology classrooms. In this work, we empirically identified examples of productive uses of mathematical representations in the context of a vearlong traineeship for undergraduate mathematics and biology majors. Using detailed field notes, video of problem-solving sessions, photographs of blackboard work, and written documents, we tracked the representational activities of a cohort of seven students. We examined this dataset for both productive and less productive instances of reasoning and communicating with mathematical inscriptions. We identified and developed three major classes of productive representational activities: translation, transformation, and extension. The unifying theme that runs through our findings is the importance of connecting mathematical inscriptions to the underlying biology. Doing so can not only help students think clearly about biological scenarios, it can potentially help them generate new questions for further inquiry. This work provides an empirical starting point for developing curricula that can prepare both students and educators for the impending shift in biology education.

S1.4.4 A Content Analysis of Images in Biology and Geoscience Textbooks

Jennifer Cromley, Temple University, jcromley@temple.edu Theodore W. Wills, Temple University Carla R. Stephens, Temple University Denis Dumas, Temple University Mary H. Herring, Temple University Ulana A. Luciw-Dubas, National Board of Medical Examiners Lindsey E. Snyder-Hogan, Temple University Derek Burton, Temple University Todd Mendelsohn. Temple University

ABSTRACT: Prior research on biology diagrams has suggested that diagrams contain certain features, such as captions, labels, and cutaways. We analyzed the full range of images in biology and geoscience textbooks at the middle school, high school, and undergraduate levels. We selected a stratified random sample of 140 images per textbook and coded for the presence of previously identified features, as well as arrows, use of color, enlargements, abbreviations, and symbols. Line diagrams showed the largest mean number of features per image, followed by other images, and photographs. The number of features per image increased from the MS to HS and UG textbooks, but did not differ between biology and geoscience textbooks. The patterns of feature use were relatively complex between geoscience and biology textbooks and relatively consistent across age groups. We close with suggestions that instruction in understanding images begin with photographs, proceed to the next most common "other" visualization (which differed by age group and domain), and then introduce features common in the more complex line diagrams.

Strand 3: Science Teaching--Primary School (Grades preK-6): Characteristics and Strategies S1.5 SC-Paper Set: Teaching Science to ALL Learners

8:30am - 10:00am, Conference Room 403

S1.5.1 Becoming an Inclusive Science Teacher: Exploring the Intersection of Inquiry and Inclusion in the Primary Classroom Sharon Dotger, Syracuse University, sdotger@syr.edu

Vicki McQuitty, Davis College

Uzma Khan, Syracuse University

ABSTRACT: As teachers participate in multiple professional development efforts, they are often left alone to integrate their learning within their classrooms. Lesson study was used at an urban elementary school to facilitate teachers' integration of inquiry science. writing, and inclusion in their primary classrooms: three simultaneous professional development initiatives in their school. This study reports on the teachers' conceptions and practices of inclusive teaching as they planned, implemented, and evaluated their science research lesson. Findings suggest that teachers' conceptions of disability, student success, and students' capabilities influenced the instructional strategies they considered. Teachers particularly relied on adults to support students with disabilities, thus minimizing their differentiation of the science lesson. The relationship between inclusive practice and science teaching is explored using a pedagogical content knowledge framework.

S1.5.2 In Search of what it means to Develop Scientific Literacy in a Primary School

Kathy Smith, Monash University, kathy s6@bigpond.net.au

Amanda K. Berry

John Loughran

ABSTRACT: Teaching for scientific literacy raises many challenges and dilemmas for primary teachers: What does it mean to be scientifically literate? What pedagogy fosters scientific literacy in the primary years? What are the implications and challenges for planning? How can scientific literacy be recognized in the classroom? How can it be assessed? Is scientific literacy realistically achievable for all students given the structures and thinking which presently define teacher practice in primary science education? This

research, based in a primary school that is working to promote scientific literacy for all students, involves teachers who are actively encouraged and supported to rethink 'learning' and the structures, which presently define their science teaching practice. The experiences, frustrations and challenges that emerge provide insights into the ways in which these teachers think about teaching for scientific literacy, how this thinking shapes their pedagogical purpose and in turn the type of learning experiences provided for students. These teachers' experiences of teaching for scientific literacy contribute to deeper understandings of the complexities and everyday challenges of an approach to science education that not only responds to individual learning needs and specific teaching contexts, but also, at building a connectedness between the student and their world.

S1.5.3 Elementary Teachers' Strategies for Teaching Science and Supporting Language Development in Urban Elementary Schools

Karen H. Adamson, University of Miami, k.adamson1@umiami.edu

Alexandra O. Santau, Duquesne University

ABSTRACT: This paper examines elementary teachers' strategies for teaching science and for incorporating language development into science instruction. The data draws from a larger research project that is aimed at improving science and literacy achievement of ELLs in urban elementary schools within an environment increasingly driven by high-stakes testing and accountability. Teacher interviews served as the primary data source to identify third, fourth and fifth grade teachers' strategies for teaching science and incorporating language development and literacy into science instruction. Teachers' responses provide valuable insights into our ongoing intervention efforts and may have implications for others involved in educational research.

Strand 4: Science Teaching--Middle and High School (Grades 5-12): Characteristics and Strategies S1.6 SC-Paper Set: Barriers to Inquiry-Based Science Teaching

8:30am – 10:00am, Conference Room 404

S1.6.1 Resident Scientists' Inquiry Instructional Practice and their Perceived Benefits and Difficulties of Inquiry in Schools

Frackson Mumba, Southern Illinois University, frackson@siu.edu

William F. Mejia, Southern Illinois University Carbondale

Vivien M. Chabalengula, Southern Illinois University

Erin Wilson-Miles, Southern Illinois University

William Hunter, Illinois State University

ABSTRACT: The purpose of this study was to determine the nature of the laboratory activities undertaken by Resident Scientists in schools through a science education outreach project. This study also attempted to determine Resident Scientists' perceived benefits and difficulties of students doing inquiry science activities in schools. A sample comprised eight Resident Scientists at a medium-sized University. Resident Scientists were serving in a University- School partnership project funded by a government agency. Resident Scientists were training to be scientists and not to be certified as teachers. Data was collected through a questionnaire. Results show that the reported laboratory activities were at guided and verification inquiry levels and nothing at structured and open inquiry levels. Resident Scientists also recognized the important role of inquiry, benefits and difficulties for implementing inquiry in schools represent barriers for open inquiry in science classrooms. These findings have implications for science learning, teaching and teacher education.

S1.6.2 The Lack of Separation between Research Questions and Methods in High School Lab Manuals and Its Effects on Teachers' Understanding of the Practice of Science

Eilat Hasson, Weizmann Institute of Science, eilat.hasson@weizmann.ac.il

Michal Ben-Nun, Weizmann Institute of Science

Anat Yarden, Weizmann Institute of Science

ABSTRACT: Recent science standards emphasize the importance of helping students learn to engage in authentic scientific inquiry which is suggested to promote psychomotoric and intellectual skills, meaningful learning, conceptual understanding, and deeper insight into the nature of science. However, differences exist between laboratory manuals used by scientists and school laboratory manuals- while the former describe methods that can be used in various ways to answer different research questions, we here show that in the latter the methods used are described intermixed with the aim of the laboratory, with no separation between them. Next, we discuss the influence of this lack of separation between questions and methods on the practice of science in schools. Finally, we report results of a survey of in- service biology teachers aimed at probing these influences. The results show that teachers had difficulties in separating between research questions and methods as well as difficulties in derived tasks. We believe that the remedy to this problem is two faceted: task developers should take more care in differentiating between questions and methods, and teachers' professional development courses should introduce teachers to this aspect of science

S1.6.4 Korean Secondary Science Teachers' Views on Barriers in Implementing Inquiry-Based Instructions

HyunJu Park, Chosun University, hjapark@chosun.ac.kr Yoonbong Park, Chungnam National University

Jeong-Min Hong, Boseoung High School Bo-Ram Hyun, Incheon Science High School Yun-Mi Lee, Jeonnam High School Ki-Rak Park, Jeonnam Girl's High School Hongseok Kim, Dobong High School Eunmi Park, Seokkwan High School

ABSTRACT: The purpose of this study was to investigate secondary science teachers' views on barriers in implementing inquirybased instructions. For this, semi-structured in-depth interviews were performed with 16 secondary science teachers who have served for more than five years in Southern part of Korea. The data of teachers' views on barriers were categorized into external and internal factors of teachers. The study found that the external factors referred by teachers included the following: lab safety and unexpected accidents, the shortage of a unit time, lack of materials and equipments, number of students in a class, too much content to cover in a certain period for curriculum, and difficulty in the assessment of students' inquiry activities. Internal factors included the following: lack of self-confidence for student's learning through inquiry-based instructions, and lack of preparation for inquiry activities, lack of patience for students' activities and movements. The various barriers presented and their causes were analyzed in detail, and possible efforts in activating inquiry activities in secondary science education were suggested.

Strand 5: College Science Teaching and Learning (Grades 13-20) S1.7 SC-Paper Set: Explanation and Reasoning in Undergraduate Chemistry and Physics

8:30am - 10:00am, Conference Room 405

S1.7.1 Exploring Dominant Types of Explanations Built by General Chemistry Students

Vicente Talanquer, University of Arizona, vicente@u.arizona.edu

ABSTRACT: The central goal of our study was to explore the nature of the explanations generated by science and engineering majors with basic training in chemistry to account for the colligative properties of solutions. Explanations were collected in written form using two different quizzes that students completed under time constraints at the end of a two-semester general chemistry course. Our study revealed that students' ability to generate causal/mechanical explanations depended on the nature of the task. In general, students were more inclined or able to generate mechanistic explanations to account for the new properties of solutions (boiling-point elevation, freezing-point depression) than to make sense of a new process (osmotic flow). The analysis of the types of causal explanations built by the study participants suggests that students may be biased towards some causal models or explanatory modes characterised as causal-additive and causal-static in our work. A large proportion of the students built non-causal teleological explanations to account for osmotic flow. None of the participants in our study used a dynamic model of matter as the basis for their explanations of any of the relevant phenomena.

S1.7.2 Uncovering the Processes by Which Students Form Links between Multiple Modes of Representation In Chemistry

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

Mathew Lockett, Western Washington University

ABSTRACT: It is well established that students have difficulty learning chemistry for deep understanding and relegate chemistry knowledge to rote processes and memorized facts. This may be due in part to the fact that deep understanding of chemistry phenomena requires the simultaneous representation of those phenomena on three levels: macroscopic, submicroscopic and symbolic. Here we describe the use of a conceptual chemistry questionnaire paired with concept maps in order to better understand how students make connections between these three types of understanding. Responses to conceptual chemistry questions about the law of conservation of matter were disaggregated according to the level(s) of representation they targeted. Our data suggest students in a traditionally- taught general chemistry course were reasonably comfortable with the concept of conservation of matter at the macroscopic level alone but had increased difficulty with questions that required understanding with respect to more than one component of the chemistry triplet. Concept maps from students enrolled in general chemistry courses will be used to triangulate these data, and will provide evidence to help us understand students' link- making processes and the factors that influence them. This information can be used to inform instructional innovations across a broad range of chemistry curricula.

S1.7.3 Investigating Change and Consistency in Introductory College Students' Understanding about Pulleys

Amy Rouinfar, Florida State University

Jacquelyn J. Chini, Kansas State University

Adrian Carmichael, Kansas State University

Sadhana Puntambekar, University of Wisconsin - Madison

N. Sanjay Rebello, Kansas State University

ABSTRACT: In this study we investigate how introductory college students' conceptions change after completing physical and virtual experiments focused on learning about the concepts underlying pulleys. Students were asked to take a pre- and post-test before and after completion of activities. We also investigated the effect of context on student reasoning. Twelve individual, semi-structured interviews were conducted in which the students were asked questions similar to those on the test, but different in terms of context.

While there was overall improvement in test scores, some questions exhibited a decline in the number of correct responses. Through our semi-structured interviews we further investigated students reasoning on these questions. Our results showed that after completing an experiment, students often refer back to that experience when reasoning. The reasoning resources that are activated during the learning experience can at times lead students to incorrect responses that suspend physical intuition resulting in degraded performance on the post-test on these questions.

Strand 6: Science Learning in Informal Contexts S1.8 SC-Paper Set: Investigating the Informal-Formal Boundary

8:30am – 10:00am, Conference Room 406

S1.8.1 In What Ways Do Informal –Formal Science Partnerships For Teacher Development Play A Role In Induction, And Retention Of Urban Science Teachers?

 $Jennifer\ Adams,\ Brooklyn\ College-CUNY,\ Jadams@brooklyn.cuny.edu$

Maritza Macdonald, The American Museum of Natural History

ABSTRACT: This study examines the potential role of ISI/formal education partnerships in urban science teacher mentoring and retention. The participants in this study are a group of teachers who participated in a 2005-6 museum- based ISI/university partnership for Earth and Space science teacher preparation and continued a relationship with the museum over five years in a science education leadership role within the museum. We learned that various aspects of teachers' connection with the museum positively contributed to their level job satisfaction. As job satisfaction is an indicator of retention, this could have important implications in ISI partnerships for teacher education and retention

S1.8.2 Bridging Learning in Informal Environments and School Contexts: The Nature Learning Camp as Boundary Object

Yew-Jin Lee, National Institute of Education, Singapore, yewjin.lee@nie.edu.sg

Jennifer Yeo, National Institute of Education, Singapore

ABSTRACT: Informal learning environments (ILE) or free-choice settings are said to be characterized by many desirable features whereas formal institutional settings such as schools are said to foster literacy at the expense of learner agency and expansive learning. However, efforts to bridge the gulf between these settings to enhance science learning have not experienced much success to date. We thus propose a new means of rapprochement between ILE and conventional schooling using the notion of hybrid or boundary objects in third-generation cultural-historical activity theory as descriptor and guiding heuristic. We exemplify these claims with data from an environmental program (The Nature Learning Camp) for elementary school students in Singapore since 2007. Through this experimental curriculum that respects the distinctive strengths and motives of formal and informal activity systems without denying their many differences, we show how it is possible to partly reconcile them and bring features of informal science learning into classrooms. Our research findings has important implications for improving science education given the reported benefits of ILE and how many children are merely "doing" school.

S1.8.3 Capturing Learning across Formal and Informal Contexts

Timothy D. Zimmerman, Rutgers University, timothy.zimmerman@gse.rutgers.edu

ABSTRACT: School visits to museums are considered 'good, enriching, educational activit[ies]' (NRC, 1996). Although researchers have investigated visits from multiple perspectives, evidence of students making school-museum connections is limited. Most research on field trips focuses on learning affordances of the setting, teacher components or learning during the field trip. A few studies focused on pre-field trip activities or on post-field trip activities. Even fewer sought to connect pre-, field trip, and post- components. This paper presentation reports on research that sought to capture evidence of student leaning across all three components, or what we call: Learning Across Contexts (LAC). Building on existing research approaches in formal and informal science learning, and following the 3-Phase formal-informal curriculum integration methodology described by Author (2005; 2009), we combined a Webbased Inquiry Science Environment classroom curriculum, with mobile computing devices during an aquarium visit to study LAC. Evidence of LAC included capturing and coding studentsi_c/₂ conversations, reflections, and class work. Results indicate students utilize classroom and aquarium science learning resources to make sense of science phenomena. LAC research will lead to improved pedagogical strategies for conducting more effective school field trips, hopefully improving science education overall.

S1.8.4 Construction of Science Discourse in an Extracurricular Science and Technology Project

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Anton Puvirajah, Georgia State University

Geeta Verma, Georgia State University

ABSTRACT: Doing and learning science are social activities that require certain language, activities, and values. Both constitute what Gee (2005) calls Discourses. The language of learning science varies with the learning context (Lemke, 2001,1990). This study focused on 12 high school students from two suburban high schools, their three faculty mentors, and two engineering mentors during an extracurricular robotics activity with FIRST Robotics Competition (FRC). FRC employed student-centered inquiry focus to teach science principles integrating technology. Using Critical Discourse Analysis (CDA), the study examined participants' language

during robotic activities to determine how language used in learning science shaped the learning and vice versa. Data sources included video-recordings of participant language and semi-structured interviews with study participants. Transcribed recordings were coded initially using Gee's (2005) linguistic Building Tasks as a priori codes. Findings indicated that, for the students, FRC facilitated elements of Science Discourse. Wild About Robotics (W.A.R.) team became, through FRC, part of a community similar to scientists' community that promoted knowledge and sound practices, disseminated information, supported research and development and encouraged interaction of its members.

Strand 7: Pre-service Science Teacher Education

S1.9 SC-Paper Set: Methods for Promoting Reflective Practice in Pre-Service Teacher Education 8:30am – 10:00am, Conference Room 407

S1.9.1 Pre-Service Teacher Learning From Online, Videocase-Based Modules: Results from the Videocases for Science Teaching Analysis (ViSTA) Study

Kathleen Roth, BSCS, kroth@bscs.org Karen B. Givvin, UCLA Catherine Chen Meike Lemmens Helen Garnier. UCLA

ABSTRACT: What is effective in helping pre-service teachers begin the process of learning to teach science? What and how should they learn about the science content, pedagogical science content knowledge, and the knowledge about student thinking and learning that will enable them to start their teaching careers with both the disposition and the strategies to teach science effectively? The Videocases for Science Teaching Analysis (ViSTA) project is attempting to answer these questions by developing and studying the impact of online, videocase-based modules designed as tools to support teacher education courses. This paper presents results from the ViSTA study on pre-service teacher learning. Thirty-nine university instructors (30 experimental and 9 control) and their students participated in the study. Findings indicate that participation in the ViSTA program positively and significantly predicted science content knowledge learning. It also positively and significantly predicted pre-service teachers' ability to analyze videotaped classroom lessons in terms content knowledge, student thinking strategies, and the science content storyline. The ViSTA project serves as an example of how research can be used to develop and test the effectiveness of science teacher education curriculum materials to improve the science instruction delivered to pre-service teachers.

S1.9.2 Lesson Study with Preservice Elementary Teachers: Perceptions on the Role of Peer Feedback in Supporting Reflective Practice

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Valarie L. Akerson, Indiana University, Bloomington

Meredith A. Park Rogers, Indiana University, Bloomington

Khemmawadee Pongsanon, Indiana University, Bloomington

ABSTRACT: The following study investigated preservice teachers' perceptions and considerations of feedback they received from their peers during their science teaching field experience. Peer feedback was provided via lesson observations and lesson study sessions. In traditional lesson study, the lesson is planned by a group of teachers, implemented by one lead teacher while the others observe, and then afterward discussed by the lesson study group (Lewis & Tsuchida,1998). For the PST field experience, the lesson study format focused on improvement and revisions of the lesson. In this study, peer observations forms were analyzed for types of feedback, and compared to lesson revisions and reflections of the PST that lead the lesson. Results indicated that PSTs modified their lesson student reasoning in their lesson plan revisions and reflections. It appeared that the PSTs were more focused on reflecting about their execution of the lesson (i.e., teacher-centered reflection and pedagogy focused) rather than on the outcomes of the lesson for student learning (i.e., student-centered reflection and PCK focused).

S1.9.3 Using Observation Prompts in the Elementary Field Placement

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ABSTRACT: Abstract A key goal in teacher education is to provide meaningful opportunities for preservice teachers to gain professional knowledge and teaching experience prior to entering classrooms as teachers. Nonetheless, how preservice teachers get this experience, where they get this experience, and what they get during this experience implies a challenge for field placements in schools. Yet, there is an unspoken connection that needs to be made regarding field placement experiences—the connection to issues of diversity, culture and science in field placements in urban schools. Additionally, many teacher candidates enter science education courses believing they already know how to teach, or that diversity issues are irrelevant to teaching and learning science. At the level of teacher education programs where change is often advocated, many science educators have only one or two courses within the total teacher education program to effect change in the ways preservice teachers teach diverse students, or view and teach science. Therefore, the purpose of this study was to describe how weekly observation prompts and journaling were used to assist preservice

teachers in gaining valuable knowledge about urban schools, urban youth, and science teaching; done pre-internship and set within a semester long elementary science methods course.

S1.9.4 Reflection in Teacher Education: Exploring Preservice Science Teachers' Understanding and Implementation of Inquiry

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Gillian Roehrig, University of Minnesota

Barb Billington, University of Minnesota

ABSTRACT: The current science education reforms ask teachers to implement inquiry in their teaching. Teachers' level and type of inquiry-based practices are closely connected to their understanding of inquiry. Thus, teachers in their pre-service teacher education programs should explore their conceptions and understanding of inquiry. This study examined the change and development in nineteen pre-service teachers' learning and practices of inquiry over the 16-week long graduate level secondary science methods course at a public university in the midwest U.S. In the methods course, teachers participated in several inquiry projects, read articles about inquiry, and learned how to turn cookbook labs into inquiry. They reflected on their learning and inquiry practices on their blogs on the Moodle course site and also completed a video reflection of their own instruction. Each teacher prepared and implemented a unit plan that included inquiry lessons. Classroom observations were conducted to observe teachers' practices. This study advocates that reflection should be a part of pre-service teacher education and more guidance should be provided for pre- service teachers in facilitating effective and structured discussions at the end of their inquiry lessons.

Strand 8: In-service Science Teacher Education S1.10 SC-Paper Set: Science Teacher Communities

8:30am – 10:00am, Conference Room 408

S1.10.1 Examining Topic-Specific Professional Development in a Science Teacher Induction Program

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Jodie A. Galosy, University of California at Davis

Jamie N. Mikeska, Michigan State University

Katie R. Green, Michigan State University

Suzanne M. Wilson, Michigan State University

ABSTRACT: This study examines a science museum's two-year induction program for the impact of topic-specific professional development on new science teachers' confidence, knowledge, and practice around those same topics. Teachers in the induction program receive a variety of support (e.g. mentoring, workshops, coaching, resources); some of that support is topic-specific and some is not. In turn, each teacher crafts, in conjunction with the program, a different path through the program. This study capitalizes on the program's variation among participating teachers by looking at its components' relative merits (in this case, its topic-specific aspects) against one another. Our results suggest that topic-specific help has a relationship with new teachers' improving confidence and content knowledge for that topic, but only in the first year of the program. When it comes to those aspects more closely tied to practice (PCK, alignment with standards, and "active learning"), topic-specific help shows no relative merit over the non-topic specific help teachers receive. We discuss implication of those results, including methodological considerations when using "natural experiments" such as this.

S1.10.2 Science Teachers as Reform Leaders in their Community

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Ayelet Egosi, Haifa University

Lily Orland-Barak, Haifa University

ABSTRACT: Science teachers, as well as teachers in other fields, often feel frustrated as if they were facing "mission impossible": Science teachers need to juggle between the system expectations to cover all the curriculum standards, the intentions to have all students understand and develop thinking skills, and the varied abilities and background of students in heterogeneous classes. As a result of this frustration, teachers may lose motivation in their work. As science educators, our task is to find ways to make the mission possible for teachers, not by "telling them" but by working in cooperation with them as valuable partners, in a way that research informs practice and practice informs research. In this study, we investigate a model for working with science teachers as part of a larger multidisciplinary group of teachers in one city, in order to develop a team of reform leaders, who seek excellence in teaching and learning. We hope to develop intrinsic motivation resulting from teachers' sense of ownership and belonging to the community of the school as well as the community of the city.

S1.10.3 Teachers and Researchers Learning in Communities: Enhancing Praxis in STSE Education

Erminia G. Pedretti, OISE, University of Toronto, epedretti@oise.utoronto.ca Katherine Bellomo, University of Toronto

ABSTRACT: This naturalistic case study is set in the context of elementary schools in a large district school board, implementing a new science and technology curriculum. Faced with the challenge of implementing new curricula that emphasizes STSE education, a professional learning community (PLC) was established. This one-year PLC involved a district/ university collaboration that engaged nineteen elementary teachers, five outdoor education teachers, three board personnel, and two university researchers. Our research sought to: explore how teachers, outdoor education staff, and education researchers can work together, through PLCs, to address theoretical and practical challenges to teaching STSE; and to understand the nature of university/school board collaborations. Our findings suggest that participation in the PLC enhanced teacher confidence and connections to the outdoors. However taking action and politicization in the context of science education, were viewed as risky and problematic. With respect to the nature of PLCs, our research suggests that diverse membership, support, passion, and providing theoretical apparatus for participants are important features. However, a number of issues emerged that also serve to problematize PLCs: competing agendas and philosophies (i.e., different orientations to STSE) that require careful negotiation, and sustaining the community beyond its formal project life.

S1.10.4 Membership to a Teacher Professional Learning Community: A Stimulus for Teacher Movement from Central to Periphery

Viola Manokore, Michigan State University, manokor1@msu.edu

Gail Richmond, Michigan State University

ABSTRACT: This case study analyses how an elementary school science teacher (Kay) uses questioning to scaffold students' thinking during a science lesson. Kay was a member of a science teacher's professional learning community (PLC) that was set up to help teachers develop reform-based science teaching. This case study focuses on the role that questioning plays in facilitating inquiry and does so by analyzing Kay's questioning during a focus lesson in his first, second and third years of participating in the PLC. The analysis shows that Kay's questioning moved from more simple recall type of questioning to question that scaffold students to higher levels of cognitive processes.

Strand 9: Reflective Practice S1.11 SC-Paper Set: Informing Practice 8:30am – 10:00am, Conference Room 409

S1.11.1 What Does It Mean To Be Reflective Science Teacher Educators? What/How Can We Learn About Our Practice? Deborah J. Trumbull, Cornell University, djt2@cornell.edu

Kimberly G. Fluet, University of Rochester

ABSTRACT: The process of becoming a science teacher educator is a wonderful, and challenging, and perhaps never-ending journey. In this manuscript, we describe how our knowledge of our own practices has developed through detailed analyses of the written work of our preservice teachers. We outline our initial findings and the ways we used the literature to deepen these analyses. We then discuss how our analyses link to the wider literature in teacher education, and draw out implications for our work as science teacher educators. We sketch out ways in which we could intervene earlier to support the development of reflective science teachers, and how we can support our own development as reflective science teacher educators.

S1.11.2 Expanding the Action Research Process to Facilitate Transformation in the Teaching of Science

Kimberly A. Lebak, The Richard Stockton College of New Jersey, Kimberly.Lebak@stockton.edu

Ron Tinsley, The Richard Stockton College of New Jersey

ABSTRACT: This proposal seeks to report upon the implementation of a new professional learning model that empowers teachers to transform into reflective, self-directed practitioner researchers by incorporating expanded opportunities for collaboration, self-reflection, and consultation with current professional resources. The transformative learning experiences of a 5th grade science teacher, participating as a member of a diverse group of five teachers engaged in a 15 week inquiry process is highlighted. Case study methodology is utilized to provide an in- depth description of the transformative processes through which the teacher challenges her own science teaching and ultimately changes her pedagogical approach. The on-going collaboration and self reflection built into the new professional learning model described in this proposal offer promising opportunities for teachers to develop as science practitioners able to implement pedagogical approaches leading to inquiry-based, student-centered learning.

S1.11.3 A Teacher Inquiry Project: Teachers' Practices of Classroom Inquiry Informing Research on Teacher Knowledge and Learning

Youngjin Song, University of Northern Colorado, youngjin.song@unco.edu

Steve Oliver, University of Georgia

ABSTRACT: The study investigated the way chemistry teachers developed their professional knowledge for teaching science in line with gained understanding of students' learning when they joined the teacher inquiry project by using Video Analysis Tool (VAT). Three chemistry teachers chose the focus of their classroom inquiry at the beginning of the study. In order to investigate their knowledge growth, a qualitative case study approach was employed. Multiple sources of data from multiple methods of data collection such as videos, classroom observations, in-depth interviews, and documents were used. Data analysis was carried out in two phases—

analysis of video data on VAT and inductive analysis of the interview data and document data. The findings suggest that through the teacher inquiry project chemistry teachers (1) expanded teaching repertories for a given concept, (2) created new ways of implementing the lessons, (3) revisited, broadened, and deepened their science content knowledge, and (4) camp with modification of teaching practice. The study suggests considering 'the epistemology of practitioner research' (Zeichner & Noffke, 2001, p. 304) in the science education community.

Strand 10: Curriculum, Evaluation, and Assessment

S1.12 SC-Paper Set: Science Curriculum, Instruction and Assessment: Perspectives of Students 8:30am – 10:00am, Conference Room 410

S1.12.1 Conceptions of Science Assessment among Tenth Graders in Taiwan: A Phenomenographic Study

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Chin-Chung Tsai, National Taiwan University of Science and Technology

ABSTRACT: Research into student learning has emphasized that students' conceptions of assessment have a potential impact on their quality of learning. However, in the area of science education research, high school students' conceptions of science assessment have not been well investigated. This study aims to explore the conceptions of science assessment among tenth graders in Taiwan where examination-oriented culture is remained. Research data were collected through individual interviews with 60 tenth graders in Taiwan. The interview data were analyzed by using a phenomenographic method, and six qualitatively different categories of conceptions of science assessment were identified, that is, science assessment as "reproducing knowledge," "rehearsing," "revealing the learning status," "improving learning," "applying," and "the justification of knowledge." The "rehearsing" conception may have been shaped by the educational climate in Taiwan which has stressed the high-stakes examinations and the widely used "supplementary trade books." Moreover, many of the students held less mature conceptions of science assessment as "revealing the learning status," "rehearsing," and "reproducing," implying that they tended to perceive science assessment as recalling and revealing the accumulative amount of scientific knowledge. This finding suggested that the students conceptualized science assessment more oriented to "prove" learning, rather than to "improve" learning.

S1.12.2 What Do Students Know about Engineering and Technology? Effects of a Design Unit

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Brandon J. Orszulak, Museum of Science, Boston

Alexandra Stein, Museum of Science, Boston

Lily Zhang, Museum of Science, Boston

Christine M. Cunningham, Museum of Science, Boston

ABSTRACT: Findings are presented from a research program conducted by a curriculum development project. Elementary school students participating in testing of the project's curriculum materials were given pre-assessments and post-assessments that included questions about general engineering and technology concepts. Analysis of the data reveals that most students have a limited understanding about engineering and technology. Their naïve conceptions include the ideas that technology is only modern things, or things that are powered by electricity; and the idea that engineers work with engines or fix technology. Findings are consistent with earlier studies of middle-school students (Bame et. al. 1993) and students from Greece (Solomonidou & Tassios, 2007). This study takes the work a step further in coding the data into construct maps, representing levels of sophistication, which were used to score the assessments. Post-assessments indicate that students have a more sophisticated understanding of these concepts after exposure to the project's curriculum materials.

S1.12.3 Improving Students' Attitudes toward Science: A Case Study of one High School Defying the Odds

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Mary Oliver, University of Western Australia

Nancy Longnecker, University of Western Australia

Leonie Rennie, Curtin University of Technology

ABSTRACT: The purpose of this case study was to explore high school students' attitudes toward science subjects including biology, chemistry, human biology, and physics, at point of choice. In particular, the research focused on whether the students wanted to study these science subjects or not and the reasons behind their intentions. The case study was conducted in one suburban high school from a middle class community. Data collection included a two-tiered survey of 174 Grade 10 students, focus group interviews with ten students, and interviews with three science teachers. The survey generated descriptive and explanatory data and the focus group interviews were semi-structured. The results show that the students had relatively positive attitudes towards science compared with other research and state indicators. The major reason students wanted to study a particular science subject was because they were interested in the subject matter and because they felt they would achieve well in that subject. Less important was whether they wanted to be taught by a particular teacher and their parents' opinions. The findings are important as developed nations face a crisis in science

education with poor student attitudes toward science and falling proportional enrolments, particularly in the enabling sciences of physics and chemistry.

S1.12.4 Science Performance of English Language Learners: Findings from 1996, 2000, 2005 Science NAEP Assessments Jerome M. Shaw, University of California, Santa Cruz, jmlshaw@ucsc.edu

ABSTRACT: This paper presents important new findings on the achievement of English Language Learners (ELLs) in science at the national level. Overall performance trends at grades 4, 8, and 12 across three administrations of Science NAEP (1996, 2000, 2005) show a narrowing of achievement gaps between ELLs and Non-ELLs, with the reductions at grades 4 and 8 attaining statistical significance. Analyses comparing the two groups across item traits (e.g., multiple-choice versus constructed response) and using differential item functioning (DIF) showed that ELLs had greater difficulty with multiple choice and paper-and-pencil items. Conversely, there was a distinct lack of DIF-identified problems for hands-on tasks. Further research should include examining item linguistic complexity and analyses of think-aloud protocols with students.

Strand 11: Cultural, Social, and Gender Issues

S1.13 SC-Paper Set: Gender and Retention in Science: Schooling Effects and Career Trajectories 8:30am – 10:00am, Conference Room 411

S1.13.1 Gender Differences in the Timeline of Career Events for Physical Scientists

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Zahra Hazari, Clemson University

Robert H. Tai, University of Virginia

ABSTRACT: The progression from early interest in science to the completion of a doctorate in the discipline and securing a position in academia or industry is often referred to as the pipeline of science. What has been a topic of intense focus over the last several years and continues to be a current area of interest, is the leaking of talented individuals from this pipeline to other disciplines. In particular, the decision of many females to either not enter the field of science or leave before reaching the end of the pipeline has further fueled interests in factors contributing to the leaky pipeline. Although research has looked at many of these factors, the characteristics of those that persist in the discipline are relatively unstudied. This study explores the relationship between gender and the timeline and sequence of events associated with the graduate school component of the pipeline for physical scientists. Results suggest that gender does not play a role in tangible events (i.e., first publications, grant-funding, and career plans) but does play a significant role in terms of confidence and feelings of independence.

S1.13.2 Exploring the Relationship between Self-efficacy and Retention of Students, both Men and Women, in Introductory Physics

Vashti Sawtelle, Florida International University, davisvas@gmail.com

Eric Brewe, Florida International University

Laird Kramer, Florida International University

ABSTRACT: The quantitative results of Sources of Self-Efficacy in Science Courses (SOSESC) in physics will be presented as a comparison between students who pass and those who fail Introductory Physics 1, overall as well as disaggregated by gender. Self-efficacy as a theory to explain human behavior change has recently become a focus of education researchers. Amy Zeldin [1,2], et al found evidence that indicates men and women draw on different sources for evaluation of their self-efficacy in science fields. At Florida International University we have examined the self-efficacy of students in the introductory physics classes from the perspective of gender theory. The data from this research support the literature for both genders. Women who pass have a higher self-efficacy in the Verbal Persuasion source than women who fail. While men who pass have a higher self-efficacy in the Mastery Experiences source than those who fail. [1] Zeldin, A. L., & Pajares, F. (2000). American Educational Research Journal, 37(1), 215. [2] Zeldin, A. L., Britner, S. L., & Pajares, F. (2008). Journal of Research in Science Teaching, 45(9), 1036-1058.

S1.13.3 Examining the Relationship between Single-Sex Experiences in High School Science and Science Career Choice Zahra Hazari, Clemson University, zahra@clemson.edu

Philip M. Sadler, Science Education Department Harvard Smithsonian Center for Astrophysics Cambridge, Massachusetts Gerhard Sonnert, Harvard

ABSTRACT: This study explores how single-sex experiences across the nation affect science and engineering career choices. The data is drawn from the Persistence Research in Science & Engineering (PRiSE) project, which surveyed college English students nationally about their backgrounds, high school science experiences, and science attitudes. In addition to highlighting beliefs about single-sex science experiences from free-response questionnaires of 412 teachers and scientists, this study uses multiple regression to examine how single-sex experiences influence the likelihood of choosing a career in life science, physical science, and engineering for 7505 students from 40 US colleges and universities. The results indicate that despite the fact that many teachers and scientists continue to see single-sex classrooms as a viable solution for remedying representation issues, single-sex classes as they are currently being implemented across the nation have no overall effect on science and engineering career choices. However, gender quorums

seem to have a positive effect for each of the genders in the fields that are typically associated with that gender. Thus, having mostly same-sex biology classes was positive for females' choice of life science. Similarly, having mostly same-sex physics classes was positive for males' choice of physical science and engineering.

S1.13.4 Exploring the Experiences of Female Graduate Students in the Physical Sciences: A Comparative Study

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Erin Bauknight, Clemson University

Kimberly Cellucci, Clemson University

Robert H. Tai, University of Virginia

ABSTRACT: In this paper, the experiences of female graduate students in physics and chemistry are compared to their male counterparts. The data used in this analysis includes survey responses from 692 currently-enrolled graduate students (34% female). Areas of difference include: timing of first interest in science, sources of initial science interests (including the influence of a parent or mentor and school science lessons), and motivation for entering graduate school. In addition, female students are significantly more likely to report that their dissertation advisors are female and that their advisor's gender was a consideration when deciding to work with them, suggesting that some female students deliberately seek a mentoring experience from another female scientist. The results on the impact of school science lessons and encouragement by a parent/mentor are promising: they suggest that parents and K-12 educators have a genuine opportunity to improve the chances of female students choosing physical sciences as a career.

Strand 12: Educational Technology

S1.14 SC-Paper Set: Examining the Impact of Multimedia on Science Teaching and Learning 8:30am – 10:00am, Conference Room 412

S1.14.1 How does Multimedia Integrated within a Planetary Science Course Help Students with Difficult Material?

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ABSTRACT: In this study, multimedia that is integrated within a middle school science planetary science curriculum was evaluated. The goal of the project was to examine the benefit of using multimedia for difficult material within a science curriculum and its impact on student learning and interest. In addition, getting feedback that then can be redesigned to help improve it in the next version. The curriculum that was evaluated was Full Option Science System (FOSS), an inquiry-based science curriculum. This study was part of a larger evaluation with 10 middle school teachers piloting the course. Data from the larger evaluation and from a classroom using observations and think-alouds with students were utilized in this study. Think-alouds were conducted with two animations: Phases of the Moon and Jupiter's Moons. As a result, students had a better understanding of the concepts and felt the multimedia made them more interested in learning about Planetary Science. The students also gave feedback that presently is being examined by curriculum developers and media specialists. By making these changes, the goal is to improve the animations quality. In future studies, we can examine the impact that a richer multimedia has on enhancing students' learning experiences, interest, and science skills.

S1.14.2 Animated Movies in Science Education: Their Affect on Elementary School Students' Motivation To Learn Science and Achievements

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Tamar Ashkar, Technion - Israel Institute of Technology

Yehudit Judy Dori, Technion - Israel Institute of Technology

ABSTRACT: Studies that investigated the use of animated movies in the classroom found that it improves students' learning process. However, some researchers claim that animations carry potential for misconceptions. In an attempt to resolve this conflict, our study investigated the effect of animated movies on students' motivation to learn science and their understanding of scientific concepts. Employing the experimental design methodology, we divided the population (grade five students) into experimental (N=126) and control (N=62) groups, in which the teaching/learning method (the integration of animated movies) was the independent variable. Findings show that the experimental group students indicated higher motivation to study science in the post-questionnaires compared to their peers in the control group. Findings also indicated that animated movies, used in our study, improved some aspects of motivation, but not students' self-efficacy. Self-efficacy, such as students' belief in their ability to learn science should be better emphasized when developing the animated movies and the web-based learning activities. Findings also indicated that in their prequestionnaire, all students had difficulties in understanding scientific concepts and phenomena; however, experimental group students improved their understanding significantly compared to their peers in the control group.

S1.14.3 Integrating Virtual Laboratories with Hands-on Inquiry: The Roles of Perceptual Supports for Learning

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ABSTRACT: Novel domains of science such as Biotechnology and Nanotechnology transcend people's lives at multiple levels from everyday news to medical application. This paper reports on an effort to establish a blended inquiry-learning environment based on research on learning in a novel domain. The study employed two learning environments for inquiry into DNA gel electrophoresis (a common technique in biotechnology laboratories). It used a third-party virtual laboratory (VRL) available on the internet and a hands-on laboratory (HOL) that is commonly purchased in the form of a classroom kit and compared their effectiveness at different phases of students' inquiry. The results document the benefit of using perceptually rich virtual laboratories over hands on laboratories as a start for inquiry learning. The visual characteristics of the selected VRL were superior to the HOL in supporting students to experimental design, data evaluation and reasoning tasks. These results informed our ongoing effort to refine this instructional methodology for college level introductory biology classrooms.

S1.14.4 Science Process Skills through Interactive Software in Middle School Chilean Learners

Ruby Olivares, University of Chile, rolivares@c5.cl

Jaime Sanchez, University of Chile

ABSTRACT: The purpose of this research was to study the effect of the use of educational simulation software on the development of science process skills in 6th and 7th grade students. We worked with eight sections in two different schools, assisted by two different teachers. A quasi-experimental research design was used. The experimental group had classes with the educational software and accompanying written materials, while the control group had traditional classes and standard written materials. In order to measure the students' science process skills, a test using the Biology Test of Science Processes (BTSP) instrument as a base was created, which was applied as both a pre-test and a post-test to the control and experimental groups, calculating gain scores. The software usability was also evaluated by end-users through the use of end-user questionnaires. The data was analyzed by running MANCOVA, ANCOVA, ANOVA and Student's t test for independent samples. Although no statistically significant differences were found between gain scores for either the control or experimental groups, the results obtained from the usability evaluation indicate that the software was highly accepted by the students and pleasurable.

Strand 13: History, Philosophy, and Sociology of Science

S1.15 SC-Paper Set: Biology, Evolution, and Nature of Science

8:30am – 10:00am, Conference Room 413

S1.15.1 College Students' use of Science Content during Socioscientific Issues Negotiation: Evolution as a Prevailing Concept

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

Dana L. Zeidler, University of South Florida

ABSTRACT: The purpose of this study was to explore college students' use of evolution-related science content during the negotiation of socioscientific issues (SSI).Content used to negotiate three SSI scenarios was analyzed for sixty college biology majors and non-majors. There were five themes directly related to evolution: variation in a population, inheritance of traits, differential success, change in a population over time, and misconceptions about evolution. Non-evolution science content was not as prevalent and fell into a sixth theme of miscellany science content. Each of the six themes occurred in all three SSI scenarios; however, the way they were utilized varied by scenario. Results from this study provide science educators with an inventory of science content used during the negotiation of three types of SSI scenarios. Implications for research and practice are discussed.

S1.15.2 Influence of the Nature of Science Instruction on the Learning of Evolution: A Qualitative Study

Wilbert Butler, Tallahassee Community College, butlerw@tcc.fl.edu

Sherry A. Southerland, Florida State University

ABSTRACT: In the past decade, there has been a growing emphasis on the teaching and learning of biological evolution. However, the state of public understanding of evolution remains woefully lacking. The purpose of this study was to investigate the role an explicit, reflective teaching approach to the nature of science plays in supporting students' learning of evolution. This quasi-experimental study investigated the role an explicit reflective approach to the nature of science plays in supporting students' understanding of evolution. In this study, there were two treatment groups, both introductory biology courses: A) an explicit, reflective NOS group and B) an implicit, traditional NOS approach. In the explicit, reflective NOS class, the aspects of NOS were highlighted throughout the semester and students discussed and wrote about the NOS aspects that they identified in the activities and reading assignments. The implicit NOS class experienced the same activities, discussions, and writing assignments in reference to the evolution lessons but without NOS emphasis. Data were collected qualitatively using the VNOS and weekly writing prompts. Results indicate that student learning of biological evolution was related to change in the understanding of NOS aspects in the explicit, reflective NOS class.

S1.15.3 No Progress: The Rhetoric of Decline in a Regional Creationist Facility

Paul Wendel, Mansfield University, pwendel@mansfield.edu

ABSTRACT: Although "declinist" and "progressive" views of biological development are noticeable before and after publication of The Origin of Species, a progressive view of evolution dominated through much of the 20th century, followed by a more recent

rejection of the progressivist view of evolution among biologists. Creationists, by contrast, have adopted a markedly declinist tone. In a case study of The Fossil Museum (pseudonym), a small regional creationist museum, a declinist ethos is observed in numerous exhibits and oral arguments, including assertions of an overall decline in the virility of life on earth since antediluvian times. Humans are claimed to be physically smaller, less attractive, and less intelligent than in the past. Natural selection is acknowledged as an active natural process, but it is interpreted as a process leading to overall genetic decline rather than advancement. These arguments rely on the broad appeal of declinist rhetoric as well as the popular association of evolution with progress. It is concluded that science educators should encourage the de-coupling of evolution from progress, and suggestions are offered for how to do so.

S1.15.4 Darwin and the Nature of Science: Investigating the Use of Knowledge, Belief, Acceptance, and Understanding in the Origin of Species

Mike U. Smith, Mercer University School of Medicine, smith_mu@mercer.edu

ABSTRACT: Charles Darwin's Origin of Species continues to have a profound impact on discourse in political, philosophical, and educational spheres. These discussions often invoke the constructs of belief, acceptance, knowledge, and understanding. Evolution education research has demonstrated that these constructs can be given different affective and cognitive weights depending on those who employ them and how the constructs are used. In light of discussions distinguishing among these terms, we were interested in Charles Darwin's usage in his seminal text. We conducted a semantic analysis of the first edition of Origin of Species to determine patterns in the use of these and related terms, as well as the support provided and amount of certainty stated or implied. Findings reveal great thoughtfulness in the construction of a very sophisticated argument. Pedagogical implications and congruence with modern notions of the nature of science will be discussed as well.

Strand 14: Environmental Education

S1.16 SC-Paper Set: Urban Environments and Student Learning in Environmental Education

8:30am - 10:00am, Conference Room 414

S1.16.1 Bouncing and Trapping the Sun's Rays: Seventh Grade Students' Mental Models of the Greenhouse Effect

Daniel P. Shepardson, Purdue University, dshep@purdue.edu Soyoung Choi, Purdue University

Dev Niyogi, Purdue University

Umarporn Charusombat, Purdue University

ABSTRACT: The purpose of this study was to investigate seventh grade students' mental models of the greenhouse effect. The study was naturalistic in nature and involved the analysis of 225 student drawings and explanations from three different schools in the Midwest, USA. The data were analyzed for content in an inductive manner to identify students' mental models of the greenhouse effect. Five distinct mental models were identified. Curricular and instructional implications are also explored.

S1.16.2 Exploring Positionality in Urban Children's Sense of Place

Miyoun Lim, Georgia State University, mlim@gsu.edu

ABSTRACT: This study explores what sense of place urban children have and how urban children's sense of place is framed by the context and content of the lived experiences. This study, informed by ethnographic research approaches, is carried out with 8 informants in an urban public middle school that is located in a low-income immigrant neighborhood in New York City. We share a conceptual model which is to describe our students' stories ecologically. Then, to portray students' sense of place in its dynamic and dialectical nature, we frame our analysis and discussion with two conceptual constructs, affordances and positionality. Using this analytic framework, we explored dialectical children-place interactions, which revealed the place-specific (or context- specific) particularities of the ecological relationship.

S1.16.3 Investigating the Implementation of a Land Use Change Curriculum with Urban Middle School Learners

Alec M. Bodzin, Lehigh University, amb4@lehigh.edu

ABSTRACT: This paper reports on the implementation of a 4-week Geospatial Information Technology (GIT)-embedded Land Use Change curriculum designed to assist urban middle school students in understanding land use change concepts and to promote the learning of spatial thinking skills used in remotely-sensed (RS) imagery interpretation. Five 8th grade earth and space science classes in an urban middle school consisting of three different ability level tracks participated in the study. Data gathering methods included pre/posttest assessments, daily classroom observations, daily teacher meetings, and analysis of student produced artifacts. Data results found that the use of a GIT-embedded curriculum improved urban middle school students' understandings of land use change issues that are typically associated with sprawl and development. Content knowledge about environmental issues associated with land use change and spatial skills increased for all learners. In most areas, effect sizes were larger for lower and middle track learners than for upper track learners. The curricular implementation appeared effective for enhancing the spatial skills involved with RS image interpretation to identify objects in images and investigate ground cover features. Learners at all ability levels had difficulty interpreting environmental contexts in time-sequenced images.

Co-Sponsored Session—External Policy and Relations Committee & Strand 15: Policy S1.17 Administrative Symposium: "The Opportunity Equation: Transforming Mathematics and Science Education for Citizenship and the Global Economy": A Moment of Urgency and of Research Opportunity 8:30am – 10:00am, Conference Room 415

Presenters:

Michele Cahill, Urban Education Carnegie Corporation of New York

Sharon J. Lynch, The National Science Foundation

Elizabeth A. Davis, University of Michigan

ABSTRACT: This presentation focuses on Carnegie Corporation of New York/Institute for Advanced Study new report, The Opportunity Equation: Transforming Mathematics and Science Education for Citizenship and the Global Economy. The Opportunity Equation has been endorsed by over 70 major policy, business, and advocacy organizations, from National Governors Association, the National Science Teachers Association, the National Education Association, and the National Council of La Raza, as well as NARST. US Secretary of Education Arne Duncan also supports the Report's recommendations on behalf of President Obama and the US Department of Education. The Opportunity Equation challenges the nation to mobilize for coordinated action to: • Establish common standards for the nation in mathematics and science— standards that are fewer, clearer, and higher—along with high-quality assessments • Improve math and science teaching—and our methods for recruiting and preparing teachers and for managing the nation's teaching talent • Redesign schools and systems to deliver excellent, equitable math and science learning The report calls for sweeping changes in the way that science is taught in US schools and in the way that they are organized with science and mathematics in the central role for a new literacy preparing all students for 21st Century life

Publications and Advisory Committee Sponsored Session S2.1 Administrative Symposium: Publication in the Journal of Research in Science Teaching

10:30 am - 12:00 pm. Conference Room 501

Angela Calabrese Barton, Michigan State University, acb@msu.edu

Joseph S Krajcik, University of Michigan

ABSTRACT: The change of editors often bring new ideas to a journal and trepidation to the community that publishes in that journal. The new JRST co-editors and associate editors will share their philosophy, goals and visions for the Journal of Research in Science Teaching. The editorial team will present their model for how manuscripts are reviewed. Discussion of the publication guidelines that reviewers of the Journal of Research in Science Teaching use when reviewing submitted manuscripts will also be examined and discussed. 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. JRST Editors, Associate Editors, Editorial Board Members, reviewers and JRST Office personnel will be present to share experiences and insights.

Strand 1: Science Learning, Understanding and Conceptual Change

S2.2 SC-Paper Set: Representational Reasoning

10:30am - 12:00pm, Conference Room 401

S2.2.1 Identifying Cognitive Processes as Learners Engage With Multimedia Presentations

Michelle Cook, Clemson University, mcook@clemson.edu

ABSTRACT: The purpose of this study was to apply a method for describing and understanding the cognitive processes of students as they interacted with various multimedia presentations on mitosis. Specific research questions included: (1) What cognitive processes do learners use when viewing and interpreting four different multimedia presentations on mitosis? (2) Do the cognitive processes used differ for high and low prior knowledge learners? and (3) How do split-attention, modality, redundancy, and cueing influence the cognitive processes used?

S2.2.2 Knowledge of Scale Construction for Graphing in Undergraduate Students

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

ABSTRACT: Knowledge of scale construction in undergraduates at a major public research university was assessed. Scale construction is a little-studied component of graphing, an essential scientific practice. Students in an interdisciplinary Big History course took pre- and post-tests asking them to place objects or events along a line so their positions represented their sizes or ages; objects ranged from atom to football field for the size task, and from Big Bang to first moon landing for the time task. Sizes or ages of the objects or events were given. Pre-test data shows that students performed at a low level; only 40% took a logarithmic approach, and a similar percentage assigned intermediate numbers that were independent of the data points given. Only one-third of the students employed equal linear or logarithmic intervals. Post-tests show improved performance; even though the course did not focus on scale construction, lectures included diverse graphs and the course syllabus was organized logarithmically. This study can inform secondary

and university curriculum and instruction by pointing out areas of weakness and strength in scale construction, and builds on a learning progression for size and scale.

S2.2.3 Effectiveness of Scientific Visualizations for Supporting Conceptual Development in High School Physics and Chemistry

David R. Geelan, The University of Queensland, Brisbane, Australia, d.geelan@uq.edu.au

Michelle M. Mukherjee, The University of Queensland, Australia

Brian Martin, The Kings University College, Canada

Peter Mahaffy, The Kings University College, Canada

ABSTRACT: Teachers, scientists and science educators are developing a range of computer-based visualizations - animations, simulations and other dynamic visual media - to support students' science learning. These visualizations are being enthusiastically adopted in science classrooms. While there is considerable qualitative information about their effects on student motivation and enjoyment, there is almost no high quality quantitative evidence about whether they are effective for student learning. Conceptual knowledge items based on the Force Concept Inventory and Chemical Concept Inventory were developed and used in pre- and posttests within a quasi-experimental crossover design, in which each class-and-teacher analysis unit acted as its own control group. Results showed that student conceptual learning was better with than without scientific visualizations for physics learning: this result was statistically significant but the effect size was small. There was no significant difference observed for chemistry learning. Implications include the idea that while there may only be small benefits to students' conceptual learning, there is at least no harm. Juxtaposed with the widely reported benefits for student engagement, this finding supports continued adoption of scientific visualizations, but may moderate some of the more optimistic claims made about their learning benefits.

S2.2.4 Student Summative Assessment in Science: The Effects of an Explicit Representational Focus

Bruce Waldrip, Monash University, Bruce.Waldrip@education.monash.edu.au

Vaughan Prain, La Trobe University

ABSTRACT: There is growing research interest in the challenges and opportunities learners face in representing scientific understandings, processes and reasoning. These challenges include integrating verbal, visual and mathematical modes in science discourse, and making strong conceptual links between classroom experiences and diverse 3D and 2D representations. Our paper reports on a project that aimed to identify practical and theoretical issues entailed in maximizing representational opportunities for learners to develop conceptual understandings in science. We focus here on three case studies of middle school science topics. Analysed examination scripts indicate that a representational approach to teaching resulted in students using representations more in their responses to exams, wrote longer and more comprehensive explanations and scored higher in achievement tasks than students normally obtained in these scripts. The representations empowered the students to verbalise concepts that they find more conceptually difficult

Strand 2: Science Learning: Contexts, Characteristics and Interactions S2.3 Symposium: Questions and Insights about Blacks in K-Career Science Education: Complexities and Centrality of Contexts from African Diasporic Perspectives

10:30am – 12:00pm, Salon D **Presenters:** Mary M. Atwater, University of Georgia Eileen R.C. Parsons, University of North Carolina at Chapel Hill, rparsons@email.unc.edu Jennifer Adams, Brooklyn College-CUNY

Kabba Colley, Eduinformatics, Vermont

Christopher Emdin, Teachers College, Columbia University

Shirley G. Key, University of Memphis

Jacqueline T. McDonnough, Virginia Commonwealth University

Obed Norman, Morgan State University

Wesley Pitts, Lehman College, CUNY

ABSTRACT: Context is a term broadly used to capture settings and situations that are bounded by and that transcend time and space. It includes historical events and contemporary surroundings that inform what is known in the present. In examining challenges that face Blacks in science education from kindergarten to career, typical approaches isolate challenges from the past and future and considerations commence and conclude with the immediate here and now. Deviating from the tradition that situates challenges in a vacuum, context is central in this symposium and a few challenges that face Blacks in K-Career science education are viewed as inseparable from historical and contemporary contexts. The primary purpose of this symposium is to provide a forum in which African Diasporic perspectives, worldviews that are relatively absent in mainstream science education, are shared, critiqued, and discussed. Forums that bring together voices that are usually marginalized or silenced in the dominant discourse into one arena can be helpful in stimulating innovative responses to persistent problems—a significant contribution to teaching and learning of science. The

symposium's African Diasporic perspectives emphasize from different angles the importance of context in issues involving underrepresented groups, some with a specific emphasis on Blacks, in science education.

Strand 2: Science Learning: Contexts, Characteristics and Interactions

S2.4 SC-Paper Set: Discussion and Interaction in Science Learning

10:30am – 12:00pm, Conference Room 402

S2.4.1 What Student Talk Teaches Us: Findings from a Study of a Science Professional Development Model Incorporating Student Interaction Strategies

Therese B. Shanahan, University of California, Irvine, tshanaha@uci.edu

Lauren M. Shea, University of California, Irvine

ABSTRACT: A synergy exists between science and language learning. Yet, the majority of teachers are unprepared to integrate the science and language teaching (Stoddart, Pinal, Latzke, and Canady, 2002). For English language learners (ELL), this missed opportunity can contribute to increased student failure. This paper shows how a professional development (PD) program explicitly embedded language learning strategies, including promotion of academic student talk and student interaction, into modeled science lessons to attempt to increase achievement in science literacy, improve production and comprehension of academic science vocabulary, and practice structures of the English language. The subsequent teacher learning, teacher perceptions, and classroom implementation demonstrate that the PD program provided teachers with a noninvasive and accessible model to incorporate more academic student interaction into science lessons. Structured classroom observations provided data to show that certain implementation strategies were more likely to promote student interaction. Additionally, the paper illustrates how the results of this study informed the design of the following year of PD implementation.

S2.4.2 Engaging Students in Guided Science Inquiry Discussions: Elementary Teachers' Oral Strategies

Alandeom W. Oliveira, State University of New York at Albany, aoliveira@albany.edu

ABSTRACT: This study explores how elementary teachers perceive and use engaging oral strategies (i.e., manners of speaking that encourage students to participate and become engaged in science discussions). It is reported that the strategies employed as well as their frequency varied substantially depending upon on the teachers' grade level and perceptions. While a kindergarten teacher viewed such strategies negatively and employed only a few figurative directives, fourth-grade teachers viewed them positively, frequently resorting to a variety of speech figures, parallel repetition and engaging questions. It is argued that teachers' engaging oral strategies are multifunctional, serving important social and cognitive functions.

S2.4.3 Identifying Effective Feedback Practices on Student Learning: A Literature Synthesis

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

Min Li, University of Washington

Yue Yin, University of Illinois, Chicago

Andrew E. Morozov, University of Washington

Satprit Kaur, University of Washington

Courtney Courtney, University of Washington

ABSTRACT: Feedback practice is often reported as one of the weakest areas in teachers' classroom assessment, especially in science and mathematics education (Black & Wiliam, 1998), yet, feedback is one among the top five most powerful educational reform methods that influence student learning (Hattie, 1999). However, little is known about what makes feedback practices effective. Some recent attempts have been made to unearth what generally makes some feedback effective, some unproductive, and some destructive (Brookhart, 2008; Butler & Winne, 1995; Hattie & Timperley, 2007; Kluger & DeNisi, 1996; Shute, 2008). Nevertheless, none of this work has systematically addressed the specific and nuanced characteristics of effective feedback in science education. In this study we synthesize the literature on feedback practice in science. The main purpose of this paper is to integrate empirical research in an attempt to discover the consistencies (critical characteristics) in feedback practices that have proved to lead to positive impact on student learning in science. The synthesis is guided by the following research questions: (1) What constitutes the range of feedback strategies currently being implemented in science classrooms? (2) What are the critical characteristics of feedback strategies that have empirically proved to have a positive impact on student learning?

S2.4.4 A Model of Collaborative Discourse to Promote Participatory Classroom Culture and Literacy in a High-school Science Classroom

Jessica Mezei, Teachers College, Columbia University, jmm2221@columbia.edu

Ann Rivet, Teachers College, Columbia University

ABSTRACT: A new wave of culture known as prosumer culture (Tofler, 1980) is becoming increasingly relevant in new technologies, such as Web 2.0 applications. This has spawned new conceptions of valuable skill sets and what it means to be literate today. Conceptions of how people learn also currently support models that emphasize learning in social and collaborative contexts (Doyle, 1986). Teachers must be prepared to respond and integrate current models in their classrooms. This study explores the concept

of fostering a participatory culture, and promoting 21st century literacy skills through pedagogical actions. The study asks: What strategies does a beginning science teacher use to encourage a prosumer versus consumer discourse classroom culture, to enable scientifically literate students? An innovative dynamic social routine called a Do Now activity is discussed. Interviews and observational data were collected and analyzed. Findings suggest this Do Now can represent pedagogical skills required for teachers to be facilitators of social discourse for learning, while students act as prosumers constructing their knowledge. Recommendations of this study suggest that teachers can learn from such new innovative models and evaluate their adaptability toward their own classrooms as well as further explore the learning potentials this environment provides.

Strand 3: Science Teaching--Primary School (Grades preK-6): Characteristics and Strategies S2.5 SC-Paper Set: Science as a Catalyst for Interdiciplinary Learning

10:30am – 12:00pm, Conference Room 403

S2.5.1 Biomusic: Science and Music Interdisciplinary Curriculum Development for the Elementary Classroom

Sarah Carrier, North Carlina State University, sarah_carrier@ncsu.edu

Eric N. Wiebe, North Carlina State University

Patricia Gray, University of North Carolina - Greensboro

David Teachout, University of North Carolina - Greensboro

ABSTRACT: Policymakers and industry are calling for a 21st century education that is inherently interdisciplinary in nature. The research presented here examines the teaming of BioMusic scientists and science and music education researchers with elementary science and music teachers who developed curriculum based on cutting edge BioMusic research that connects science and music in the natural world. We follow the processes beginning with teachers learning about BioMusic from various researchers in the field, the curriculum development, pilot testing process. We will examine some of the challenges and benefits of innovative and interdisciplinary elementary school curriculum development that can further inform interdisciplinary curriculum design efforts. We will also discuss professional development opportunities in the transition of research into the classroom.

S2.5.2 Teaching about Nature of Science and Scientific Inquiry Integrated With Language Arts at The Elementary Level

Hasan Deniz, University of Nevada Las Vegas, hasan.deniz@unlv.edu

Valarie L. Akerson, Indiana University Bloomington

ABSTRACT: This study aimed to (1) to determine to what extent elementary teachers' nature of science (NOS) and scientific inquiry (SI) views improve after a 5-day professional development program designed to teach about NOS and SI integrated with language arts and (2) to determine to what extent 5-day professional development program designed to improve elementary teachers NOS and NOSI views help elementary teachers improve their science teaching efficacy beliefs. It was found that elementary teachers improved their NOS and SI views after the professional development program. It was also found that elementary teachers improved their science teaching efficacy beliefs with regard to student teaching outcome expectancy (teachers' belief that student learning can be influenced by effective teaching).

S2.5.3 To What Extent Do Science Trade Books Provide Vocabulary Support and Promote Inquiry?

Hagop Yacoubian, University of Alberta, hagop.yacoubian@ualberta.ca

Carolyn Freed, University of Alberta Sun Joo Hur, University of Alberta Yu Lei, University of Alberta Michelle Miller, University of Alberta

Linda M. Phillips, University of Alberta

Stephen P. Norris, University of Alberta

ABSTRACT: The purpose of this study was to determine the extent to which science trade books provide vocabulary support as well as promote inquiry. A random sample of 158 science trade books found at the library of an elementary science school was analyzed for the vocabulary support present in the books. Forty books were chosen randomly from this sample to analyze the extent to which they promote inquiry. Analytic frameworks for vocabulary development and inquiry, based on an extensive search of the literature, constituted the bases for our evaluation of the books. The results showed that in addition to fostering the development of attitudes towards science and scientific attitudes, most books provided extensive or adequate levels of vocabulary support and presented acceptable or substantial levels of scientific content knowledge. However, the majority of them failed to present nature of science and scientific inquiry as well as procedural knowledge as an explicit part of the text. Moreover, they were inconsistent in creating opportunities for students to practice scientific inquiry skills and often limited those skills to asking the readers to perform direct observations of nature or secondhand investigations of photos in the book.

Strand 4: Science Teaching--Middle and High School (Grades 5-12): Characteristics and Strategies S2.6 SC-Paper Set: Strategies for Improving Student Learning

10:30am - 12:00pm, Conference Room 404

S2.6.1 The Effect of Science Writing Heuristic Approach on Chemistry Achievement of 9th Grade Students

Sevgi Kingir, Selcuk University, kingirsevgi@gmail.com

Omer Geban, Middle East Technical University

Murat Gunel, Ataturk University

ABSTRACT: The present study was conducted to compare the effectiveness of science writing heuristic (SWH) and traditional approach on ninth grade students' chemistry achievement in two consecutive chemistry units on chemical changes and mixtures. 122 students from four intact classes of two different teachers in a public high school were participated in this study. Two classes of one teacher were assigned as experimental groups, and two classes of other teacher were assigned as control groups. Students in the experimental groups were instructed by SWH approach while students in the control groups were instructed by traditional approach. Chemistry Achievement Test (CAT) was developed by the researchers to measure the students' academic achievement. CAT was administered to both groups as a pretest to determine group differences prior to the study. The same test was administered as a posttest to both groups to understand the effectiveness of the treatment. The overall results indicated that students instructed by SWH approach scored significantly higher than those instructed by traditional approach on chemistry achievement test. Moreover, it was found that low-achieving and middle-achieving students in experimental groups outperformed low-achieving and middle-achieving students in control groups.

S2.6.2 The Use of Learning Contracts on Tenth Grade Urban High School Student Motivation in Biology

Sean Kendall, kendal32@students.rowan.edu

Issam H. Abi-El-Mona

ABSTRACT: The purpose of this study was to determine if the use of a learning contract could effectively improve motivation in a 10th grade biology class in an urban high school. The following question guided this study: How does the use of learning contracts as an instructional and assessment strategy affect the motivation of students in a 10th grade biology urban high school classroom? The study used a qualitative approach grounded in action research. Participants were 10 diverse high school students (6 Hispanic; 2 African American and 1 Asian) located in an urban public high school. The study was implemented during the fourth marking period (2-3 weeks) of the academic year. Learning contracts were introduced to participants during the fourth marking period. Student work samples pre, during and post intervention were collected. Informal interviews for each participant along with post surveys were also collected. Data analysis indicates that use of learning contracts led to better student achievement and behavior as well as an increase in student motivation to improve performance. In general, outstanding findings showed that (1) students enjoyed the degree of structure related to the contract; (2) behavior among students improved, and (3) student grades improved.

S2.6.3 Incidental Use of Concept Maps and Its Effects on Student Understanding of Optics

Roland Meijerink, Herbert Vissers College, Nieuw-Vennep (the Netherlands), rolandme@gmail.com

Jan T. van der Veen, University of Twente, Enschede (the Netherlands)

ABSTRACT: Concept maps are a means to represent knowledge graphically, helping learners to develop better understanding. Research on maps traditionally focuses on their structural application. This paper describes an experiment in which maps are used incidentally, before and after a lesson series on optics in ninth grade. Students that work with the maps outperform students in the control class at both the regular exam and a test for misconceptions. We suggest that these better results can be explained by a reactivation of prior knowledge and a novelty effect. More research is needed to establish the exact relation. The results also suggest that maps are particularly useful to improve conceptual understanding, something the regular lessons fail to do.

S2.6.4 The Effect of Macro-Micro-Symbolic Teaching on Grade Ten Students' Conceptual Understanding of Chemical Reactions

Lama Z. Jaber, American University of Beirut, lama_jaber01@hotmail.com

Saouma BouJaoude, American University of Beirut

ABSTRACT: The purposes of the study were to identify difficulties that hinder Grade 10 Lebanese students' conceptual understanding at the micro-macro-symbolic interface in chemistry, investigate the effect of a macro-micro-symbolic teaching approach on students' conceptual understanding of chemical reactions, and characterize students' conceptual profiles regarding their understanding of chemical reactions in terms of macro, micro, and symbolic levels at the end of the teaching sequence. Forty-six Grade 10 students in two class sections participated in the study. Students in both sections took a pretest whose purpose was to identify their conceptual difficulties about chemical reactions. Then, both sections received student-centered instruction about chemical reactions. However, instruction in the experimental group underscored the interplay between the macro-micro-symbolic levels, integrated various schematic representations, and focused explicitly on models. Finally, all students completed a post-test, a concept map task, and a number of purposively selected students from both sections were interviewed. Findings indicated that macro-micro-symbolic teaching enhanced students' conceptual understanding and relational learning of chemical reactions. Besides, four

assertions related to students' conceptual and epistemological thinking in response to teaching are discussed. Implications for instruction and for teacher education and recommendations for further research are presented in light of these findings.

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

S2.7 SC-Paper Set: Assessment of Student Learning and Faculty Teaching in College Science Courses 10:30am – 12:00pm, Conference Room 405

S2.7.1 A Way Forward for Mixing Quantitative and Qualitative Methods of Studying Problem Solving

Ozcan Gulacar, Southern Connecticut State University, gulacaro1@southernct.edu

Herb Fynewever, Calvin College

ABSTRACT: We present a quantitative model for predicting the level of difficulty subjects will experience with specific problems. The model explicitly accounts for the number of subproblems a problem can be broken into and the difficultly of each subproblem. Although the model builds on previously published models, it is uniquely suited for blending with qualitative methods for the study of problem solving processes rather than being limited to final outcomes. We illustrate the usefulness of the model by analyzing the written solutions and think aloud protocols of 17 subjects engaged with 25 chemical stoichiometry problems. We find that familiar themes for subject difficulty are revealed, including mapping of surface features, lack of interconnected knowledge hierarchy, and algorithmic operations at the expense of conceptual understanding.

S2.7.2 Undergraduate Science Assessment in Context: A Case Study of a Biology Professor's Classroom Assessment Environment and Student Assessment Experiences

Michele H. Lee, University of Missouri, mlee@post.harvard.edu

Aaron J. Sickel, University of Missouri

ABSTRACT: Given the importance of classroom assessment within science education, this qualitative, interpretive case study examined the nature of assessment practices within the context of an upper-level college biology course from the perspective of both professor and students. Prior research suggests K-12 teachers are key in establishing the 'classroom assessment environment' (Stiggins & Conklin, 1992), determining aspects such as assessment purposes, methods, and uses of resulting data. Yet no empirical studies have explored college science contexts or provided student viewpoints. Observations, professor and student interviews, student questionnaires, and course artifacts were collected data coded, analyzed, and triangulated to elucidate the classroom assessment environment and its meaning for all participants. The theory of teacher practical knowledge (TPK) and notion of classroom assessment environment guided the interpretive data analysis. The professor's assessment goals, methods, practices, and decisions were related to: (a) past experiences, (b) current teaching situation, and (c) vision of what science instructional practice should entail. Even without formal education in science teaching and learning, a professor's TPK not only existed but also informed assessment practices. Student data revealed perspectives that align to and contradicted the professor's views of assessment purposes and rationales. Finding support the imperative to research student assessment experiences.

S2.7.3 Development of an Assessment Tool for Advanced Observational Skills

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ABSTRACT: Observational skills are vitally important to the success of practitioners in biological fields. Presently, a simple quantifiable assessment of observational skills for older students is unavailable. This paper presents a description of these advanced observational skills, as well as the development of an assessment tool to measure these skills. The six-part assessment is designed to examine the participant's attention to detail, ability to compare and contrast, and comprehension of a three-dimensional form. Five of the six parts showed low reliability. The sixth part, which measures all three specific skills, showed strong reliability is strong over time (re-rater reliability = 98%) and between raters (inter-rater reliability = 71-90%). Multiple tests of validity support that this portion of the Assessment is quantifying the specific observational skills important for scientists.

S2.7.4 University Faculty Assessments of Reformed Teaching and Learning Practices: Validating a New Measure

Lisa Martin-Hansen, Georgia State University, lmartinhansen@gsu.edu

Chad D. Ellett, CDE Research

Judy Monsaas, University System of Georgia, Board of Regents

Kadir Demir, Georgia State University

ABSTRACT: This paper describes the development and initial validation of a new measure of higher education science and mathematics faculty perceptions of teaching and learning practices (Inventory of Teaching and Learning) (ITAL). Data were collected from 276 science and mathematics faculty in eight regional universities in a single state. Principal Components Analyses empirically verified the original content classification of the ITAL items and three teaching and learning measurement dimensions: a) inquiry-based; b) standards-based; and c) traditional. Alpha reliability coefficients for these dimensions were .95, .88, and .84. The results are discussed in view of moving faculty from more traditional to reformed teaching and learning practices, conducting needs assessments, evaluating new courses and curricula in science and mathematics, and faculty professional development activities.

S2.7.5 Students' Geocognition of Deep Time, Conceptualized in an Informal Educational Setting

Renee M. Clary, Mississippi State University, rclary@geosci.msstate.edu

James H. Wandersee, Louisiana State University

Robert F. Brzuszek, Mississippi State University

ABSTRACT: Students in a Landscape Architecture Design 1 course (N = 25) at a US research university developed design solutions implementing geologic time for an informal education site. Those students who employed abstract metaphors for their designs (n = 8) were more successful than students who proceeded with a linear design construct. Pre- and posttest assessments using the Petrified Wood Survey and student-constructed timelines suggested that 1) 75% geoscience content knowledge is needed for successful design, and 2) relative understanding of Earth events and the barrenness of early Earth's landscape is also prerequisite for successful design implementation. Most revealing of students' cognitive processes were the concept statements and concept maps produced during the project. The concept statement forced students to address the project's requirements, take a position with their concept development of abstract metaphorical representation, and proceed with a final design solution. It appears that concept statements with accompanying concept maps facilitate student cognition by forcing student comprehension and application of geoscience content knowledge. We suggest that an inclusion of concept statements when teaching application of a complex Earth system or process may facilitate students' geoscience cognition in design and/or informal educational settings.

Strand 6: Science Learning in Informal Contexts

S2.8 SC-Paper Set: Museums and School Field Trips

10:30am – 12:00pm, Conference Room 406

S2.8.1 A Comparison of Views about Nature of Science Among Informal Science Educators and Exhibit Designers

Gary M. Holliday, Illinois Institute of Technology, ghollida@iit.edu

Norman G. Lederman, Illinois Institute of Technology

ABSTRACT: Those visiting an informal science institution (ISI) have been shown to leave with less developed views about Nature of Science (NOS). Considering this, what are the views of the staff primarily responsible for presenting and representing science content in ISIs? In this study, the focus is on exhibit designers, full-time and part-time educators. ISI staff members were asked to fill out an online version of the Views of Nature of Science - Form C (VNOS-C) questionnaire and 64 fully completed surveys, along with their interview responses, were analyzed qualitatively and coded. While all participants demonstrated a strong interest and knowledge about science, full- time and part-time educators were shown to have less informed views of NOS than exhibit designers. Since ISI visitors often do not interpret exhibits in a manner that is in line with exhibit designers' intentions, this leaves the task of educating visitors to those with less informed views of NOS. It is recommended that explicit instruction of NOS occur during professional development of ISI educators and exhibit designers. Doing this would hopefully enable both groups to address NOS during ISI education programs when working with preexisting exhibits or when creating new exhibits.

S2.8.2 Teachers' Sources of Knowledge for Field Trip Practices

Bryan M. Rebar, Oregon State University, rebarb@onid.orst.edu

ABSTRACT: Teachers draw from many personal and professional experiences when organizing and leading field trips. The following study uses surveys, interviews, artifacts, and observations gathered from teachers who led trips to an aquarium in order to identify the influences on teachers' field trip practices. Findings reveal the types of influence and the impact these have on practice. For example, teachers adapt knowledge acquired for use in their field trips from three types of training: (1) informal mentoring; (2) past experience on various trips; and (3) various outdoor education training. Discussion centers on the nature of each of these training types and how teachers acquire and adapt their knowledge. Previous research has shown that while a variety of cognitive and affective learning often results from field trips, there is also a pattern of underutilized resources and missed learning opportunities on trips. This study offers insight regarding strengths and weaknesses of teachers' preparation for leading field trips by documenting how and what skills are learned and applied. Therefore it is suggestive of ways in which efforts to formally support and enhance teachers' trip leading skills might build on teachers' existing sources of knowledge.

S2.8.3 Communicating Phylogeny: Evolutionary Tree Diagrams in Museums

Teresa E. MacDonald, University of Kansas Natural History Museum, tmacd@ku.edu

ABSTRACT: Evolutionary trees are graphic depictions of the concept of phylogeny, a central pillar of modern biology, and as such these diagrams have the potential to play a significant role in conveying evolutionary ideas and principles. Informal science institutions perform an important role in communicating about evolution, and phylogenetic diagrams form a major graphic element in many museums. The interpretation and understanding of these graphics involves a complex interaction between the users knowledge and grasp of underlying concepts such as similarity, ancestry and relatedness, and their ability to read the relationships depicted in a schematic tree diagram. This study explored the form and content of 88 tree diagrams used in informal settings to help inform effective strategies for their use in communicating about the tree of life. The findings suggest that the ambiguity of many diagrammatic elements makes interpretation difficult, a problem which may be ameliorated by labeling and making explicit references

to the tree diagram and its meaning in associated interpretative text. In addition, some aspects of how trees are presented in museums likely hinders their use by visitors, and several topological elements common to tree diagrams have the potential to reinforce misconceptions about evolution.

S2.8.4 Experience with an Informal Science Center Exhibit on a Field Trip as Preparation for Future Learning

Bill Watson, The George Washington University, watsonb@si.edu

ABSTRACT: This paper presents data from a quasi-experiment that examined whether different types of interactions 243 sixth-grade students experienced with a Giant Lever exhibit during a field trip to a science center affected how well they understood mechanical advantage. A 2 x 2 x 2 factorial design was employed to explore the viability of a Preparation for Future Learning (Bransford & Schwartz, 1999) conceptual framework for explaining effects of physically interacting with the Giant Lever, attempting to produce an explanation for the phenomenon observed, and encountering an expert explanation of the phenomenon in school the next day. A Multiple Regression analysis indicated that the greatest level of understanding was associated with producing an explanation for the phenomenon experienced at the Giant Lever, but only when the opportunity to subsequently hear an expert explanation was provided (for the interaction term, b = .286, t, 70 = 2.407, p < .05.). Physical interaction with the exhibit did not appear to affect understanding the phenomenon. Implications for understanding the impact of experiences in science centers and the subsequent reinforcing events (Falk & Dierking, 2000) that are assumed to solidify learning are discussed in the context of the Preparation for Future Learning framework.

Strand 7: Pre-service Science Teacher Education

S2.9 SC-Paper Set: Pre-Service Teachers Learning To Teach Through Inquiry

10:30am – 12:00pm, Conference Room 407

S2.9.1 Preservice Elementary Teachers' Adaptation of Science Curriculum Materials for Inquiry

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

ABSTRACT: Multiple methods are employed to investigate how preservice elementary teachers adapt existing science curriculum materials to better support students' engagement in inquiry. The study involved 46 preservice elementary teachers in an undergraduate elementary science methods course and seven preservice teachers from this larger group studied in-depth during the methods semester. Data collection was focused on two 'reflective teaching assignments' in which they asked to adapt existing science curriculum materials to make them more inquiry-based, enact these science lessons in elementary classrooms, and reflect upon both lesson planning and enactment. Results suggest that preservice teachers can learn to adapt existing science curriculum materials to better align with tenets of scientific inquiry as articulated in contemporary science education reform. However, they also illustrate how the preservice teachers made specific types of adaptations to better promote each of the five inquiry practices. These findings have important implications for science teacher educators and science curriculum developers, in terms of not only better understanding how preservice teachers engage with curriculum materials, but also how they draw upon their understandings of inquiry to do so.

S2.9.2 Being In The Hot Spot: How Beginning Teachers' Describe Their Experiences Enacting Inquiry Within The Culture Of Schools?

Oliver Dreon, Millersville University, oliver.dreon@millersville.edu

Scott McDonald, Penn State University

ABSTRACT: This phenomenological study demonstrates the influence that affective factors have on beginning teachers' ability to enact instructional practices. Through narratives shared in interviews and web log postings, two beginning science teachers' emotional engagement with their instructional practices, especially that of implementing inquiry-based instruction, and the resulting impact these emotions had on professional decision- making were evidenced. Anxiety emerged as the most significant impacting emotion on instructional decision- making with the participants. Through their stories, the two participants describe how their emotions and views of self influence whether they continue using inquiry pedagogy or alter their lesson to adopt more didactic means of instruction. These emotions arise from their feelings of being comfortable teaching the content (self-efficacy), from the unpredictability of inquiry lessons (control beliefs), from how they perceive their students as viewing them (teacher identity). This research also demonstrates how intertwined these aspects are, informing each other in a complex, dialectical fashion. By providing descriptions of teachers' experiences enacting inquiry pedagogy, this study expands our understanding of factors that influence teachers' instructional practices and provides a basis for reforming science teacher preparation.

S2.9.3 Beyond "Repeating the Textbook" and "Problem Solving": Teacher Candidates Talk about Learning to Teach Physics Shawn M. Bullock, University of Ontario Institute of Technology, shawn.bullock@uoit.ca

ABSTRACT: The way that science teachers learn to teach is profoundly influenced by the effects of what Lortie (1975) called the "apprenticeship of observation." Teacher candidates' long experiences as students in schools serve as a powerful acculturation into a dominant culture of teaching and learning. Science teacher candidates come to pre-service teacher education program with a default set of ideas about what science teaching and learning look and feel like. This paper is an in-depth study of how physics teacher candidates' visions of teaching physics develops over the course of a B.Ed. program with a particular emphasis on how they construct

professional knowledge during field experiences and in the context of a physics curriculum methods course. The results indicate that the practicum, a familiar and often unquestioned feature of teacher education, tends to encourage candidates to adopt conservative views of education. Attention to student-centred, active-learning pedagogy in a methods course, however, has the potential to disrupt many assumptions about teaching and learning. This paper considers the notion that coursework need not be perceived by teacher candidates as irrelevant to their development as teachers. A coherent pedagogy of teacher education can help candidates to reframe their understandings of how to teach.

S2.9.4 Promoting PCK Development in an Ecology-specific Methods Course: A Characterization of Teacher Educator's Practice

Danusa Munford, Universidade Federal de Minas Gerais - Brazil, danusa@ufmg.br

Letícia M. Calab, Universidade Federal de Minas Gerais - Brazil

Paulina M. Barbosa, Instituto de Biociências, Brazil

ABSTRACT: In this study we examined the practice of a teacher educator in an Ecology-specific methods course, trying to understand processes involved in supporting Pedagogical Content Knowledge (PCK) development among prospective science teachers (PSTs). A naturalistic design was employed in this case study. We adopted a methodological framework that focused on social interaction and language in a contextualized manner. We conducted moderate participant observations taking field notes, and audio and video recording. We also conducted a semi-structured interview with the participant. We characterized a cycle that structured the discipline: "elaborating", "doing", "discussing", "re-elaborating", "doing". Through this cycle PSTs had contact with reflective practice, reflecting in-action and about the action (Schön, 1980). The teacher educator modeled and made explicit a process of accessing multiple knowledge bases in an integrated manner when discussing PSTs' activities. These results not only support views of transformative model of PCK but also show how reflective practice is intertwined with PCK development in multiple contexts. Moreover, her practice reflect current perspectives on learning, once she acted (and interacted) in the social space in ways that, in the future, could be internalized by prospective teachers as these actions become part of individual reflective practices that support PCK development.

Strand 8: In-service Science Teacher Education S2.10 SC-Paper Set: Beliefs 10:30am – 12:00pm, Conference Room 408

S2.10.1 Inquiry Professional Development: Can We Use Teacher Beliefs to Predict Who Will Enact Reform Practices?

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

Greg Rushton, Kennesaw State University

Jonathan Singer, University of Maryland, Baltimore County

ABSTRACT: This study investigated 20 secondary teachers' beliefs about teaching and learning and their use of inquiry-based practices in their classrooms after a professional development program. The program consisted of a summer workshop, five follow-up academic year workshops, and classroom observations. The teachers were interviewed before and after the summer workshop and again after the academic year using a semi-structured interview protocol. The interviews contained the Teacher Beliefs Interview (TBI, Luft & Roehrig, 2007) questions that were used to ascertain the teachers' beliefs of learning and knowledge. The teachers were videotaped twice teaching an inquiry lesson and the videotapes were analyzed using the Reformed Teaching Observation Protocol (RTOP, Sawada et al., 2002). Nine teachers showed a change in their beliefs over the professional development period from more teacher-focused to more student-focused as measured with the TBI. Ten teachers showed no change in their beliefs over time. The teachers RTOP scores corresponded with their beliefs as identified on the TBI in that teachers with more traditional beliefs scored lower on the RTOP than teachers with more student-focused beliefs. This study shows that the TBI can be a tool to diagnose the degree of intervention needed during professional development programs for inservice teachers.

S2.10.2 Teacher Beliefs about Teaching and Learning with a Focus on Teacher Beliefs about How Students Learn

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

Brian Hand, University of Iowa

Soonhye M. Park, University of Iowa

ABSTRACT: Consideration of the impact of teacher beliefs upon their practices in the classroom has become central to studies on teacher change and professional development initiatives. The notion of the transfer of theory into practice is a major focus in the educational research community. A person's beliefs about how students learn are thought to directly affect their teaching practices (Nisbett & Ross, 1980; Bryan, 2003; Fang, 1996; Pajares, 1992). Approaches to teaching, then, are affected by a teacher's belief about what learning is (Martin & Hand, 2007). While some teachers remain committed to traditional views of learning, many teachers have traded-in their previously held theories for newer views. While teacher's hold an array of beliefs, this study focuses on teacher beliefs about teaching and learning. The importance of this set of beliefs in relation to their practice has been widely advocated in the literature and is thought to be of primary importance when teachers consider the implementation of new instructional practices within their classroom (Tobin & LaMaster, 1995; Yerrick, Parke, & Nugent, 1997). This study is an attempt to describe, in detail, one set of

beliefs, that of how the teacher views her role as the teacher, and the teacher's beliefs about how students learn during implementation of an inquiry-based approach to teaching science.

S2.10.3 Beginning Secondary Science Teachers in Their First Three Years of Teaching: Changes in Beliefs and Practices

Julie A. Luft, Arizona State University, julie.luft@asu.edu Krista Adams, Arizona State University Jonah Firestone, Arizona State University Irasema B. Ortega, Arizona State University Sissy S Wong, Arizona State University Derek Fay, Arizona State University

ABSTRACT: The first years of teaching are often discussed with reference to all teachers, not the specifics important to new content specialists. More studies are needed pertaining to early career content specialists in order to ensure that they are supported adequately as they learn to teach in their content area. In this study, we followed over 80 beginning secondary science teachers to determine how their beliefs and practices changed over a three-year period. This mixed-methods study used qualitative and quantitative data collection and analysis techniques. Interviews and classroom observations were collected and this data were analyzed using teachers as a group and the teachers' induction programs as a sub- group. 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 influenced by their school cultures. In addition, the findings suggest that beliefs are more likely to change in the first years, while practices are more stable over time. From these data it is evident that beliefs and practices are malleable, but that they are impacted by different factors. From this study, we suggest new directions for science teacher educators in their work and research with beginning science teachers.

S2.10.4 Learning and Transfer in a Complex Professional Development Setting: A Cross-Case Analysis of the Perceptions and Practices of Science Teachers

Lisa Brooks, Washington University in St Louis, lbrooks@wustl.edu

Carol L. Stuessy, Texas A&M University

ABSTRACT: This mixed-methods multiple case study examined relationships among three high school science teachers' classroom contexts, teaching practices, personal practice theories and learning from a professional development experience (PDE). Data included classroom observations, in-depth interviews, teacher-generated written work from the PDE, and student classroom perceptions. The within-case analyses revealed that each teacher's thoughts, actions and perceptions were highly congruent. The cross-case analysis illuminated variations among the cases. Bandura's (1999) model of triadic reciprocal causation was applied as an interpretive frame. This frame was used to connect five relevant indicators to coherently compare and evaluate the alignment of each case with the focus of the PDE. Results show that the differences among the cases stemmed from the different problems the teachers believed reformbased teaching methods addressed. Recommendations for the design of PDEs include the importance of (a) focusing on flexible learning goals, (b) understanding and engaging teachers' prior knowledge, (c) making changes in teachers' thinking visible and (d) keeping in mind the challenges involved in changing practice to reflect the recommendations of reform. Recommendations for future research include the development of learning trajectories for teachers with different orientations toward reform and deepening our current understandings of teacher educator expertise.

Strand 9: Reflective Practice S2.11 SC-Paper Set: Professional Development

10:30am – 12:00pm, Conference Room 409

S2.11.1 Expectations to Success—The Contrasting Journeys of a Teacher and His Coach

William L. Romine, University of Missouri, romine.william@gmail.com

Andrew West, University of Missouri

Mark J. Volkmann, University of Missouri

ABSTRACT: Under the frameworks of constructivism, social cognitive theory, and cognitive developmental theory, we address the following question: How do the paths from expectations to fulfillment of these differ from a teacher to his/her coach? Research instruments interviews and cognitive coaching conversations. We use a grounded theory method of analysis. In light of cognitive developmental theory (Kegan, 1982), we find that the new teacher tends to take on an interpersonal mindset, whereas the coach tends to take on an institutional mindset. For the new teacher, expectations and success tend to be defined externally, whereas the coach tends to put more responsibility on himself. Action leads the way from expectations to success, and obstacles impede. Obstacles can be surmounted actively though coping strategies or passively by positive self judgment. Once these are surmounted, the teacher and coach experience a sense of success. We find that teacher and coach share many coping strategies, but that the coach has more control over his self judgment. The coach serves to guide the new teacher towards self authorship and understanding.

S2.11.2 Addressing Socioscientific Issues in yhe Science Classroom: Lessons Learnt in Lesson Study

Isha DeCoito, York University, idecoito@oise.utoronto.ca

Maurice DiGiuseppe, University of Ontario

ABSTRACT: Lesson study is a form of job-embedded professional development in which teachers work collaboratively to plan, teach, reflect on, critique, revise, and re- teach a specific classroom lesson with the overall goal of improving student learning. The lesson study project reported here involved the work of four secondary school science teachers and focuses on improving students' engagement with socioscientific issues (STSE). This particular study will report on how secondary school teachers utilized the process of lesson study to: a) address STSE expectations focusing on the analysis of socioscientific issues, and b) create and sustain a supportive professional learning environment in which groups of teachers worked on theoretical and practical issues related to the design and implementation of effective science and technology teaching, learning, and assessment. Team members came to the conclusion that providing opportunities for students to analyze socioscientific issues improved student overall engagement and participation in the teaching-learning process, student application of critical thinking skills in analyzing the issue, and improved overall understanding of the effects of road salt on the environment. These conclusions were arrived at through deep reflections on, and critiques about, their instructional approaches as a collaborative lesson study team.

S2.11.3 Embedding Formative Assessment into Middle Level Problem-Based Science: A Participatory Action Research Study

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

Gayle A. Buck, Indiana University

Anndra Morgan, Monroe County Community School Corporation

ABSTRACT: Problem-based learning (PBL) has increasingly become an educational approach for engaging students in scientific inquiry. In PBL, students investigate authentic problems and propose well-reasoned and dynamic solutions. Formative assessment has the capacity to foster students' learning in PBL and support teachers' instructional decision making. The purpose of this research is to develop a rich, authentic understanding of the conditions that support or constrain efforts to utilize formative assessment in PBL. Using a participatory action research approach, a middle school teacher and post-secondary researcher worked collaboratively to embed formative assessment into two PBL instructional units, analyze student outcomes, make relevant, timely instruction decisions, and provide students with descriptive feedback. Through this research, constraints and affordances to using formative assessment in PBL were identified, as well as implications for practice.

S2.11.4 Building Professional Learning Communities for Developing Dialogic Practice and Argumentation in Science

Shirley Simon, Institute of Education London, s.simon@ioe.ac.uk

ABSTRACT: To establish a curriculum which foregrounds the epistemic aspects of science requires a pedagogy that promotes a dialogic approach to the evaluation of evidence and arguments for scientific ideas. Such an approach, where students and teachers address learning tasks together, listen to each other and consider alternative viewpoints, is not the most familiar or comfortable for many science teachers. Moreover it can pose a significant challenge to their teaching of science. Informed by previous research on the conditions for teachers' professional learning, this research compares the development of dialogic practice in four high school science departments. Two lead teachers from each school attended a program introducing a pedagogical approach for dialogic teaching using argumentation activities. These lead teachers subsequently introduced activities and resources in their curricula and held meetings with colleagues to share their practice and collaboratively reflect on their experiences. Interviews, observations of lessons, and recordings of reflective meetings provide data sources for qualitative analyses from which narratives of development in each department are drawn. The perspectives of teaching and learning science held by lead teachers, their school structures and colleagues' existing practices determine different approaches for building learning communities.

Strand 10: Curriculum, Evaluation, and Assessment S2.12 Administrative Symposium: Alignment among the Science Content Standards, Textbooks, and Standardized Tests: the Chinese Approach

10:30am – 12:00pm, Conference Room 410 Xiufeng Liu, State University of New York at Buffalo, xliu5@buffalo.edu Xian Chen, Nanjing Normal University Yu-ying Guo, Beijing Normal University En-shan Liu, Beijing Normal University Lei Wang, Beijing Normal University Zu-hao Wang, East China Normal University Joe Engemann, Brock University ABSTRACT: Standards based science education reform is an ongoing we

ABSTRACT: Standards-based science education reform is an ongoing world-wide movement. One key premise for the standardsbased science education reform is the alignment among the content standard, classroom instruction, and standardized test. How well such a premise is enacted in practice is an empirical research question. While there have been a few studies on the alignment between science content standards and standardized tests, and between content standards and classroom instruction, few studies have been

reported on the alignment among all three components (i.e. content standards, classroom instruction, and standardized tests). Further more, while much has been taking place in science education reforms in mainland China, little is known outside mainland China on the theories and practices of Chinese science education reforms. Participants in this special invited symposium are key players in the most recent and ongoing science education reforms through the development of the national content standards, textbooks, and national/provincial standardized tests; they will present their perspectives on how the Chinese national science content standards are enacted into textbooks, which in turn are enacted in classroom instruction, and how national/provincial standardized tests are enacted from the national science content standards . They will speak specifically on the subjects of junior high school integrated science (Dr. Xian Chen), and junior and high school biology (Dr. Enshan Liu), chemistry (Drs. Lei Wang and ZuHao Wang) and physics (Dr. Yuying Guo). This symposium will provide a unique Chinese perspective on theories and practices related to the alignment among science content standardized tests.

Strand 11: Cultural, Social, and Gender Issues

S2.13 SC-Paper Set: Language, Culture, and Identity: Pedagogical Implications 10:30am – 12:00pm, Conference Room 411

S2.13.1 Testing a Model for Developing Content Knowledge and Academic Language in Science: The 5 Rs for Teaching Ella

Molly H. Weinburgh, Texas Christian University, m.weinburgh@tcu.edu

Cecilia Silva, Texas Christian University

Tammy Oliver, Texas Christian University

ABSTRACT: This research examines the development and testing of a model for improving academic language and content knowledge in science. The model was developed over two years of working with ELL students ages 9-11 who participated in a summer school experience that used erosion as the academic focus. During a 3-week period, instruction '…married scientific activities with scientific ways of using words rather than with lifeworlds languages' (Gee, 2004, p. 25) as we blended strategies from inquiry-based science with strategies from the SIOP language model. The model of using 5Rs was tested during the third summer with two sections of 22 recent immigrants. While academic language development is critical for all students, supporting the acquisition of this type of Discourse (Gee, 2004) becomes essential for the increasing number of immigrant students enrolling in schools in the United States today. Programs such as Sheltered Instruction (SI) and the SIOP model systematically integrate language and content objectives. However, we hypothesize that every day language should emerge from the science lesson, be replaced with scientific language immediately, be reloaded and repositioned each subsequent day, and retired when students are comfortable with it. In addition, scientific words that have no every day equivalent should be revealed to students, reloaded, reposition, and retired.

S2.13.2 Access and Equity: A Teacher's Role in Border Crossing

Adriane M. Slaton, Michigan State University, slatonad@msu.edu

ABSTRACT: Abstract: Guided by the question, "How are opportunities to learn science impacted by how students are positioned in an urban science classroom?", this project seeks to better understand the complexities of how teachers play a pivot role in student border crossings from lived experiences to traditional school/science settings. Drawing from Victoria Costa's framework describing students' lived worlds and the worlds of science, this paper discusses how a teacher provides differential access to meaningful science learning based on student positionings.

S2.13.3 Cultural Relevance in Science Pedagogy (CRISP): Results of an Action Research Network

Mistilina Sato, University of Minnesota, msato@umn.edu

Stacy A. Ernst, University of Minnesota

ABSTRACT: The Cultural Relevance in Science Pedagogy (CRISP) action research network comprises four regional sites across a state. Twenty-six teachers engaged in engaged in collaborative action research focused on enacting culturally relevant pedagogy in science teaching and learning. The network, supported with professional development expertise by a public university and a science museum, engaged science (K-8) teachers in critical analysis of practice and pedagogy. Pre- and post-questionnaire data show significant change in measures of culturally relevant pedagogy, teachers' approaches to culture in science, and scientific inquiry. Qualitative analysis examines the role of teachers' cultural identity awareness related to enacting culturally relevant pedagogy specifically in science. Second-order analysis of the action research projects suggests six distinct areas of development in teachers' practice.

S2.13.4 Working Together For Student Success: The Development of a Culturally-Relevant Science Curriculum for a Tribal College

Jessie C. Antonellis, jcantone@email.arizona.edu

ABSTRACT: This study documents the development and implementation of an introductory physics course at a tribal college, designed by the researcher in collaboration with the tribal college community. Efforts to ground the development of the course in culturally-relevant pedagogical theory, and to enact the theory in classroom practices, are described. This paper highlights students'

co-construction of the course through their reflections on connections between the content and their personal and cultural backgrounds, using qualitative data from written work and spoken class dialogue.

Strand 12: Educational Technology

S2.14 SC-Paper Set: Evaluating Technology Enhanced Learning Tools

10:30am – 12:00pm, Conference Room 412

S2.14.1 The Life Cycles of Technological Tools: Implications for the Science Classroom

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

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

ABSTRACT: This study examined and documented the complex life cycles and transformations of two technological tools: Biology Student Workbench (BSW) and ChemViz. The life cycle involves phases of conception, design, development, adoption and implementation. Data collection included two phases of in-depth interviews and collected artifacts. The development time line and activities for both tools indicate that, from a current perspective on "best practice," all the necessary components and ingredients were in place to create stable and viable tools, which could substantially and favorably impact precollege science teaching and learning. The findings have implications for tool implementation in science classrooms and teacher preparation programs. It exposes the need to critically analyze and understand the life cycles of technological tools noting context, the role of expertise and the inherent nature of technology.

S2.14.2 Wiimote Interactive Whiteboards: Outcomes from Three Undergraduate Preservice Student Research Projects Brian C. Baldwin, Kean University, bbaldwin@kean.edu

ABSTRACT: The Nintendo Wii Remote Interactive Whiteboard (WiiMote IWB) is a technological too which can enable science teachers to present subject matter in an interactive manner, similar to the SMARTboard, at a small fraction of the cost. This research project reports on three different undergraduate preservice student research groups that implemented the WiiMote IWB in a school setting – two groups in high school classrooms, and one group in a professional development teacher inservice setting. Summative results from each of the three groups indicated a number of factors: the WiiMote IWB allows for greater student engagement in both classroom activities and subject matter content; greater amount of student interactive via the tool with the subject matter content; and, a willingness of veteran teachers to incorporate this powerful yet inexpensive tool into their pre-existing pedagogical strategies in their own classrooms. Providing pilot study for further extensive research, the implementation of this tool within learning environments of preservice and inservice teachers shows great promise for ease of introduction of cutting-edge educational technologies within classrooms lacking funding for more expensive devices with similar uses.

S2.14.3 Assessing the Technology-Supported Science Learning Environment

Adit Gupta, Model Institute of Education & Research, India, aditgupta@yahoo.com

Rekha B. Koul, Curtin University of Technology, Perth, Australia

ABSTRACT: Technology has invaded the field of education in a big way and is being regarded as a tool having immense educational possibilities. It has the potential to influence each and every aspect of education and its applications are clearly visible and expanding with respect to classroom teaching. Technology today, is becoming an integral part of the curriculum in schools and is proving to be a useful tool in the hands of the teacher in providing information and knowledge and thereby, encouraging student participation in the learning process. The present study reports the use of the modified form of Technology–Rich Outcomes-Focused Learning Environment Inventory (TROFLEI) for assessing the students' perceptions of their learning environments in a technology-supported section and they perceived their technology-supported learning environments in a positive manner. Significant associations between students' perceptions of their technology-supported learning environments and their their attitude towards science, academic efficacy and academic achievement were also observed. Student interviews also corroborated the results of the study.

S2.14.4 Designing and Evaluating Web-Based Interactive Learning Objects

Khang-Miant Sing, National Institute of Education, Singapore, khangmiant.sing@nie.edu.sg

Benson Soong, University of Cambridge, United Kingdom

ABSTRACT: Web-based interactive multimedia learning objects (LOs) have gained prominence and are becoming more pervasive in recent years. Youths, belonging to the Net Generation, are particularly enamoured with these LOs because they can interact with the manipulative elements and receive just-in-time feedback which act as scaffolds to guide learning, anytime and anywhere in the world – as long as they have access to the web. A similar form of web- based interactive multimedia known as Interactive Resources (IRs) which are designed and developed by the Ministry of Education in Singapore are being used by many local schools. The easy access to this form of learning resource coupled with its affordances for science learning have stirred up interests in educators to explore the use of IRs to learn science. Our presentation and paper describes the designing of web-based IR, shows the results of the first phase of

evaluation of the IR, and further puts forward the possibility of integrating IRs into a learning environment (that is socially interactive and supportive of dialogic teaching/learning) to enhance learning of science concepts.

Strand 13: History, Philosophy, and Sociology of Science

S2.15 SC-Paper Set: Scientists, Teachers, and Epistemology of Science

10:30am – 12:00pm, Conference Room 413

S2.15.1 Biotechnology and Risk: Perceptions of Science Instructors

Grant E. Gardner, North Carolina State University, grant_gardner11@hotmail.com

Gail Jones, North Carolina State University

ABSTRACT: Preparing students to become scientifically literate citizens remains an important goal of science education. Scientifically literate citizens will increasingly be faced with advances in biotechnology, and their attitudes and perceptions of risk will affect their interactions with this technology. This study's purpose was to determine how a range of science educators perceived the risks posed by biotechnology. Ninety-one instructors (including preservice and inservice K-12 educators, graduate teaching assistants, and university professors) were administered a survey and card sort task to determine their general risk perception, characteristics of biotechnology that make it risky, and perceived differences in risks of biotechnology applications. Similarities in perceptions were found within inservice, preservice, and teaching assistant groups, with university professors having noticeable differences. The differences included a lower general perception of risk and a higher propensity to see the 'gray areas' on controversial issues of risk. Results are discussed in the context of risk perception on science teacher beliefs and subsequent pedagogical practices.

S2.15.2 Purposeful and Targeted Use of Scientists to Support In-Service Teachers' Understanding and Teaching of Scientific Inquiry and Nature of Science

Kevin J. White, Illinois Institute of Technology, whitkev@iit.edu

Norman G. Lederman, Illinois Institute of Technology

ABSTRACT: The purpose of this study was to explore the relationships of in-service teachers' views of scientists, their understandings of NOS and SI, their students' understanding of NOS and SI, and their view of teaching NOS and SI while engaged in a professional development experience that provides participants with a sustained emersion into the culture, beliefs and knowledge of scientists while in a NOS/SI course. The participants included 10 in-service science teachers who were part of a Masters degree leadership cohort at a small university. Clear gains in understandings of nature of science and scientific inquiry were observed. In addition, teachers changed their views about scientists and the roles they see scientists could play in their own classrooms. The results of this investigation suggest an approach to teaching nature of science and scientific inquiry that may be a more effective, longer lasting and more efficient use of scientist-teacher educator collaborations. A sustained and more choreographed teacher-scientist relationship may be a better format for in-service science teacher education programs.

S2.15.3 The Influence of an Authentic Context on Enhancing Teachers' Understandings of Nature of Science

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

Xenia S Meyer, Cornell University

Daniel K. Capps, Cornell University

ABSTRACT: This paper reports on the influence of a professional development (PD) program that situated ten upper elementary, middle level, and high school teachers in an authentic research setting, in addition to providing innovative curricular materials centered in inquiry, nature of science and evolutionary concepts, on teachers' views of science. The theoretical framework involved constructs of situated cognition and social constructivism on teachers' views and practice of teaching about nature of science. We built on findings of an earlier study by the first author, investigating the impact on preservice teachers' views of the nature of scientific work as a result of their working in an authentic setting, either as part of a laboratory or in a field research project, and then reflecting on their experiences. The current project extended the model by utilizing an innovative PD combining opportunities to examine real fossils with virtual experiences, focusing on relevant content in biological evolution, geology, inquiry, and nature of science, and teacher reflection. There is evidence that the authentic context provided by the professional development program and authenticity of the fossil investigation contributed to teachers' developing understandings of several tenets of nature of science.

S2.15.4 Interactions between Inquiry Experiences and Epistemology in Understanding the Nature of Science in an Undergraduate Research Experience

Maya R. Patel, Cornell University, mrp14@cornell.edu

Deborah J. Trumbull, Cornell University

Barbara A. Crawford, Cornell University

ABSTRACT: This study examined interactions between undergraduate students' epistemological development, understandings about the nature of scientific inquiry (NOSI) and understandings about the nature of scientific knowledge (NOS) within the context of a 10-week summer undergraduate research internship. This study builds on our prior work examining students' learning during an NSF-

supported Research Experience for Undergraduates in biotechnology and genomics. In this paper we focus on students' pre-program characteristics and inquiry experiences as summer research interns. Our research questions were: 1) What changes, if any, in understandings about NOSI and NOS and level of epistemological development occurred during a 10-week research internship? and 2) In what ways, if any, did intern's experiences with aspects of inquiry or interns' personal epistemologies influence their learning/understanding of the tenets of NOSI and NOS? Though we found no changes in interns' epistemological development via participation in the internship, we found that interns with higher levels of epistemological thinking and higher levels of active inquiry experience were more likely to make gains in understanding the tenets of NOS and, especially, NOSI through participation in research.

Strand 14: Environmental Education S2.16 Administrative Symposium: The Intersection of Research in Science Education and Environmental Education

10:30am – 12:00pm, Conference Room 414
Michael Barnett, Boston College
Sheron Mark, Boston College
Alec M. Bodzin, Lehigh University
Charles W. Anderson, Michigan State University
Kristin L. Gunckel, The University of Arizona
Beth Covitt, University of Montana
Lindsey Mohan, Michigan State University
Hui Jin, Michigan State University
Rita Hagevik, The University of Tennessee
Ioana Badara, University of Tennessee
Teddie Phillipson-Mower, University of Louisville

ABSTRACT: The goal of environmental education as defined by the Belgrade Charter, "is to develop a world population that is aware of, and concerned about, the environment and its associated problems, and which has the knowledge, skills, attitudes, motivations, and commitment to work individually and collectively toward solutions of current problems and the prevention of new ones" (UNESCO-UNEP, 1976). Both NSTA and ASTE strongly support the inclusion of environmental education in science education as a way to instill environmental literacy and sustainability in our nation's preK-16 students. In fact, environmental education context for the teaching and learning of core science content and issues of environmental justice. Environmental education is critical because informed decisions regarding the future of our planet depend upon an environmentally literate citizenry. All the papers of the symposium will address three questions: • What are the intersections between environmental education and science education and environmental education? • What methodologies can help strengthen research in both environmental education and science education? Two papers explore how using the out of doors and geospatial technologies are motivating teachers and students to learn about the environment. The third and fourth papers explore environmental literacy and how it is related to practices of environmentally responsible citizenship.

Co-Sponsored Session—External Policy and Relations Committee & Strand 15: Policy S2.17 Administrative Symposium: A Panel Discussion: How might NARST fit into the"The Opportunity Equation: Transforming Mathematics and Science Education for Citizenship and the Global Economy"? 10:30am – 12:00pm, Conference Room 415

Presiders:
Sharon J. Lynch, National Science Foundation, slynch@nsf.gov
Elizabeth A. Davis, University of Michigan
Presenters:
Richard A. Duschl, Pennsylvania State University
Janice Earle, National Science Foundation
Francis Eberle, National Science Teachers Association
Jo Ellen Roseman, AAAS Project 2061
Sherry A. Southerland, Florida State University
Martin Storesdieck, National Academies of Science
ABSTRACT: This panel discussion follows a presentation by Michele Cahill, Commission Co-Chair; Vice President, National
Programs and Program Director, Urban Education of the Carnegie Corporation of New York. Cahill will have spoken at an earlier

NARST session focusing on The Opportunity Equation: Transforming Mathematics and Science Education for Citizenship and the Global Economy. The Opportunity Equation's history and purposes were described in the report as follows: "In 2007, Carnegie Corporation of New York joined with the Institute for Advanced Study to create a Commission composed of distinguished mathematicians, scientists, educators, public officials, and business and nonprofit leaders. The Commission was charged with assessing the current state of math and science education in the U.S. and developing actionable recommendations for the country to fully prepare American students in mathematics and science so that every student has the opportunity for a productive adult life in our rapidly changing world." The purpose of this panel discussion is hear and discuss the views of policy makers and NARST members about the promises, limitations, or pitfalls for the vision offered by the Opportunity Equation. The science education research community has an important role to play in responding to this new vision of science education reform.

Presidential Invited Session

S3.1 Symposium: Learning Progressions and Pathways

1:00pm – 2:30pm, Conference Room 501 Richard A. Duschl, Penn State University, rad19@psu.edu Richard Lehrer, Peabody College Vanderbilt University Tom Corcoran, Teachers College Columbia University Ravit Duncan, Rutgers Alicia Alonzo, Michigan State University Cynthia Hamen Farrar, The College Board ABSTRACT: Recommendations from recent National Researc

ABSTRACT: Recommendations from recent National Research Council reports have emphasized the importance of rethinking K-12 science curriculum and standards in terms of 'core knowlege', 'practices' and 'learning progressions'. Panel participants represent individuals who have coordinated either NSF research projects and/or NSF-sponsored workshops that are examining learning progressions and pathways. The session will be a moderated discussion with panelists on initiatives and lessons learned to date. Questions solicited from the audience will be incorporated in the deliberations.

Publications and Advisory Committee Sponsored Session

S3.2 Administrative Symposium: Minding the Research–Practice Gap: Attending to the Dialogic Nature of Research AND Practice

1:00pm - 2:30pm, Salon C

Panel Members:

Julie A. Luft, Arizona State University John Settlage, University of Connecticut Joe Krajcik, University of Michigan Scott McDonald, Penn State University

Presenters:

Melissa Braaten, University of Washington - Seattle, WA Bethany Sjoberg, Technology, Engineering, and Communications High School on the Evergreen Campus Highline, WA

Michelle Brown O.Henry Middle School

Gretchen Kehrberg O.Henry Middle School

Meena Balgopal, School of Education, Colorado State University

Shaun Cornwall, Shepardson Elementary School, Fort Collins, CO

ABSTRACT: In the 1980's and 1990's NARST sponsored the publication of Research Matters, brief summaries of research with specific implications for classroom practice. http://www.narst.org/publications/research.cfm Recently there has been a growing interest among some organization members to resurrect the publication with the intent of making important research findings accessible to teachers, administrators and policy-makers. However, others have called for more dialogic models of research and practice, as opposed to the unidirectional impact conveyed through the original Research Matters. This session is sponsored by the Publications Advisory Committee and will showcase three examples of the dynamic interplay of research and practice as conveyed by NARST members and their teacher collaborators. Each presentation will be accompanied by a "new media publication" intended to spark conversation about contemporary foci and outlets for this important work. A panel of esteemed colleagues, including original Research Matters authors, will comment on the presentations. Audience discussion will follow with the goal of generating ideas for a new generation of Research Matters that can be taken under consideration and moved to an action plan by the Publications Advisory Committee.

Strand 1: Science Learning, Understanding and Conceptual Change

S3.3 SC-Paper Set: Learning and Argumentation in the Global Context

1:00pm – 2:30pm, Conference Room 401

S3.3.1 Vygotsky and Primary Science: Theory into Practice

Colette Murphy, Queens University Belfast, c.a.murphy@qub.ac.uk

ABSTRACT: This presentation will consider some of Vygotsky's ideas in relation to children's development and science learning. The literature concerning children's learning in science at primary (elementary) school is surprisingly neglectful of the work of Vygotsky; most emphasis is still placed on Piagetian ideas. Three main Vygotskian ideas will be explored in relation to young children's learning of science: concept development, the zone of proximal development, and the importance of play. There are some schools in Russia which implement fully Vygotskian principles into primary school teaching (Golden Key schools, see Holzman 2007). This researcher participated in an immersion summer school set in a Golden Key school in June 2009, to learn about how Vygtoskian theory is practised in Russian schools and what can be transferred to schools to improve science teaching in Western cultures. The presentation will illustrate findings from the Russian experience and subsequent applications of Vygotskian approaches in European schools with photographs and video clips.

S3.3.2 Elementary Children's Preferences for Causal Justification

Aylin Çam, Middle East Technical University, aylincam@gmail.com

William Sandoval, University of California, Los Angeles

ABSTRACT: The purpose of the study is to elicit young children's preferences for types of causal justification. Twenty-six children (14 boys, 12 girls) took part in the study; they were students in a combined 3rd/4th grade classroom in a progressive laboratory school affiliated with a public university in a large city in California. A set of story problems were developed in which students were required to compare a pair of justification for a causal claim, choose the justification they thought was better, and say why. One of the justification including either appeal to authority or plausible cause. The other justifications is evidentiary justification of experiment with appropriate graph, whether covariation or non-covariation data. The result of the study demonstrated that these children were significantly more likely to select the evidentiary justification than the base justification. Majority of these children preferred evidence over authority, but plausible mechanism over ambiguous evidence. The most common reason children gave for their own choice was attacking the credibility of the competing choice.

S3.3.3 Profiling and Interpreting East African Students' Science Learning Worldviews

Samson M. Nashon, University of British Columbia, samson.nashon@ubc.ca

David Anderson, University of British Columbia

ABSTRACT: This paper reports on the quantitative analysis of Kenyan students' responses to a validated 36-item questionnaire, Composite Instrument for Assessing Disposition for Contextual Learning of Science (CI_ADCLOS), as part of a study aimed at investigating East African (EA) students' ways of knowing (WOK) in science discourses. CI_ADCLOS comprises three scales, attitudes towards contextual learning of science (ATCLOS), personal awareness of influences on learning science (PAILS), and orientation towards collateral learning (OTCL). Items on the ATCLOS and PAILS scales were separated into substantively and null stated and responses analyzed. Interpretation of the outcomes of the quantitative analysis reveals that Kenyan students' worldviews of science learning can be described by three key perspective continua: decontextualist - contextualist, value-free - value-laden, and aculturalist - culturalist.

S3.3.4 How Do Students' Argumentations Depend On Their Conceptual Understanding and Vice Versa?

Tanja Riemeier, Leibniz University Hannover, Germany, riemeier@biodidaktik.uni-hannover.de

Claudia von Aufschnaiter, Justus-Liebig-University Gießen, Germany

Jan Fleischhauer, Justus-Liebig-University Gießen, Germany

Christian Rogge, Justus-Liebig-University Gießen, Germany

ABSTRACT: Science educators argue that argumentation is an important aspect of science education in general, and that argumentation promotes the learning of the science content. Conversely, research indicates that students' ability to argue is limited by their content specific knowledge. But research rarely explicitly addresses (details of) the interrelationship between argumentation and conceptual understanding. Therefore, our research project aims to investigate how the quality of students' argumentation depends on their conceptual understanding and vice versa. Data analysis is based upon two different theoretical frameworks: A refined version of Toulmin's argument patterns is used to describe the processes of argumentation and its quality. Students' conceptual understanding is investigated with a coding schema distinguishing between exploration, intuitive rule-based understanding and explicit rule-based understanding. Video data from students of different age working in groups on physics and biology instruction were analyzed with these two frameworks. Results demonstrate that each single argumentation typically contains only few different elements, and elements that are regarded to be of "higher quality" are rare. Argumentations that consist of high structural and high conceptual quality occurred when students were able to utilize everyday-experiences or specific experiences they made during the learning sequences.

Strand 2: Science Learning: Contexts, Characteristics and Interactions

S3.4 Symposium: What can we Learn from Classroom Videos? Physics Instruction in Finland, Germany, and Switzerland Compared

1:00pm – 2:30pm, Salon D Knut Neumann, Leibniz-Institute for Science Education (IPN) Kiel, neumann@ipn.uni-kiel.de Cornelia Geller, University Duisburg-Essen Jussi Helaakoski, University of Jyväskylä Melanie Keller, University Duisburg-Essen Jennifer Olszewski, University Duisburg-Essen Hans E. Fischer, University Duisburg-Essen Jouni Viiri, University of Jyväskylä

ABSTRACT: International large scale assessments such as TIMSS or PISA revealed particular differences in students' mathematics and science performances between the participating countries. Sub- sequent large scale video studies could not explain these differences by differences in instruction. This is most likely because these studies focused on superficial, i.e. low-inferent, characteristics of instruction. Later studies, which investigated instruction on a deeper level, could identify particular characteristics which may explain performance differences. Taking a model of quality of instruction in mathematics as a point of departure, a model of instructional qual-ity in physics was developed in the study presented. On the basis of this model, physics in-struction in three countries, namely Finland, Germany and Switzerland, is investigated. Alto-gether, 250 physics lessons from all three countries are video recorded and analysed with re-spect to surface and deep level characteristics. The examined characteristics are related to students' performance and motivation. Additionally, framework conditions, e.g. students' socio-economic backgrounds or teachers' professional knowledge, are taken into account. Within the symposium, the study is introduced in general, while results on particular aspects of instructional quality are presented in greater detail.

Strand 2: Science Learning: Contexts, Characteristics and Interactions

S3.5 SC-Paper Set: Exploring and Assessing Argumentation in Classrooms

1:00pm – 2:30pm, Conference Room 402

S3.5.1 Explanation, Argument and Evidence in Science, Science Class, and the Everyday Lives of Fifth Grade Students Katherine L. McNeill, Boston College, kmcneill@bc.edu

ABSTRACT: Science is a practice that includes more than just concepts and facts, but also encompasses scientific ways of thinking and reasoning. Students' cultural and linguistic backgrounds influence the knowledge and experience that they bring to the classroom, which impacts their degree of comfort with the norms of scientific practices. Consequently, the goal of this study was to investigate fifth grade students' views of explanation, argument and evidence across three contexts - what scientists do, what happens in science classrooms, and what happens in everyday life. Furthermore, we were interested in how students' ability to engage in one specific practice, argumentation, changed over the school year. Multiple data sources were collected and analyzed: pre and post student interviews, videotapes of classroom instruction, student writing, and a teacher interview. We found that students' views of explanation, argument and evidence of the school year, while their everyday meanings remained more constant. Students developed more sophisticated views of these scientific practices and were able to write stronger scientific arguments by the end of the school year.

S3.5.2 Questioning and Argumentation During Group Discussions in Science: Discursive Interactions Associated with Productive Discourse

Christine Chin, National Institute of Education, Singapore, christine.chin@nie.edu.sg Jonathan F. Osborne, Stanford University

ABSTRACT: This study investigated the discursive interactions (with respect to questioning and argumentation) between more and less successful groups when they engaged in discussion to negotiate and develop conceptual understanding. Four classes of students, aged 12-14 years from two countries, discussed which of two graphs best represented the changes in temperature as ice was heated to steam. The students first wrote any questions that they had. Working in groups with members who had different viewpoints, they then posed questions to each other and discussed contrasting arguments, guided by an argument sheet and an argument diagram. One group of students from each class was audiotaped. Discourse transcripts from the four groups were then analyzed for differences in the nature of talk that included the number and type of questions posed, and the types of arguments generated. Productive discourse of the more successful groups was characterized by: (a) questions which focused on key inquiry ideas and a greater variety of salient concepts; (b) an explicit and conscious reference to the structure and components of an argument; (c) a continual elaboration and expansion of the arguments constructed; and (d) a prevalence of exploratory, instead of disputational, cumulative, or triadic teacher talk. Implications for instruction are discussed.

S3.5.3 Assessment of Scientific Argumentation in the Classroom: An Observation Protocol

Patrick Enderle, Florida State University, pje07@fsu.edu

Joi P. Walker, Florida State University

Catherine Dorgan, Florida State University

Victor Sampson, Florida State University

ABSTRACT: Scientific argumentation continues to emerge as a critical area for science education research and ultimately the achievement of a scientifically literate population. Mirroring communication and knowledge building that occurs within the science community, argumentation in the science classroom offers a powerful vehicle for helping students gain conceptual understanding and enhance reasoning skills. To understand and assess the quality of the process of argumentation occurring in the classroom, instruments must be developed to measure not only the coherency and structure of the argument product, but also the dialogical interactions occurring among students as well. This aim of this study was to generate on observation protocol that could be used by researchers and teachers to assess the quality of argumentation occurring in science classrooms. The resulting protocol contains 20 items organized into four categories representing critical aspects of argumentation. A theoretical and methodological framework for the development and validation of the observation protocol will be described. Reliability and validity check results will be discussed and protocol items explored.

S3.5.4 Argument-Based Activities in the Wake of the National Science Education Standards: A Review of Argument Activities in K-12 Science Classrooms from 1996-2009

Andy R. Cavagnetto, Binghamton University-SUNY, acavagne@binghamton.edu

ABSTRACT: It has been over a decade since the National Science Education Standards (NRC, 1996) recommended greater emphasis on "providing opportunities for scientific discussion and debate among students" (p. 52). While argument has not received the attention of inquiry in school science, there has been a dramatic increase in the argument in science education literature. This paper explores the literature to gain an understanding of the nature of argument (both generation of and participation in) that occurs in K-12 science classrooms. The paper specifically addresses the question, how well do argument activities in K-12 science classrooms align with argument use in science? Forty-three peer reviewed journal articles from 1996-2009 were reviewed using three areas of consideration as frameworks, a) the nature of the argument activity, b) the emphasis of the argument activity, c) the aspects of science included in the argument activity. Results suggest argument is used in a variety of ways in K-12 classrooms. Some uses of argument align closely with argument in science communities while a considerable number of others are only slightly characteristic of science communities. Theoretical and practical implications for researchers and science educators are discussed.

Strand 3: Science Teaching--Primary School (Grades preK-6): Characteristics and Strategies S3.6 SC-Paper Set: Assessment

1:00pm – 2:30pm, Conference Room 403

S3.6.1 Development of an Oral Protocol to Assess Young Children's Views of Science

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

Norman G. Lederman, Illinois Institute of Technology

ABSTRACT: Science educators and teachers are becoming increasingly interested in young students' understandings of nature of science and scientific inquiry. However, all of the nature of science and scientific inquiry assessments presently require students to have the ability to read and write. They exclude assessing young children who have not yet learned to read and cannot fully express their thinking in writing. Without valid and reliable assessment techniques teachers are unable to discern the effectiveness of their efforts. The focus of this study was the production of a valid and reliable instrument that is developmentally appropriate for the assessment of young children's views of science. The study reports on the design, development, and validation of an orally administered assessment protocol that will provide researchers and teachers access to students' understandings at an age level not previously available. The assessment protocol will allow for the collection of data on the development of young students' understandings of nature of science and scientific inquiry and, for the first time, the opportunity for a coherent connection of data collection across K- 12 grade levels and a mechanism to further enrich the data available.

S3.6.2 The Development of an Instrument for Assessing Preschoolers' Attitudes toward Science

Mia D. Dubosarsky, University of Minnesota, dubo0053@umn.edu

ABSTRACT: The topic of preschoolers' attitudes towards science has rarely been studied. One of the challenges is the lack of a standardized method to measure very young children's conceptions of science and scientists. Teaching science in early childhood is important to support natural curiosity, cognitive development and the development of essential skills. Preschools, and especially Head Start program support young children from disadvantage families that are not exposed to science enrichment activities at home. However, to support the practice of early childhood science education, a measurement tool that gauges in a standardized way the attitudes and concept of science of preschool children is required. Although such tools are available for older age students, those tools are not applicable to preschool children. This paper discusses the methodology of developing a standard, computer-based
measurement of preschool children attitudes and concept towards science, the challenges and the application of such an instrument for science education research and science program evaluation.

S3.6.3 Development of a Measure to Guide and Assess Inquiry Science Lessons by Pre-service and In-service Teachers in **Elementary Classrooms**

Betty J. Young, University of Rhode Island, byoung@uri.edu Kathleen Peno, University of Rhode Island Elaine S Mangiante, University of Rhode Island Minsuk Shim, University of Rhode Island Barbara Fitzsimmons, Morris College South Carolina Judith K. Paolucci, Yarmouth Public Schools, Maine Sharon K. Lee, Rhode Island Department of Education

ABSTRACT: This study describes the creation and implementation of a tool to operationalize components of an inquiry science lessons appropriate to elementary classrooms. Based in literature on the elements of quality inquiry lessons, the Inquiry Science Lesson Design Tool (ISLe) observational coding tool that can also be used as a lesson design guide for preservice and inservice teachers who are learning to incorporate inquiry lessons into their repertoire of approaches to teaching science. With practice using this guide, teachers can begin to introduce variations on the elements in order to design lessons that include various types of inquiry approaches to teaching elementary science. This guide provides an observational tool for teacher educators and researchers. The purpose of this paper is to: • introduce the ISLe Design Tool, • examine the results of its use in determining the quality of the science lessons of 27 elementary preservice teachers during science methods instruction and a year later during their student teaching experience, and • examine the science lessons of these students' 27 cooperating teachers. The results are examined using discriminant function analysis to determine which of the lesson elements contributed most to the differences between the highest and lowest quality inquiry lessons.

Strand 4: Science Teaching--Middle and High School (Grades 5-12): Characteristics and Strategies S3.7 SC-Paper Set: Technology for Science Teaching 1:00pm – 2:30pm, Conference Room 404

S3.7.1 Examining the Use of Laboratory Activities in Secondary Science Online

Kent J. Crippen, University of Nevada Las Vegas, kcrippen@unlv.nevada.edu

Leanna M. Archambault, Arizona State University

Cynthia L. Kern, University of Nevada Las Vegas

ABSTRACT: Teaching science to students online is a growing national trend. However, the extant literature contains little information regarding the nature of science teaching and learning in this unique medium. In order to bring about the vision of science education promoted in the various policy documents for students learning science online, a deep understanding of the relationships among the materials, activities, participants, and context is needed, particularly in relation to laboratory activities. Through a Webbased survey regarding laboratory activities, this study describes the perspective of 35 secondary teachers from 15 different U.S. states who are teaching science online. Teachers responded concerning the types and examples of laboratory activities they use and the nature of their instruction with these activities. They also described influences on their decision-making and unique barriers to inquiry pedagogy in online science. This study embodies the NARST theme-Research into Practice: Practice into Research by using the perspective of practitioners to build our understanding of online science teaching while clarifying an opportunity for translating established best practices from face-to-face teaching into a new and unique medium.

S3.7.2 Impact of GK12 Fellows on Teachers' Pedagogical Practices and Students' Science Attitudes

Kathryn Scantlebury, University of Delaware, kscantle@udel.edu

George Watson, University of Delaware

John Madsen, University of Delaware

Jane B. Kahle, Miami University

ABSTRACT: This paper focuses on a GK12 program located in a vocational-technical school district. This paper focuses on the program's second goal, improve STEM instruction in K-12 schools, through an analysis of questionnaires completed by the project's Fellows, teachers and the high school students. These data are triangulated with excerpts from interviews conducted with the Fellows. The students completed the questionnaire before and after their interaction(s) with the Fellows. The student questionnaire contained subscales on teaching practices, student learning activities, parent/adult support of science studies, friends' interest in science, and student views of science. The positive influence of having Fellows in the classes was found in students' responses. Students reported that they less frequently did science problems from textbooks or agreed with the statement learning science is mostly memorizing facts. Students responded that they were more frequently asked to give reasons for their answers, write about solving science problems, and had their homework checked. Another positive influence is seen in the change in responses to items concerning future

plans. After having a Fellow in their classes, more students indicated that they would take 1-2 more years of science courses in high school and more indicated that they would go to college.

S3.7.3 Scaffolded Development of Representational Skills in Chemistry: An Instructional Model to Integrate Ditigal Technologies

Annette I. Hilton, The University of Queensland, Australia, a.hilton@uq.edu.au

ABSTRACT: Success in chemistry requires students to understand its subject-specific representations and language. This study investigated the use of multimedia resources and multimodal writing-to- learn activities to enhance students' representational competencies and to develop their understanding. Students find chemistry challenging because of its abstract and complex nature and the need to understand and represent it on three levels: macro, submicro, and symbolic. This requires understanding complex concepts, representational competence (the ability to interpret and use multiple representations), and visualization skills. Two Year 11 chemistry classes in an Australian secondary school participated in the study (n = 27, n = 22). Pretest and posttest data and students' texts were collected and analysed and an evaluation questionnaire and student interviews were administered to examine the effect on students' learning outcomes and to identify the ways in which students used multiple representations to explain and predict chemical phenomena. Results revealed that using multimedia resources to learn and write in chemistry is effective for developing and improving students' understanding and their subject-specific literacies. These findings build on other research in this area by focusing on identifying instructional approaches that utilize multimedia applications for developing and enhancing students' learning outcomes in chemistry.

S3.7.4 Everyone Needs a PET – A Predictive Evaluation Tool to Help Teachers Select Technology

Michelle M. Mukherjee, The University of Queensland, Australia, m.mukherjee@uq.edu.au

ABSTRACT: There are many studies of the use of various forms of technology in science classes e.g. dataloggers, probes, simulation software. However, there is very little formal research work on how teachers identify productive technologies for use in the classroom. The research question for this study is: What are the explicit and tacit bodies of knowledge that teachers (should) consider when selecting technology for science classrooms? It proposes that for successful implementation of technology, there must be a match between the technological tool, the teacher, the students and the classroom environment. The study integrates data from interviews with experienced teachers discussing their approach to acquiring technology, existing inventories for the evaluation of classroom technology, usability theory to examine the "user friendliness", set up and maintenance of the technology, and Activity Theory to examine the physical classroom constraints together with the learning goals and the characteristics of the teacher and students. The study syntheses the data to produce a Predictive Evaluation Tool (PET) intended to help teachers supported the choice of included items, whilst novice teachers discovered new, previously unconsidered areas for evaluation that they found valuable.

Strand 5: College Science Teaching and Learning (Grades 13-20) S3.8 SC-Paper Set: Professional Development and Resources for College Faculty and Teaching Assistants 1:00pm – 2:30pm, Conference Room 405

S3.8.1 Synergistic Interactions of K-16 Partnership Work, Research, and Teaching in Higher Education Science Faculty Members

Deborah Pomeroy, Arcadia University, pomeroy@arcadia.edu

ABSTRACT: Work between higher education faculty and K-12 schools and teachers is fairly common, sometimes initiated by schools, sometimes designed by science professors under the aegis of broader impact as mandated by research grant solicitations and most recently mandated by the National Science Foundation's Math Science Partnership (MSP) solicitations. While most such work is focused on K-12 impact, this series of case studies examines the "push-back" effects of such work on the professors' teaching, scientific research, and in some cases, their institutions. The study is informed by and contributes to Ernest Boyer's discussion of scholarship in academia (Boyer, 1990). Four of the subjects of this study were engaged in an MSP project and one professor's work evolved from outreach as part of other research grants. All subjects formed partnerships characterized by mutual commitment, growth, respect and trust. The findings variously and powerfully illustrate interactions between: partnership work and the professors' teaching, partnership work and research, and teaching and research. It also uncovers factors impacting these interactions.

S3.8.2 The Role of Professional Community in Promoting Changes in College Science Instruction and Supporting Successful University-School Partnerships

Stacy Olitsky, Math and Science Partnership of Greater Philadelphia, olitsky@mspgp.org

ABSTRACT: The involvement of college faculty in schools has the potential to enhance K-12 instruction, as faculty can contribute content knowledge and research experiences. However, because college teaching tends to rely on lecture, faculty involvement could instead interfere with reform initiatives such as inquiry-based instruction. University-school partnerships might be more effective if participating faculty changed their instructional practices to reflect student-centered approaches. This paper investigates faculty change through a case study of twelve science and five math faculty who worked with one particular Math and Science Partnership.

Findings showed that faculty did not undergo extensive changes in their practice and sometimes reduced MSP participation when they experienced identity conflict and had little support for change among colleagues. However, faculty members who worked within a professional community that supported reform experienced high levels of commitment and changed their practices. This study offers insight into the role of identity conflict in faculty change and the importance of professional communities, and has practical implications for the administration of successful university-school partnerships. Recommendations include recruiting in teams from departments, providing numerous opportunities for collaboration with teachers and colleagues in other institutions, and supporting the "content provider" role-identity while still fostering collaboration with teachers.

S3.8.3 Reforming Undergraduate Science Courses: How Much Does Funding Matter?

Corinne Lardy, San Diego State University, corinne lardy@yahoo.com

Cheryl L. Mason, San Diego State University

ABSTRACT: A large amount of resources are invested in professional development programs designed to improve undergraduate science courses. However, little if any follow-up occurs concerning the sustainability of reform following professional development, especially for those who do not receive continued support. The goal of this study is to examine the long-term success of undergraduate STEM faculty in instituting and sustaining reforms in their science courses despite the lack of post-program grant support by the NASA Opportunities for Visionary Academics (NOVA) program. Data were collected through an online survey to assess subjects' level of perceived success in instituting and sustaining their proposed reforms, as well as components that influenced that success. Results reflect a complex combination of factors affecting the ability to institute and sustain reform, including those related to social and practical aspects, as well as motivation. Lack of NOVA funding did not result in a complete abandonment of reform efforts for a majority of subjects, especially when other sources of funding and/or a supportive social university network were available. In order for undergraduate science reform to be successful, faculty members expressed a need for strong motivation as well as support and cooperation from STEM and Teacher Education colleagues, and administration.

S3.8.4 Fostering the Facilitation of Collaboration: An Inquiry into Graduate Teaching Assistant Professional Development Bridget Brennan, University of Delaware, bridgetb@udel.edu

ABSTRACT: Graduate Teaching Assistants (GTAs) are a crucial part of undergraduate education at research universities, yet there is little research on programs designed to prepare GTAs for their pedagogical duties. This study is a qualitative inquiry into the GTA professional development associated with a design-based research laboratory curriculum project. The Collaborative Introductory Laboratory Activities (CILA) is a program designed to enhance student preparation for traditional chemistry laboratory experiments using small-group activities to create a collaborative learning environment. Our primary research question is: How do the teaching practices of GTAs evolve during participation in the CILA project? A multiple case study approach is utilized to evaluate the impact of the project on GTA instructional practices. The focus of the laboratory observations was the GTA actions with respect to teaching the CILA curriculum on a weekly basis. Some of the deviation from the intended instructional practices is attributed to the CILA project materials or implementation and some of the deviation appears to be GTA initiated. Our work adds to literature suggesting a tendency for some GTAs to value their personal experiences and naïve theories about learning over their professional development experiences.

Strand 6: Science Learning in Informal Contexts

S3.9 SC-Paper Set: Investigating Informal Science Education on a Large-Scale 1:00pm – 2:30pm, Conference Room 406

S3.9.1 Measuring the Impact of a Science Center on Its Community

John H. Falk, Oregon State University, falkj@science.oregonstate.edu

ABSTRACT: In 1996 research was begun in an effort to document the impact of the California Science Center on its community. This paper reports on one part of that research, a series of random telephone surveys of the L.A. community. Results suggest that over a ten year period the Science Center positively impacted nearly half of L.A.'s adults. The vast majority of whom agreed that visiting increased their science knowledge and interest, and changed their behavior. Examples of learning spanned the range of content areas presented at the Science Center. The main form of learning was reinforcement and extension of existing knowledge. This finding was reinforced by significant changes in the public's understanding of a "marker" concept, which as predicted, also showed that learning is cumulative and difficult to attribute accurately. Finally, results also demonstrated a relationship between the public's perception of its science understanding and visits to the Science Center. Individuals who visited the Science Center were more

informed/knowledgeable about science than those who did not visit the Science Center. Collectively, the data suggest that the Science Center directly contributes to the science learning, interest, and behavior of a large subset of the L.A. community.

S3.9.2 A Multisited Ethnography of Diverse Urban Youths' Forms of Participation and Intercultural Positioning In Community Science Programs

Irene Rahm, Université de Montréal, Canada, jrene.rahm@umontreal.ca Fasal Kanouté, Université de Montréal, Canada

Anne Gorry, Université de Montréal, Canada Itzel Vazquez, Université de Montréal, Canada Audrey Lachaîne, Université de Montréal, Canada

ABSTRACT: We know little about diverse families' and youths' engagement in science outside of school and what such engagement does for them or what form it takes. In this paper, we offer stories of diverse urban youths' engagement in science drawn from a multisited ethnography, a research tool that moves the research imaginary beyond site-based studies of science literacy development towards its study across space and over time. ArtScience is a science club in a Saturday tutoring program of a community center while the scientific journal writing activity took place in an afterschool science program for girls only, Scientifines. Through four stories of youths' forms of participation and intercultural positioning work, we illustrate the complex interweaving of ways of knowing that are culturally constituted yet enrich meaning making of science. As shown, by putting cultural ways of knowing to use, youth can come to own science and experience agency in science. In the conclusion, we discuss insights gathered through this project about ways we may inform and guide the vast infrastructure of informal science to tap into cultural ways of knowing that then may enrich science literacy development for all involved.

S3.9.3 The Use of the Nature of Scientific Knowledge Scale as an Entrance Assessment in a Large, Online Citizen Science Project

Aaron Price, Tufts University, aaron.price@tufts.edu

ABSTRACT: Citizen Sky is a new three-year, astronomical citizen science project launched in June, 2009 with funding from the National Science Foundation. This paper reports on early results of an assessment delivered to participants when they first join the project. The goal of the assessment, based on the Nature of Scientific Knowledge Scale (NSKS), is to characterize their attitudes towards the nature of scientific knowledge. Our results are that the NSKS components of the assessment achieved high levels of reliability. Both reliability and overall scores fall within the range reported from other NSKS studies in the literature. Correlation analysis with other components of the assessment reveals some factors, such as age and understanding of scientific evidence, may be reflected in scores of subscales of NSKS items. Further work will be done using online discourse analysis and interviews. Overall, we find that the NSKS can be used as an entrance assessment for an online citizen science project.

S3.9.4 The Impact of Free-Choice STEM Experiences on Girls' Interest, Engagement, and Participation in Science Communities, Hobbies and Careers: Results of Phase 2

Lynn D. Dierking, Oregon State University, dierkinl@science.oregonstate.edu

Dale McCreedy, Franklin Institute Science Museum

ABSTRACT: This paper describes research findings investigating long-term impacts of informal science, technology, engineering, and mathematics (STEM) experiences on girls. The goal is to determine whether informal contexts contribute to science learning broadly defined as careers and education but also hobbies and habits-of-mind. Four investigations provide increasingly in-depth insights into how informal STEM experiences influence girls' interest, engagement, and participation in science. A web-based survey of 67 women gathered data about early free-choice STEM experiences to determine impacts and understand ways in which they describe their relationship to science. Participants were recruited from five initiatives for girls; most had participated at least 10 years before. Findings suggest a range of impacts, some STEM-related, but also improved self-esteem and leadership skills. Salient features and impacts are intertwined with life experiences both far-reaching and complex. Science-related hobbies indicate broad perceptions of "what science is." There is evidence for the role of community, particularly for women who pursued further education or careers; professional networks established by programs were beneficial. Findings will help identify active and core participants to contact next; in-depth phone interviews will probe impacts in more depth. A subsample of young women will also be visited, and focus groups and observations conducted.

Strand 7: Pre-service Science Teacher Education S3.10 SC-Paper Set: Content Specific Issues in Pre-Service Teacher Education

1:00pm – 2:30pm, Conference Room 407

S3.10.1 Attitudes of Teacher Students towards Fostering Comeptence-Oriented Teaching of Biology

Doris Elster, University of Vienna

ABSTRACT: This study reports findings of the initial part of the project BIOKOMP (Competence Oriented Teaching and Learning in Biology), a four-years-lasting Austrian-wide project financed by the Austrian Foundation of Research. The project aims to facilitate the implementation of national educational standards in the biology domain. On the level of pre-service education the key question is about the change of student teachers' attitudes towards competence oriented teaching and learning of biology (e.g., fostering of the competency areas subject knowledge, subject inquiry, subject-related communication and judgement; KMK 2004) during their university education. These characteristics are related to teachers' personality traits (McCrae & Costa, 1999), their self-concepts of teaching and learning and their epistemological knowledge. The data are based on a questionnaire survey conducted at the University of Vienna in 2009. 360 teacher students (210 beginners, 150 advanced) participated in the survey (quasi-experimental design; factor analysis). The main findings (i) allow classifying in three student types: subject-related (52%), method-innovative (25%), context-

oriented (23%); (ii) regarding the students' attitudes to foster competences seven factors can be identified; (iii) extraversion, mental stability and conscientiousness are accompanied by commitment and openness in exercising the aspired competence orientation, (iv) the university education has little impact on the attitudes of the students.

S3.10.2 Backwards Faded Scaffolding Impact on Pre-Service Teachers' Cognition in Astronomy

Stephanie J. Slater, University of Wyoming, sslaterwyo@gmail.com

Daniel J. Lyons, University of Wyoming

Timothy F. Slater, University of Wyoming

ABSTRACT: In response to national reform movements calling for future teachers to be prepared to design and deliver science instruction using the principles of inquiry, we created and evaluated a specially designed course for pre-service elementary education undergraduates based upon an inquiry-oriented teaching approach framed by the notions of backwards faded-scaffolding as an overarching theme for instruction. Students completed both structured- and open-inquiry projects and presented the results of their investigations several times throughout the semester. Using a single-group, multiple-measures, quasi- experimental design, students demonstrated enhanced content knowledge of astronomy and inquiry as well as attitudes and self-efficacy toward teaching as measured by the Test of Astronomy STandards (TOAST), the Science Teaching Efficacy Belief Instrument – Version B, and the Attitudes Toward Science Inventory.

S3.10.3 Examining Student Teachers' Use of Atomic Models in Explaining Subsequent Ionisation Energy Values

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ABSTRACT: Students' explanations of ionisation energy phenomena have revealed a number of non- scientific or inappropriate ideas being used in their arguments. Research has attributed this to many science teachers using these ideas themselves (Taber, 2005-6 and Tan and Taber, 2009). This research extends this work by considering which atomic models are used in these explanations and how that relates to the causality of ideas expressed. 24 pre-service teachers were interviewed. Each was asked to describe the features of an atom that they could note from 4 different atomic representations (Rutherford, Electron cloud micrograph, Bohr and Schrödinger types). They also provided an explanation for the subsequent ionisation energy values for an oxygen atom and identified which representations were helpful in explaining the values. Significantly, when pre-service teachers only used Bohr type representations they did not use repelling electron ideas in their explanations. However arguments that were based on electron – electron repulsion, used Schrödinger atoms. These findings suggest that many pre-service teachers need to develop Schrödinger type atomic models, which can accurately represent the charge properties of electrons and hence, allow electrostatic principles to be applied correctly to atoms.

S3.10.4 Towards Treating Chemistry Teacher Candidates as Human

Brian Lewthwaite, University of Manitoba

Rick Wiebe, St James-Assiniboia School Division

ABSTRACT: The purpose of this study is to apply the research orientations of both Learning Environment research and Bronfenbrenner's bioecological model in an integrated manner to both understand and systematically conceptualize the individual chemistry teacher candidate (student teacher) personal attribute and environmental factors that influence teacher candidate development during their teaching practicum. It emphasizes that individual attributes and characteristics of the environment, in particular the microsystem, have the ability to enable or constrain chemistry teacher candidate development. Furthermore, it endeavors to both identify and systematically represent these attributes in a format that allows teacher candidates to self-evaluate and reflect-onaction. Furthermore, the study uses this information to provide strategies for teacher educators for systematically providing support for teacher candidates in their developmental trajectories.

Strand 8: In-service Science Teacher Education

S3.11 SC-Paper Set: Reasoning and Modeling

1:00pm – 2:30pm, Conference Room 408

S3.11.1 Teaching for Transfer: Transforming Knowledge into Practice

Leigh K. Smith, Brigham Young University, leigh_smith@byu.edu

Pamela Cantrell, Brigham Young University

ABSTRACT: Aligning classroom practice with current standards requires significant knowledge of subject matter, context, and inquiry pedagogy. According to Shulman's Model of Pedagogical Reasoning and Action (1987), also requisite is the ability to transform this knowledge into forms that are pedagogically powerful and yet adaptive to a variety of student abilities and backgrounds. This transformation lies at the point where the various forms of teacher knowledge intersect, where comprehended ideas are interpreted and then represented in ways that can be understood and learned by others. In this study, this process of transformation is conceptualized as a type of learning transfer, which occurs when learning in one context enhances or undermines a related performance in another context. A total of 52 teachers (grades 3-12) participated over three years in a yearlong professional development program in which specific instructional strategies designed to foster learning transfer were utilized. Results indicate that

participants made significant improvements over time in their understanding of inquiry and their ability to develop inquiry-based learning experiences and enact them in their classrooms. These findings suggest that teaching for transfer fosters the ability to transform knowledge into practice and holds promise for inservice science teacher education.

S3.11.2 What Makes For An "Exemplary" Science Lesson?: Model Based Reasoning And Science Teachers' Evolving Understanding Of Curriculum

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

Patrick F. Dowd, University of California, Davis

Connie J. Hvidsten, University of California, Davis

Lin Xiang, University of California, Davis

Arthur C. Beauchamp, University of California, Davis

ABSTRACT: This study examines whether and in what ways in-service science teachers' conception of quality instruction changed after participating in a multi-year professional development program centered on model-based reasoning (MBR). This program aimed to guide science teachers to an understanding of the way models are used in the generation of scientific knowledge and how model-based reasoning can be used as an instructional tool in 6th – 12th grade science classrooms. Data from a cohort of 24 teachers was analyzed to explore changes in the teachers' goals for instruction, their methods for reaching those goals, the criteria they chose when critiquing their lessons, and evidence that elements of an MBR perspective infused teachers evolving understanding of curriculum and instruction. A detailed case study of seven representative teachers explicates the broad data emerging from the larger group of 24. Data sources include: writing prompts, focus groups and video documentation. Findings show participants' evolving understanding of exemplary science instruction after the professional development program included making connections with real world phenomena, incorporating peer oriented dialogue allowing for argumentation and the logical construction of ideas, and placing greater emphasis on student conceptual understanding rather than on student affect and engagement.

S3.11.3 Teacher Learning: Co-Constructing An Understanding Of Model-Based Reasoning And Its Implementation In Secondary Classroom Contexts

Connie J. Hvidsten, University of California, Davis, cjhvidsten@ucdavis.edu

Cynthia Passmore, University of California, Davis

ABSTRACT: This study evaluates what secondary science teachers report to have learned, how new learning impacted their teaching practices and how these aspects of teacher learning track to specific elements of a sustained professional development program centered on model-based reasoning (MBR). MBR is an approach to instruction that engages students in using scientific models – sets of ideas – to make sense of the world in much the same way that scientists use models to formulate explanations and make predictions. The design of the two-year program provided an opportunity for teachers, scientists and researchers to co-construct knowledge about MBR, the design of MBR curriculum, and classroom implementation of MBR lessons. The study documents the knowledge gains reported by teachers in four areas: self knowledge, science content knowledge, pedagogical content knowledge and knowledge about the integration of MBR into school and classroom contexts. The research relied primarily on teachers' individual written reflections and interview responses, while focus groups, video of teacher interactions, and curriculum development products provide triangulating data. This study helps to demonstrate how partnerships between researchers and teachers can inform the planning and improvement of MBR-focused professional development while also helping to understand how MBR can be productively implemented in science classrooms.

S3.11.4 Hat Are The Differences Between Science Majored And Non-Science Majored In-Service Teachers' Knowledge About Functions Of Models And Modeling Processes?

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Hsiu-Fen Lin, Taipei Municipal University of Education

Yu-Lun Wu, Taipei Municipal University of Education

ABSTRACT: The purposes of this study are three. First, understand in-services teachers' viewpoints about the functions of models and modeling processes. Second, compare the differences between the science majored and the non-science majored teachers' viewpoints. Third, explore the reasons of the differences between the science majored and the non-science majored teachers' viewpoints further. This study adopts 4-points Likert-type scale of Model and Modeling in Methodology perspective to measure the 81 in-services teachers' (50 science majored and 31 non-science majored) knowledge about functions of models and modeling processes. Among them, six teachers are selected to think aloud and observe their ranking more deeply. One month after ranking the scale, 24 teachers are randomly selected for a follow-up interview to understand the reasons of these teachers' ranks. The results show these teachers hold positive agreement in all items. Except the items in advanced level of functions of model, the agreement scores of the science majored teachers are lower than the non-science majored ones. The quantitative analysis show the possible reasons are science majored teachers tend to rank their answers in a rigorous manner, and the functions of models for science and social science are different. In the end, implications are discussed.

Strand 9: Reflective Practice

S3.12 SC-Paper Set: Uses of Technology

1:00pm – 2:30pm, Conference Room 409

S3.12.1 Cognitive Presence in E-mail Listserv: Secondary Teachers' Reflective Discourses on Food and Nutrition Instruction Ting-Fang Hsu, Indiana University, thsu@indiana.edu

ABSTRACT: The purpose of this qualitative research was to examine the ways in which secondary teachers reflected on their food and nutrition instruction through their asynchronous online text conversions in an e-mail listserv. The cognitive presence is a fundamental element that allows computer-mediated communication to enhance higher education, also known as critical thinking. The use of listserv allows for open consideration of different perspectives through discussions of meanings of terms, concepts, and themes because of its cognitive presence. Additionally, it supports subscribers to overcome the current and future challenges by integrating perceived knowledge and information into their existing schema and forming collaborations. The study collected a total of 2586 e-mails of a statewide e-mail listserv from June 2006 to May 2008, and 925 of them were identified food- and nutrition-related content. The coding scheme used to analyze e-mails was guided by the Community of Inquiry model, developed by Garrison, Anderson, and Archer (2000). The findings provided first-hand information that serves as a reference for educational institutions and government agencies examining and establishing school-based health initiatives. The issues of science teaching (e.g., food labs) mentioned by the subscribers can also inspire science educator and researchers to get involved in school nutrition education.

S3.12.2 Research into Practice: Using Digital Video to Foster Pre-Service Science Teachers' Collaborative Reflection around Scientific Inquiry

Len Newton, The University of Nottingham, UK, len.newton@nottingham.ac.uk

Pete Sorensen, The University of Nottingham, UK

ABSTRACT: This paper reports on the use of digitally mediated video in one UK initial science teacher education course to foster collaborative reflection around scientific inquiry. A primary purpose of the research was to encourage a habit of practitioner inquiry in beginning teachers that can support their career-long collaborative reflective practice. The work is situated within a theoretical frame that draws upon social constructivist and dialogic learning theory, situated cognition and the development of theory through praxis. We report evidence derived from learning episodes in the Nature of Science, involving activities constructed around and mediated through the use of digital video of exemplary teaching and video of the participants' own teaching. The latter videos were themselves used in a further teaching episode. The episodes generated discussion board postings, participants' teaching videos, and group activities around these that were videoed and subjected to content analysis. Phased focus group discussions provided further evaluative evidence of the participants' experience of the approach. The findings show that whilst there are logistical obstacles to be overcome, digital video can help to develop observational skills and foster an approach that reflects inquiry stances in contemporary science curricula.

Strand 10: Curriculum, Evaluation, and Assessment

S3.13 SC-Paper Set: Developing Standards-Aligned Items to Assess Student Understanding 1:00pm – 2:30pm, Conference Room 410

S3.13.1 Probing Middle and High School Students' Understanding of the Forms of Energy, Energy Transformation, Energy Transfer, and Conservation of Energy Using Content-Aligned Assessment Items

Cari F. Herrmann-Abell, AAAS Project 2061, cabell@aaas.org

George E. DeBoer, AAAS Project 2061

ABSTRACT: This paper presents a summary of middle and high school students' understanding of the topic of energy and the differences and similarities in the ideas that the middle and high school students hold. The student data are a result of a field test of items aligned to ideas about forms of energy that was administered to 8225 middle and high school students in 35 states and a pilot test of items aligned to ideas of energy transformation, energy transfer, and the conservation of energy that was administered to 3238 middle and high school students in 30 states. This work is part of a larger project to develop items that are precisely aligned with national content standards. Each item is developed using a procedure designed to evaluate an item's match to important science ideas and its overall effectiveness as an accurate measure of what students do and do not know about those ideas. During item development, feedback is obtained from students during pilot testing and from scientists and science education experts during a review of the items using a set of criteria to ensure content alignment and construct validity. After revisions are made based on the feedback, the items are field tested on a large national sample to determine the psychometric properties of the items.

S3.13.2 Using Content-Aligned Assessments to Probe Middle School Students' Understanding of Fundamental Concepts for Weather and Climate

Jill A. Wertheim, AAAS/Project 2061, jwerthei@aaas.org George E. DeBoer, AAAS/Project 2061

ABSTRACT: Despite the recent emphasis on promoting public understanding of climate change, there has been little effort focused on examining how well students understand the concepts that underlie this complex topic. We report on the results from pilot testing of 90 multiple-choice assessment items aligned to essential ideas about weather and climate. The items assess students' knowledge of and misconceptions about the properties of air, changes in air temperature (including daily and seasonal change), causes of wind, changes in humidity, and precipitation. The items were administered to 2063 middle school students and 1006 high school students from 76 schools across the country, sampling a wide range of demographic groups. This paper will describe the pilot test results and the insights these data offer into 6-12th grade students' misconceptions, compare the results of high school students and middle school students, and will describe how student comments have been used to determine which items most successfully assess the targeted knowledge. This work is part of a larger project funded by the National Science Foundation to develop items that test knowledge of national middle school content standards and to determine the prevalence of common alternative ideas.

S3.13.3 Testing the Validity of an Approach for Developing High Quality Assessment Items in Middle School Science

George E. DeBoer, AAAS Project 2061

Cari F. Herrmann-Abell, AAAS Project 2061

Jill A. Wertheim, AAAS Project 2061

ABSTRACT: We report here on a study that we conducted to determine the validity of a central aspect of an approach that we use for developing high quality assessment items in middle school science. Our item development process involves a two-year cycle of creating and refining items according to a set of alignment criteria, and then using feedback from students obtained during pilot testing and feedback from expert panels of reviewers combined with rigorous psychometric analysis of the pilot test data including Rasch analysis in the revision process. In this presentation, we focus on the extent to which student responses change between pilot and field testing. We found that some changes did lead to significant changes in how students responded, and that this resulted in more valid measures of student knowledge; some changes affected student responses to particular misconceptions but not the correct answers; and some changes had essentially no impact on the way students responded. The work is part of a multi-year, NSF-funded project to develop assessment items aligned to middle school content standards for 16 topics in science, mathematics, and the nature of science (Author, 2008).

S3.13.4 Probing Students' Ideas about Models Using Standards-Based Assessment Items

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Jo Ellen Roseman, AAAS Project 2061

ABSTRACT: This paper presents assessment items aligned to key ideas about models and describes how we use information gathered from the students to gain insight into students' thinking as well as insights about the quality of the items themselves. We report the results of a pilot test of 68 assessment items administered to 2170 sixth, seventh, and eighth grade students from 68 widely varying school districts from 27 different states in the spring of 2009. Our data indicates that while about three quarters of middle school students believe that objects can be modeled, only about half believe that events and processes can be modeled. In addition, our data indicate that about a third of students believe that making a model more similar to its referent always makes it a better model, a larger percentage of students than reported in other studies. Since students participating in the pilot test were asked to provide explanations for their answer choices, we will use these explanations to provide further insights on the quantitative results in the final paper.

Strand 11: Cultural, Social, and Gender Issues

S3.14 SC-Paper Set: Constructing Views of Self and Science through Classroom Discourse 1:00pm – 2:30pm, Conference Room 411

S3.14.1 Exploring Urban African-American Girls' Understandings of the Nature of Science Through the Use of Worldview Theory

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Cassie F. Quigley, Indiana University-Bloomington

Nicole Beeman-Cadwallader, Indiana University-Bloomington

Valarie L.Akerson, Indiana University-Bloomington

ABSTRACT: The construct of the nature of science (NOS) has been advocated as an important goal for school science for approximately 100 years (Central Association of Science and Mathematics Teachers, 1907). However, present in the NOS literature is often a broad statement of students' understandings of nature of science aspects, without mention of race, socioeconomic background, or gender (Walls, 2009). In order to assure a more inclusive understanding of students' understandings of NOS, we sought to understand the worldviews of 75 African American girls at an all girls science academy in an urban area. Our research efforts included the girls' views of NOS and how context shapes those views to develop understandings that improve overall equity – that is, we approached the methodological design from a feminist perspective (Lather, 1986, 2001; Reinharz, 1992) with worldview theory guiding our studies. Through individual and focus group interviews we discovered the girls held a broadened sense of science. Overall

these girls demonstrated that, to them, faith is a part of science, science includes ways to understand history, science is inherently useful, and the girls have a broadened conception of what constitutes science.

S3.14.2 Interplay of Discourses (D / D1) as Third grade Urban and Suburban Students Learn Science

Carmen Mendoza, University of Cincinnati, karinuc@yahoo.com

ABSTRACT: This qualitative research project is a multidimensional comparative critical discourse analysis (CDA) of the interanimation of Discourses (D/D1) in an urban versus suburban elementary science classroom. D designates the instructional and formal academic science Discourse and D1 represents the students' social, home language Discourses. Communicative approach and distinct patterns of interaction are critically analyzed as the science teachers enact the same kit-based, inquiry science lesson with their respective urban and suburban students. CDA provides both the theoretical framework and micro-sociocultural level analytical lens. The overarching goal is to examine underlying issues of equity and power embedded in the instructional Discourse of science. These factors may contribute to the persistence of the gap in achievement between urban and suburban students learning science. The research also informs development of linguistic-based "best" practices to contribute toward promoting linguistic environments that support all students learning science Discourse and to serve as a springboard for future educational science researchers' use of CDA.

S3.14.3 Leveraging Students' Everyday Resources: A Microanalysis of Classroom Interactions in a 4th Grade Lesson Blakely K. Tsurusaki, Washington State University, tsurusaki@wsu.edu

ABSTRACT: This study seeks to understand how a third/hybrid space is created, where students draw their everyday knowledge and experiences during in a school science lesson. It analyzes a lesson where the students learn and apply their understanding of adaptations and ecosystems in order to design a bird. This lesson takes place in a 4th grade classroom in an urban school in the Midwest that serves predominately low-income, minority students. I use discourse analysis to examine how the interactions between the teacher and students 1) create, maintain and change the object/goal of the activity; 2) position the teacher and students; and 3) create a third/hybrid space where the students leverage their everyday resources.

S3.14.4 Students' Subject Positioning According to Science Teaching Modalities in Terms of Discourse Register and Language Code

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Chan-Jong Kim, Seoul National University

ABSTRACT: Research into the role of language in science classroom needs to study students' pedagogic subject positioning not with the vocabulary used in the discourses, but with the discursive interaction itself. In this study, the formation of students' pedagogic subject positioning was examined according to the linguistic and grammatical features of a science classroom discourse in terms of the discourse register and language code. This study also, investigated the variation in students' pedagogic subject positioning based on the modalities of science teaching according to the discourse language code. The participant in this qualitative case study was a middle school Earth science teacher. Data included transcribed discourse texts from four seventh-grade lessons on rocks and rock forming processes. The discursive interaction between a teacher and students posed students specific pedagogic subject position such as a successful science learner, a positive science discourse participant, a simple discourse participant, and a failed science learner. The science classroom discourse in a specific teaching modality can serve as an intermediary for students' pedagogic subject position and their being members of science learning community of practice. A teacher's pedagogic subject positioning students as successful science learners can be the route towards the promotion of their science learning.

Strand 12: Educational Technology

S3.15 SC-Paper Set: Technology, Teacher Learning, and Teacher Practice

1:00pm – 2:30pm, Conference Room 412

S3.15.1 Using Video Games to Support Pre-Service Elementary Teachers Learning of Basic Physics Principles

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

Michael Barnett, Boston College

ABSTRACT: The purpose of this work is to share our findings in using video gaming technology to facilitate the understanding of basic electromagnetism with pre-service elementary teachers. To this end we explored the impact of using a game called Supercharged! on pre-service teachers' understanding of electromagnetic concepts compared to students who conducted a more traditional inquiry oriented investigation of the same concepts. Results of this study show that video games can lead to positive learning outcomes, as demonstrated by the increase in test scores from pre- to post-assessment. Additionally, this study also suggests that a complementary approach, in which video games and hands-on activities are integrated, with each activity informing the other, could be a very powerful technique for supporting student scientific understanding. Further, our findings suggest that video game designers should embed meta-cognitive activities such as reflective opportunities into educational video games to provide scaffolds for students and to reinforce that they are engaged in an educational learning experience.

S3.15.2 Can A Digital Switchover In Primary Science Switch On The Learner?

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Julian G. Greenwood, Stranmillis University College Belfast Northern Ireland

ABSTRACT: This paper reports on the design, implementation and findings from an innovative continuing professional development (CPD) programme, 'Digitally Resourced Engaging And Motivating Science' (the DREAMS Project). The project seeks to develop teachers' and schools' use of digital resources within primary science, by firstly modelling the approach and then supporting a cluster of teachers and schools in their development. The project comes at a time of curriculum reform within Northern Ireland which may possibly result in the marginalisation of science. The project therefore connects science, through the creative use of ICT ,to other areas of the curriculum such as Literacy, Numeracy and Thinking Skills and Personal Capabilities. Evaluation data collected by questionnaires, classroom observation tasks, focus group interviews, teachers' journals, videos and video diaries, report that the use of data-loggers, Digital Movie Creators and computer microscopes greatly enhance children's attitude to science and promote the engagement and learning of children aged between 6 and 11. The project has greatly developed the confidence and competence of the teachers involved with all schools seeking to embed this approach in their future practice.

S3.15.3 Learning in Context: Technology Integration in a Teacher Preparation Program Informed by Situated Learning Theory

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Randy L. Bell, University of Virginia

ABSTRACT: This investigation explores the effectiveness of a teacher preparation program aligned with situated learning theory by examining how program participants used technology during their student teaching experiences. Participants included 26 preservice science teachers enrolled in a two-year MT program. A specific program goal was to prepare teachers to use technology to support reforms-based science instruction. To this end, the program integrated technology instruction across five courses, and situated this instruction within the context of learning to teach science. A variety of data sources were used to characterize the participants' intentions and instructional practices, including classroom observations, lesson plans, interviews, and written reflections. Data analysis followed an analytic induction process and sought to describe how and why the participants integrated technology into their instruction. Results indicated that all participants used technology throughout their student teaching, including digital images, videos, animations, and simulations. The seminar that accompanied student teaching provided opportunities to plan instruction and share successes and frustrations with peers and student teaching supervisors. As a result, they became increasingly proficient in incorporating specific models of instruction as the semester progressed. These findings support the application of situated learning theory in preparing teachers to integrate technology in science instruction.

S3.15.4 Using Peer-Driven Web-based Formative Assessment to Improve Students' e-Learning Effectiveness

Tzu-Hua Wang, National HsinChu University of Education, Taiwan, thwang@mail.nhcue.edu.tw

ABSTRACT: This research tries to develop the 'Peer-Driven Assessment Module of the WATA system (PDA-WATA)' on the basis of the WATA system. The major purpose of PDA-WATA is to create an active mode of cooperation between 'examinees, peers and teachers', giving examinees more diverse feedbacks provided by peers. The main assessment strategies of PDA-WATA are: 'Adding Answer Notes,' 'Reading Peer Answer Notes,' 'Recommending Peer Answer Notes' and 'Stating Confidence.' Examinees are allowed to add answer notes to explain why they choose the answers and state their confidence about the explanations (answer notes) for peer reference. Besides reading peer answer notes, examinees can also recommend the peer answer notes they take as the most valuable reference. The recommendation can be queried by all examinees. Quasi-experimental design was adopted to understand the effectiveness of PDA-WATA in an e-Learning environment. Participants were 125 seventh-grade students. In the PDA-WATA group, the Web-based assessment in the e-Learning environment is administered in the form of PDA-WATA. In the N-WBT group, it is administered in the form of normal Web-based test (N-WBT group). The result indicates that students in the PDA-WATA group have significant better learning effectiveness than those in the N-WBT group.

Strand 13: History, Philosophy, and Sociology of Science S3.16 Administrative Symposium: Putting Nature of Science Research into Classroom Practice: Real Teachers...Real Teaching

1:00pm – 2:30pm, Conference Room 413 **Presenters:** Valarie L. Akerson, Indiana University Robert Pearson, Eddyville Schools, Oregon Alice SL. Wong, The University of Hong Kong Ho Lin Lie, Po Kock Secondary School, Hong Kong Ellen Granger, Florida State University, Florida Karen Rose, Rickards High School, Florida Norman G. Lederman, Illinois Institute of Technology

Judith S Lederman, Illinois Institute of Technology Norman G. Lederman, Illinois Institute of Technology Judith S Lederman, Illinois Institute of Technology

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

Sherry A. Southerland, Florida State University

ABSTRACT: The philosophical and empirical work on nature of science is rich. But how is this work translated into practice by classroom teachers? What are teachers actually doing in their classrooms to teach about the epistemological basis of science? How do they take research recommendations and implement them in their daily practice? What challenges do they encounter? What supports and resources are most helpful? This symposium gathers researchers, teacher educators, and teachers to discuss the reality and practicality of presenting the epistemological basis of science within the confines of a science classroom. Practicing K-12 teachers will present examples of their teaching and describe their experiences of putting research into practice.

Strand 14: Environmental Education

S3.17 SC-Paper Set: Teachers' Impacts on Environmental Education

1:00pm – 2:30pm, Conference Room 414

S3.17.1 Investigation of Pre-Service Science Teacher's Beliefs Regarding the Nature of Environmental Knowledge

Elif Adibelli, Middle East Technical University

Ozgul Yilmaz-Tuzun, Middle East Technical University

ABSTRACT: This study is an investigation of prospective science teachers (PSTs)' epistemological beliefs regarding the dimensions of source, certainty and structure of knowledge in the domain of environment and whether environmental epistemological beliefs in these dimensions differ across knowledge in the domains of physics, chemistry, biology and mathematics. The participants of the study consisted of 17 PSTs. The instrument used for assessment of PSTs' epistemological beliefs regarding knowledge was a semi-structured interview developed by Schommer-Aikins (2008). To examine domain-specific epistemological beliefs, participants answered each question first for the domain of environment and then the domains of physics, chemistry, biology and mathematics. Comparative data analyses methods were used to analyze data. The qualitative analyses of PSTs' responses to a set of interview questions indicated that PSTs' do not espouse the same beliefs regarding the source, certainty and structure of environmental knowledge, the nature of knowledge. The findings of this study also highlighted that in addition to the amount of environmental knowledge, the nature of knowledge gained in environment must be addressed in environmental education.

S3.17.2 Revitalization of the Shared Commons: Implications for Eco-Justice and Place-Based Education

George E. Glasson, Virginia Polytechnic Institute and State University, glassong@vt.edu

ABSTRACT: Understanding the underlying eco-justice issues that are involved in revitalizing the shared commons is essential for understanding place-based education in the context of education for sustainability. This paper reports on research that describes how indigenous farmers struggle to practice sustainable agriculture within the context of globalization and the colonial legacy of economically marginalized countries in Africa. Interviews in English and local tribal languages were conducted in a sub-Saharan African country with traditional farmers to better understand sustainable agricultural practices that have been passed down from generations. Opportunities were provided for sustainable practices to be described within the hybridized realm of third space connecting western and indigenous knowledge. The farmers in these interviews shunned the use unaffordable synthetic fertilizers that eventually depleted the soil in favor of traditional organic farming practices. Unfortunately, indigenous knowledge is marginalized in the standardized school curriculum and the knowledge and practice of sustainable agriculture is being lost. The data was used to inform practice for developing a place-based curriculum that focuses on eco-justice issues involved with sustainable agriculture. In this curriculum, collaboration with community elders and active engagement of children in growing gardens contributed to revitalization of the shared commons.

S3.17.3 Exploring Science Teachers' Affinity for Nature

Charles J. Rop, The University of Toledo, Crop@utoledo.edu

ABSTRACT: This paper presents research on teachers' professional attitudes and choices about teaching in natural areas and their personal attitudes and choices about interacting with nature. Children's current estrangement from nature and its implications for the future have become common knowledge. It is also recognized that in order to properly care for the natural world people must care about it. Care requires familiarity: individuals rarely work to protect or nurture that which is unfamiliar or strange. Science and environmental education teachers have potential for mitigating this problem by engaging students with the natural world in deep and thoughtful ways. However, research indicates that this rarely happens. Previous research shows teachers often feel apprehensive about their lack of training and preparation as well as the lack of curricular support for teaching outside, leading to an assumption that professional development programs designed to address these concerns is the solution. In the research presented here science and environmental education teachers claim to highly value nature interactions for students but do not necessarily value similar

experiences for themselves. This suggests that teachers' lack of personal affinity for nature may create a significant barrier to the efficacy of professional development programs designed to facilitate such study.

S3.17.4 The Piloting of Two Instruments to Measure Prospective and Practicing Teachers' Understanding of and Attitudes about Global Climate Change

Julie Lambert, Florida Atlantic University, jlambert@fau.edu Abdou Ndove, University of North Carolina Wilmington Cyndy Leard, FutureVision, Inc. Joan Lindgren, Florida Atlantic University Laura Cottongim, University of Hawaii

ABSTRACT: Climate change has become an important global issue, and it is critical that teachers have an understanding of the fundamental science, the natural and human-induced factors affecting climate, and the potential consequences and solutions in order to educate their students on this important issue. Also, embedding an interdisciplinary theme, such as climate change, provides an opportunity to model inquiry-based science instruction while also reviewing fundamental science concepts from the earth, life and physical sciences. In order to develop effective teachers in this area, it is important to determine the current level of knowledge teachers have in the content areas associated with the global climate change issue as well as, appropriate instructional interventions necessary to ameliorate any knowledge shortfalls. One way to obtain this information is to measure teacher understanding using a formative and summative assessment instrument. This paper describes the development and pilot testing of two such instruments derived from the constructive modeling approach framework. The four building blocks of this approach (the construct map, items design, outcome space, and measurement model) are discussed. In addition, the pilot test including the instructional intervention is described along with findings from the study, and an analysis of the instruments themselves.

Strand 15: Policy

S3.18 SC-Paper Set: Elementary School Science and NCLB: Challenges and Responses 1:00pm – 2:30pm, Conference Room 415

S3.18.1 District Leadership and Policy for Science Education under NCLB: The Use of K-12 Departments to Support **Elementary Science Education**

Christopher L. Miller, University of Illinois at Chicago, clmiller@uic.edu

ABSTRACT: By contrasting two qualitative case studies of school districts, taken from a broader study of eight school districts, this paper demonstrates the utility of K-12 departments in supporting science education, especially at the elementary level. District-wide departments are particularly useful under NCLB, both as a response to the policy's push towards the articulation of curriculum across all grades and as a possible bulwark against NCLB's erosion of instructional time on science at the elementary level.

S3.18.2 Toward a Curricular Policy for Advancing School Reform by Integrating Reading Comprehension within Time-**Expanded Science Instruction in Grades K-5**

Michael R. Vitale, East Carolina University, vitalem@ecu.edu

Nancy R. Romance, Florida Atlantic University

ABSTRACT: Identified are implications for curriculum policy in grades 3-4-5 that would justify replacing time for traditional reading instruction with increased time for in-depth science instruction within which reading comprehension is integrated. Presented are the findings of a multi-year NSF-funded study which found that such an integrated model (Science IDEAS) resulted in greater student science and reading achievement in grades 3-4-5 and positive achievement transfer in science and reading to grades 6-7-8. Discussed are issues in building the capacity of schools necessary for implementing such in-depth science models in grades 3-4-5 and adaptations of the model for grades K-1-2 that would increase the amount of time science is taught in grades K-5.

S3.18.3 Elementary Teachers' Beliefs about Teaching Science: Examining the Impact of Pre/Post NCLB Testing in Science

Andrea R. Milner, Adrian College, amilner@adrian.edu

Toni A. Sondergeld, Bowling Green State University

Kadir Demir, Georgia State

Charlene M. Czerniak, The University of Toledo

Carla C. Johnson, University of Cincinnati

ABSTRACT: It is currently unknown how No Child Left Behind (NCLB) required state science testing in elementary schools has impacted teachers' beliefs about teaching science and their classroom practice. The purpose of this study was to fill the gap in the current literature by investigating this problem. Ajzen and Madden's Theory of Planned Behavior (1986) was used to develop a survey of elementary teachers' beliefs about science teaching. A random sample of practicing elementary teachers was surveyed pre- and post- NCLB required science testing implementation. To supplement information from the quantitative survey, all teachers completed an open-ended questionnaire and a smaller sample completed follow-up interviews to provide further information about their classroom science teaching practices. Quantitative and qualitative results indicated that teachers' beliefs about teaching science

remained unchanged despite policy changes mandated in NCLB required state assessment of science. Interestingly, teacher beliefs related to their perceptions of what their administrators and peer groups' think they should be doing influenced their practice the most. The second most influential factor on practice was teachers' attitudes toward the teaching of science. Implications for stakeholders in science education reform including recommendations for the areas of school restructuring, teacher training, and policy are discussed.

S4.1 Administrative Symposium: The NARST Linking Science Educators Program (LSEP): Enhancing Capacity Building in Science Education in Developing Countries

2:45pm – 4:15pm, Conference Room 501 **Presenters:** William C. Kyle, Jr., University of Missouri-St. Louis, USA, bill_kyle@umsl.edu Astrid T. Sinnes, Norwegian University of Life Sciences, Norway Mercy Kazima, Chancellor College, Malawi Dorothy Nampota, Chancellor College, Malawi Uchenna Udeani, University of Lagos, Nigeria John E. Penick, Sangari, Brasil Mei-Hung Chiu, National Taiwan Normal University, Taiwan ADST Linking Chiure Educators Processor (LSER).

ABSTRACT: The first two NARST Linking Science Educators Program (LSEP) initiatives had a common theme: research capacity building amongst emerging leaders in science education in developing countries in sub-Sahara Africa. Both the 2008 program, titled "Development of research capacity in Malawi through partnerships in science education," and the 2009 program in Nigeria, titled "Developing research capacities of S&T teachers and graduate students," address the critical issues of creating an infrastructure to support a research culture, establishing partnerships to sustain scholarly engagement, and building capacity to engage in meaningful research. The session will focus upon the accomplishments of the NARST supported LSEP initiatives, as well as the challenges associated with ensuring that science education research in developing countries is both meaningful and locally situated to facilitate community development and social transformation.

Equity and Ethics Committee Sponsored Session

S4.2 Administrative Symposium: Equity and Ethics Scholar Symposium: Presenting Examples of Research into Practice and Practice Informing Research

2:45pm – 4:15pm, Salon D **Presenters:** Mamta Singh, Texas State University Joi Merritt, University of Michigan Fran Mateycik, The Pennsylvania State University, Altoona Rashmi Kumar, University of Pennsylvania Younkyeong Nam, University of Minnesota Femi Otulaja, The City University of New York

ABSTRACT: In this symposium, six winners of the 2009 NARST Equity and Ethics Committee Scholarships present their research. Using different theoretical frames and methodological approaches, they investigated issues of equity and ethics in the teaching, learning, and researching of science in schools. Individually and collectively, these Scholars' studies speak to the NARST conference theme: Examples of Research into Practice -- Practice Informing Research. More specifically, three Scholars focused on student learning resulting from instructional innovations grounded in existing research. One Scholar investigated college students' success in entry-level science courses; a second, the strengths and limitations of assessment items in tracking sixth grade students' understanding of matter; and a third, the use of simple strategies to facilitate student problem solving. The remaining three Scholars examined the teacher: They explored the impact of research-based professional development opportunities on science teachers' views and practices. One Scholar examined teachers' understanding and implementation of PBL; a second, urban teachers' teaching of earth system and environmental science; and a third, an urban science teachers' use of small-group discussions to promote student learning. The Scholars' collective purpose is to inform researchers and practitioners' understanding of ways to improve the teaching and learning of science for all students.

Strand 1: Science Learning, Understanding and Conceptual Change

S4.3 SC-Paper Set: Learning in Physics 2:45pm – 4:15pm, Conference Room 401

S4.3.1 Concept Networks Organizing Knowledge for Purposes of Physics Teacher Education Ismo T. Koponen, University of Helsinki, Finland, ismo.koponen@helsinki.fi

Maija Pehkonen, University of Helsinki, Finland

ABSTRACT: A characteristic feature of scientific knowledge is its organization and the connectedness of its conceptual structure. This notion is also behind the widely accepted instructional method of representing the concepts as networks. We suggest here design principles for organized concept networks representing physics knowledge. The design principles are based on procedures of operationalising experiments and modelling. It is shown that well organized concept networks can be constructed by using the suggested design principles. Moreover, it becomes possible to discern certain basic structural patterns connected to the procedures. An example of concept network in electrostatics is discussed to show the structure of organization and the role of different procedure related patterns. It is discussed how such a concept network makes visible both the structure of knowledge and the methodological procedures.

S4.3.2 Cognition in Tackling an Unfamiliar Conceptual Physics Problem

David Schuster, Western Michigan University, david.schuster@wmich.edu

Adriana Undreiu, University of Virginia's College at Wise

ABSTRACT: We have investigated and analyzed the cognition of an expert tackling a qualitative conceptual physics problem of unfamiliar type. Our goal was to elucidate the detailed cognitive processes and knowledge elements involved, irrespective of final solution form, and consider implications for instruction. The basic but non-trivial problem was to find qualitatively the acceleration direction of a pendulum bob at various stages of its motion. Methodology included interviews, introspection, retrospection and self-reported metacognition. Multiple facets of cognition were revealed, with different reasoning strategies used at different stages and for different points on the path. An account is given of the zigzag thinking paths and interplay of reasoning modes and schema elements involved. We interpret the cognitive processes in terms of theoretical concepts that emerged, namely: case-based, principle-based, experiential-intuitive and practical-heuristic reasoning; knowledge elements and schemata; activation; metacognition and epistemic framing. The complexity of cognition revealed in this case study contrasts with the tidy principle-based solutions we present to students. The pervasive role of schemata, case-based reasoning, practical heuristic strategies, and their interplay with physics principles is noteworthy, since these aspects of cognition are generally neither recognized nor taught. The schema/reasoning-mode perspective has direct practical applications in science teaching, learning and problem-solving.

S4.3.3 Facilitating Students' Problem Solving Across Representations in Introductory Physics

Dong-Hai Nguyen, Kansas State University

N. Sanjay Rebello, Kansas State University

ABSTRACT: We report on a study to investigate the common difficulties that students encounter when solving problems in different representational forms in an introductory physics course. Our research also focuses on the kinds of scaffolding that might facilitate students to overcome those difficulties. We conducted teaching/learning interviews with 20 students in a first semester calculus-based physics course. A total of four interviews were conducted with each student. In each interview, students worked on three problems – first, a problem they had already encountered on their class exam, second a problem in a different context and one in which the information was provided graphically, and third a problem in the same context as the second problem, but one in which the information was provided in the form of a mathematical function. Students were asked to think aloud as they worked through each problem. They were provided verbal hints whenever they were unable to proceed. We present some of the interview protocols, the common difficulties that students had and the hints that we provided to help them overcome those difficulties. Finally we also discuss the emergent themes from this research that describe trends across all interviews and students.

S4.3.4 Public Physics Lectures as an Instructional Resource: Tracing Changes in Students' Knowledge

Shulamit Kapon, University of California, Berkeley, shulamit.kapon@gmail.com

Uri Ganiel, Weizmann Institute of Science

Bat-Sheva Eylon, Weizmann Institute of Science

ABSTRACT: Physics educators tend to consider public scientific lectures to be intellectual entertainment rather than a venue to teach/learn physics. This study presents empirical evidence showing that such lectures can be a useful instructional resource for students who lack the prior knowledge needed for formal learning of contemporary physics topics. Fourteen graduates of a pre-academic physics course took part in the study. Two public web- lectures were used, one on quantum mechanics and one on astrophysics. The intervention included a collaborative phase after each lecture that dealt with the scientific argumentation and analogical reasoning presented in this lecture. The results show a significant increase in scientific content knowledge. This increase was independent of the lecture topic, with the watching phase and the collaborative learning phase contributing equally. The activities made a significant contribution to long term retention. The transcripts of the discussions reveal knowledge integration and seven dimensions of change in the declarative knowledge base. The activities also enhanced understanding of the nature of science (NOS) which was apparent, for instance, in a transfer of awareness of NOS features.

Strand 1: Science Learning, Understanding and Conceptual Change

S4.4 SC-Paper Set: Students' Learning in the Biological Sciences

2:45pm – 4:15pm, Conference Room 413

S4.4.1 A More Fine-Grained Measure of Students' Acceptance of Evolution: Development of The Inventory of Student Evolution Acceptance– I-SEA

Sherry A. Southerland, Florida State University, ssoutherland@fsu.edu

Louis S Nadelson, Boise State University

ABSTRACT: There is a growing interest in the role affective constructs play in shaping students' learning, particularly students' learning of evolution. For biological evolution, the affective construct that surfaces most quickly is belief or acceptance of evolution. The interplay between belief, acceptance and understanding of evolution is the focus of much research, but the findings remain inconclusive. If we are to further our understanding of acceptance/belief and knowledge of evolution, there is a need for a measure that allows researchers to disentangle students' acceptance of a wide range of evolutionary constructs. The goal of this study is to present the development of a measure that distinguishes between learners' acceptance of microevolution, macroevolution, and human evolution-- the Inventory of Student Evolution Acceptance– I-SEA. In this research, we describe the development of a 49 item survey that includes three subscales found to be important when describing students' acceptance of the various aspects of evolution. Reliability analysis reveals a Cronbach's of .91 for the I-SEA. It is our anticipation that the presentation of this inventory will generate a great deal of discussion around students' acceptance of evolutionary theory and the best ways of both conceiving of these constructs philosophically and measuring them psychometrically.

S4.4.2 Differentiation and Development of Five Levels in Scientific Inquiry Skills: A Longitudinal Assessment of Biology Students in Grade 5 to 10

Andrea Moeller, Justus-Liebig-University, Germany, Andrea.Moeller@didaktik.bio.uni-giessen.de

Stefan Hartmann, Justus-Liebig-University, Germany

Juergen Mayer, Justus-Liebig-University Giessen

ABSTRACT: The detailed developmental processes of scientific inquiry competence within the school environment have so far been studied only unsystematically. In the here presented study, we predict and measure five qualitative levels of scientific inquiry competence in the four central skills based on a differentiation through levels of complexity and a qualitative grading according to problem-solving processes. On the basis of 24 open test items a multi-matrix design was used to perform a longitudinal test on the inquiry competence of 1129 German students (age 10-16). We found all five predicted qualitative competence levels for each of the four inquiry skills present in the students' test answers. However, the achievement of the highest two levels is low and inconsistent in distribution. The expected increase of inquiry competence within one school year is due to a significant qualitative increase within the skill levels. Detailed analyses reveal that performance differs significantly within the four skills. The results support a qualitative grading according to scientific problem-solving processes and provide more accurate information about the increase within the skills. The described threshold values for each competence level permit and facilitate a targeted choice of test items and thus provide a tool for gaining accurate insight in the individual student's inquiry performance.

S4.4.3 The Impact of Classroom Argumentation about Socio-scientific Issues on High School Students' Understanding of Genetics

Vaille M. Dawson, Curtin University, v.dawson@curtin.edu.au

Grady J. Venville, University of Western Australia

ABSTRACT: The purpose of this research was to explore the impact of classroom argumentation about socio-scientific issues on high school students': 1. argumentation skills; 2. informal reasoning; and, 3, understanding of genetics. The research design was a multiple case study conducted in three schools. Each case study had a quasi-experiment embedded in the design with an intervention where the teachers embedded argumentation in the genetics course. Experimental classes in each case study implemented the intervention and comparison classes did not implement the intervention. Data collection included a pre-post-instruction survey, and teacher and student interviews. The results indicated that for all three cases the students who participated in the classroom argumentation in argumentation skills, informal reasoning and, for two of the three case studies, improved significantly more in genetics understanding.

S4.4.4 "Ascending the Pyramid": Levels of Systems Thinking amongst 10th Grade Students while Studying Human Biology Jaklin Tripto, Ben Gurion University of the Negev, Israel

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

Anat Yarden, Weizmann Institute of Science, Israel

ABSTRACT: This study assesses the extent of students' understanding of the body as a system, under the assumption that systems thinking is a necessary prerequisite to the comprehension of various singular phenomena. The study involved 120 tenth-grade students from 3 different high-schools who had completed the first stage of studying systems in the human body. This presentation emphasizes two of the several research tools employed in the data analysis – Repertory Grid and word association. Our data suggested

overwhelmingly that the students had difficulty progressing beyond a basic comprehension of system components and processes, largely failing to recognize their interrelationship. Moreover, the interrelations they did express remained chiefly on the macroscopic level, rarely acknowledging relations with microscopic elements. This latter is particularly important because interrelations between micro and macro are central to the comprehension of homeostasis. Furthermore, of the three patterns of the body as a system (hierarchy, homeostasis and dynamism), the students almost exclusively acknowledged only the first, an indication that their understanding of the human body as a system is limited. We hold that these limitations may be due in part to the lack of a supportive learning environment, focused on the development of systems thinking skills.

Strand 2: Science Learning: Contexts, Characteristics and Interactions

S4.5 SC-Paper Set: Agency and Equity in Science Classrooms

2:45pm – 4:15pm, Conference Room 402

S4.5.1 The Impact of the SETGO (Science, Engineering, and Technology Gateway of Ohio) Program Mentoring on Student Attitude Changes and Retention

Tracy L. Huziak-Clark, Bowling Green State University, thuziak@bgsu.edu Moria van Staaden, Bowling Green State University

Anne Bullerjahn, Owens Community College

ABSTRACT: Thirty-eight undergraduate students from [name] University and Twenty-one students from [name] College, participated in an NSF funded project in order to improve their confidence and retention in STEM fields. Findings suggest that mentoring in both programs was the significant factor in student success. Students from the summer bridge achieved well academically, with all students earning an A or B in their interdisciplinary course. Small class size and individual attention from the faculty and peer mentors were the main reasons given for student success and increase in confidence. Students from the Summer Research program all engaged one-on-one with a mentor to design, implement and report findings on a research project. Participants reported a gain in understanding of the rigors of research as well as enthusiasm and confidence in their abilities to complete similar projects in the future. Finally, the academic Learning Community provided a venue for all of the SETGO participants and mentors to meet, socialize, and learn together.

S4.5.2 Helping Minority Students Get into the Game: Research Outcomes of a Technology-Enhanced STEM Development Program

Sheron Mark, Boston College, marksa@bc.edu David Blustein, Boston College Michael Barnett, Boston College Emily Hoffman, Urban Ecology Institute

ABSTRACT: Experts in science, business, government, and education recognize the importance of a strong STEM workforce in order to remain economically competitive as a nation and express concern about the state of the current US STEM workforce (Stine & Matthews, 2009). As one strategy to address this problem, we describe a two-week long science education summer institute that engages inner city middle and high school students in urban ecology/environmental science field studies projects that utilize geospatial technologies. Learning activities focus on scientific inquiry, research, and the nature of science. Data were collected through online surveys and interviews. Pre/post analyses showed significant increases in students' science self-efficacy and ecological mindset. Increases were also seen with students' interest in science, career planning, and work hope, but not to statistically significant levels. Qualitative data investigated the resources and barriers to these students' education and revealed that a subsample of students that were interested in STEM, although disadvantaged with respect to some resources and capital as compared to students of higher socioeconomic backgrounds, were able to take advantage of the relational and instrumental resources provided by parents, teachers, and educational programs, such as the summer institute, to demonstrate resilience in their education.

S4.5.3 Discourse in Science Classrooms: The Relationship between Teacher Perceptions and their Practice Diane Pimentel, Boston College

Katherine L. McNeill, Boston College

ABSTRACT: The importance of increased student participation in scientific discourse during classroom discussions is as a key element required for achieving scientific literacy for all students. Evidence obtained from observing lessons taught by teachers piloting a high school urban ecology curriculum designed to foster student science talk suggests that teacher authoritative discourse continues to dominate instruction, even though teachers expressed the value of student science talk as a source of meaning making. Teacher interviews suggest some potential explanations for why discourse continues to be predominantly traditional even though they would like their class discussions to be more dialogic. Teacher moves that encourage or discourage student talk are also explored.

S4.5.4 Students Discussing Science: Individual and Collective Agency Challenging Structure and (Re)Shaping Identities in Science Classrooms

Lilian Pozzer-Ardenghi, McGill University, lilian.ardenghi@mail.mcgill.ca

Gale Seiler, McGill University

ABSTRACT: Classroom interaction in science education research has been primarily investigated from discursive approaches that focus on the structural and thematic patterns of activities, and from sociocultural approaches that focus on the negotiations of power and control in the classroom, contextualized in terms of agency|structure dialects and the opportunities afforded or denied within the culture of school science for students to participate in science and to develop science-related identities. This study combines these two approaches to classroom research (i.e., micro-analysis of interaction structures and sociocultural analysis of forms of participation) to investigate how different interaction structures function as ways of (re)producing or challenging and changing the dominant culture of the science classroom, empowering or disempowering students, and in the process also (re)shaping their identities. The data for this study comes from video-recorded interactions in two secondary science classrooms at a large Canadian city. We focus specifically on episodes in which students' science-related questions develop into student-led discussions. Our analysis and discussion show that subtle disruptions in the social order of the classroom have the potential to allow for individual and collective agency, also ratifying a new classroom culture, which can become the beginning of a process of social change.

Strand 3: Science Teaching--Primary School (Grades preK-6): Characteristics and Strategies S4.6 SC-Paper Set: Curriculum and Content Knowledge

2:45pm – 4:15pm, Conference Room 403

S4.6.1 Elementary Science Kits: Differential Use for Instruction and Assessment

Laura Robertson, North Carolina State University, lerobert@ncsu.edu Gail Jones, North Carolina State University Grant E. Gardner, North Carolina State University

Sharon Dotger, Syracuse University

ABSTRACT: This study explored science kit use in an urban district, with a high number of low performing schools and substantial pressure to raise students' high stakes assessment scores. A total of 503 elementary teachers from an urban school district received professional development, implemented kits in their classrooms for a year, and then completed a survey about science kit use as well as teaching practices. Instructional strategies, classroom practices, and assessment types were compared for teachers who reported using kits as the predominant science instructional material (75% of the science instructional time or more) and for those who used kits occasionally (less than 25% of the science instructional time). Results showed the kit-based program was differentially implemented and there were significant differences in the use of inquiry-based teaching and assessment practices. Surprisingly, both groups of teachers had similar demographic characteristics and tended to teach science for the same amounts of time and had similar confidence levels for teaching science, however, the high kit users were more likely to use reform-based instructional practices than low kit users.

S4.6.2 Using Multiple Representations as a Means of Accessing Elementary Teachers' Insights and Misconceptions About Science Principles

Suzanne M. Levine, University at Albany, suzannemlevine@gmail.com Cheryl Sheehan, University at Albany Audrey B. Champagne, University at Albany Vicky L. Kouba, University at Albany

ABSTRACT: A mixed methods study revealed that changes in elementary teachers' science content knowledge occurred after the teachers participated in a science methods course taught with an emphasis on designing representations of science principles. Further analysis from a multimodal learning perspective qualified potential gains in teacher pedagogical content knowledge, and identified several trends present within post-test responses indicating persistent misconceptions about science content. This paper presents the evolution of three typical elementary teachers' understanding of science principles via case studies of their representations designed for young learners. Findings offer insight into the impact of furthering elementary teachers' science learning on their pedagogical content knowledge and address lingering misconceptions about science concepts most challenging to tackle.

S4.6.3 The Particulate Model of Matter – An Instructional Challenge for Primary Education (Sixth Grade)

Georgios Tsaparlis, University of Ioannina, gtseper@cc.uoi.gr

Paraskevi Dalaouti, Primary State Education, Ioannina, Greece

ABSTRACT: The aim of this research study is the evaluation of the understanding of the particulate structure of matter by sixthgrade primary school students. The students attended a set of lessons aiming at the constructivist introduction of the concept of molecule through modeling of selected macroscopic phenomena by using experiments, demonstrations, analogies and computer simulations. The study demonstrated that the students use the particle model with ease in the case of the particular context that is relevant to everyday life and familiar topics. On the other hand, they experience difficulties in using the model to make predictions about phenomena. Significant was the contribution of the particle model to understanding the conservation of mass. No differences were observed in performance between boys and girls.

S4.6.4 Comparing Reform-Based and Traditional Curricula in a Large-Scale, Randomized Cluster Design Study: The Interaction between Curriculum and Teachers' Knowledge and Beliefs

Yavuz Saka, Florida State University, yys3536@fsu.edu

Ellen M. Granger, Florida State University

Todd H. Bevis, Florida State University

Sherry A. Southerland, Florida State University

ABSTRACT: This research explores the relationship between curriculum and teachers' knowledge and beliefs about teaching. Using a quasi-experimental design, the effectiveness of Great Exploration in Math and Science (GEMS) Space Science Curriculum Sequence was compared with the effectiveness of more traditional curriculum in supporting 4th and 5th grade teachers' learning of space science as well as their knowledge and beliefs associated with the teaching of science. GEMS employs an inductive approach to content (learning cycle), explicit use of evidence, and attention to scientific inquiry. Randomization occurred at the level of the teacher assignment to treatment group (not at the student level). The sample included 66 treatment and 59 control teachers. Our findings suggest that reform-based curricula combined with professional development around the curricula can be effective in shaping teachers' content knowledge and beliefs about teaching. The GEMS materials were more effective in supporting the professional development of teachers who had more to learn (i.e., teachers with lower self efficacy and teachers with lower outcome expectancy at the outset of the study.

Strand 4: Science Teaching--Middle and High School (Grades 5-12): Characteristics and Strategies S4.7 SC-Paper Set: Developing, Assessing, and Describing Science Teachers' Pedagogical Content Knowledge 2:45pm – 4:15pm, Conference Room 404

S4.7.1 Improved Science Assessments Using Student Perceptions

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ABSTRACT: This paper reports on a three-stage study aimed at developing, validating and applying an instrument that can be used to assess secondary students' perceptions of assessment. In the first stage, following a review of literature, a six-scale instrument of 48 items was trialed with a sample of 470 students from grades eight, nine and ten in 20 science classrooms in three state schools. Based on internal consistency reliability data and exploratory factor analysis, refinement decisions resulted in a five-scale instrument that was named the Student Perceptions of Assessment Questionnaire (SPAQ). In the second stage, the SPAQ was used with five scales of the What is Happening in this Class (WIHIC) questionnaire, an attitude scale, and a self-efficacy scale. This survey was administered to a larger sample of nearly 1,000 students from 41 science classes from the same grades as in the first stage. Statistical analyses confirmed the validity and reliability of the SPAQ. In the last and final stage identified exemplary teachers teaching was observed and interviews were conducted with these teachers and some students.

S4.7.2 Teachers' Approaches to Teaching Biological Evolution and the Nature of Science

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ABSTRACT: Although recommendations to include NOS within evolution instruction are common, few studies have investigated the ways in which NOS-evolution instruction manifests in high school biology classrooms. The purpose of this study was to investigate the extent to which high school biology teachers guided students in their demarcation of science from non- science during their evolution instruction. This study employed a multi-case study approach, and data collection consisted of classroom observation during evolution instruction supplemented by formal and informal interviews with the participating eight teachers. At total of 91 classroom observations were made. Interview and field note transcripts were analyzed according to grounded theory. Teachers incorporated NOS in their evolution teaching in several different ways. In particular, the approaches to role of theory, portrayal of science as a humanistic activity, demarcation of science from religion, and emphasis given to evolutionary evidence emerged as important components of evolution instruction. The dimensions of these aspects of evolution teaching are described and interpreted in light of a cultural border crossing theoretical framework. Implications for biology curriculum development and preservice/inservice biology education are highlighted.

S4.7.3 Examining Experienced Mentor Teachers' Pedagogical Content Knowledge for Teaching Osmosis and Diffusion

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Patricia M. Friedrichsen, University of Missouri Columbia

ABSTRACT: American students are falling behind their counterparts in learning science when international comparisons are made. The National Science Education Standards identify teachers as the most important factor in student learning (NRC, 1996). Reform minded science teachers draw upon their knowledge of science content, students, instructional strategies and representations to actively engage students in learning. Yet we know little about the specialized knowledge for teaching held by experienced teachers. The purpose of this qualitative case study was to examine the topic-specific pedagogical content knowledge held by six experienced biology teachers. Pedagogical content knowledge served as the conceptual framework for the study. The overarching research question was: When teaching lessons on osmosis and diffusion, how do experienced biology teachers draw upon their topic-specific

pedagogical content knowledge? Data sources included observations of two consecutive lessons, lesson plans, three semi-structured interviews (Patton, 2002), and lesson artifacts. Two assertions developed from the study: (1) Experienced biology teachers demonstrated a guided inquiry orientation to science teaching by engaging students in investigations; and (2) The teachers identified vocabulary as a potential learning difficulty for students and, as a result, focused initially on students' conceptual understanding by developing real-world connections between concepts and students' prior knowledge and experiences.

S4.7.4 Development and Evaluation of an Instrument for Measuring Biology Teachers' Pedagogical Content Knowledge (PCK)

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ABSTRACT: Besides pedagogical knowledge and content knowledge, one central aspect of teachers' professional knowledge is the concept of pedagogical content knowledge (PCK). PCK incorporates knowledge of students' pre- and misconceptions, knowledge of science teaching strategies as well as knowledge of the curriculum, nature and purpose of a subject. Current conceptualizations additionally ascribe orientations, reflection and self-efficacy as important components of teachers' PCK. To evaluate teachers' PCK and to empirically validate current PCK conceptualizations, reliable instruments would be helpful. The current study presents an inventory for measuring biology teachers' PCK concerning declarative PCK-on-action, PCK related reflection abilities, subject specific orientations as well as biology teachers' subject specific self-efficacy. The PCK inventory has been developed as a video clip supported paper pencil test with open-ended items. The scales have been evaluated on psychometric properties with pre-service and in-service biology teachers. Within the scope of the results psychometric quality criteria of scales, correlations between biology teachers' PCK and assumed PCK predictors (e.g. teaching experience, number of seminars) as well as empirical evidence for current PCK conceptualizations are presented.

Strand 5: College Science Teaching and Learning (Grades 13-20) S4.8 SC-Paper Set: Research Experiences for Undergraduates

2:45pm – 4:15pm, Conference Room 405

S4.8.1 Assessing the Educational Contribution of the International Genetically Engineered Machine [iGEM] Research Project: **Students' and Mentors' Perspective**

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Natalie Kuldell, Massachusetts Institute of Technology

ABSTRACT: This study analyzes and discusses students' and mentors' reflection on the International Genetically Engineered Machine (iGEM) project and the competition at the end of it at Massachusetts Institute of Technology (MIT). Inline with the prominent national recommendations in science education (NRC, 2003) an important aspect of iGEM was students' exposure to authentic research and to the way science is carried out in the laboratory. The goal of our study was to assess the educational contribution of the iGEM project to students and their mentors who participated in the summer activities all over the world. Students reported that the iGEM experiences provided them with a variety of skills, such as, significant learning, social and team collaboration, problem solving, lab techniques and skills, enjoyment from and interesting in learning, clarification of research subject/career, and presentation and explanation skills. Mentors commented on the difficulty of conducting authentic scientific research during one summer with students who were mostly undergraduates. Most of the students and their mentors described the iGEM projects and the competition as good to an excellent experience. We believe that the iGEM could serve as a model for other authentic scientific research projects with global and interdisciplinary approach.

S4.8.2 Student Learning Gains through Undergraduate Research Experiences with Two-Year College Students

Jeffrey S Carver, West Virginia University, jeffrey.carver@mail.wvu.edu Morna R. Brothers, Harold Washington College Thomas Dowd, William Rainy Harper College Kate Edler, Illinois State University Gregory Ferrence, Illinois State University Yvonne Harris, William Rainy Harper College Thomas B. Higgins, Harold Washington College Roger House, William Rainy Harper College William Hunter, Illinois State University Stephanie Persson, Illinois State University

ABSTRACT: This paper will report on the findings of an on-going, government supported, study of undergraduate research (UGR) at a collaborative of two-year colleges (2YCs). Students at 2YCs were engaged in an UGR experience during the academic year

followed by a summer internship at a partnering four-year college or university. Students engage in research with faculty at the 2YC in an attempt to enhance their undergraduate experience. Pre and post content exams were administered at multiple times during the three years of the project to establish multiple experimental and control groups. Students who conduct their first research experience during their second year of college show the greatest gains in the content knowledge measured.

S4.8.3 Does Chem-Research Make a Difference?

Ted M. Clark, The Ohio State University, clark.789@osu.edu Jane B. Kahle, Miami University Sarah B. Woodruff, Miami University Yue Li, Miami University

ABSTRACT: The inclusion of authentic research experiences in the undergraduate science curriculum has frequently been proposed as a way to improve STEM education, e.g. by increasing retention in STEM fields and enriching student laboratory experiences. In the current investigation a large-scale multi-institutional collaboration that is designing and implementing in-class research experiences (termed Chem-Research) in introductory Chemistry courses is evaluated. Both quantitative and qualitative methods are used to describe student views of teaching and learning practices in Chem-Research and traditional introductory Chemistry courses. Findings suggest that Chem-Research courses include many innovations that speak favorably to incorporating in-class authentic research experiences throughout the science curriculum.

S4.8.4 Undergraduate Research Experiences from a Longitudinal Perspective

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Adam V. Maltese, Indiana University

Robert H. Tai, University of Virginia

ABSTRACT: This present study evaluated the long-term perspective on benefits garnered from participation in undergraduate research experiences (UREs). This paper provides the first results of the Project XX study that was designed to assess the transition of science graduate students into fields involving scientific research. Project XX employed mixed methodologies, including both surveys and extensive interviews and was conducted between 2005 and 2008. Survey data were collected from nearly 4,400 respondents who were practicing scientists and graduate students in the field of chemistry and physics. Approximately half (49%) of the survey respondents reported exposure to genuine research experiences as the single most important gain of URE participation. Data analysis demonstrated variations between reported enhancements dependent on the type or style of research experience.

Strand 5: College Science Teaching and Learning (Grades 13-20) S4.9 SC-Paper Set: Learning and Retention in Undergraduate Chemistry 2:45pm – 4:15pm, Conference Room 414

S4.9.1 Designing and Evaluating a Teaching Intervention in Chemical Kinetics: Towards Research Evidence-Based Practice

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Cemil Aydogdu, Hacettepe University, Turkey

ABSTRACT: This paper reports on a study, which investigates the effects of a teaching intervention, the design of which is informed by evidence from educational theories and research data, on studentsï $_{i_{1}}^{i_{2}}$ ideas in chemical kinetics. A quasi-experimental design was used to compare the outcomes for the intervention. The subjects of the study were 83 university first-year students, who were in two different classes in a 4-year pre-service science teacher-training programme in Turkey. During teaching, an $i_{i_{1}}^{i_{2}}$ evidence-informed instruction $i_{i_{1}}^{i_{1}}$ was applied in the experimental group whereas $i_{i_{1}}^{i_{2}}$ traditional instruction $i_{i_{1}}^{i_{2}}$ was followed in the control group. Students $i_{i_{1}}^{i_{2}}$ understandings of chemical kinetics were elicited through a series of written tasks and individual interviews. In order to find out the effect of the teaching intervention on students $i_{i_{1}}^{i_{2}}$ understandings in chemical kinetics in both groups on the pre-test (t (72)= - 0.30, p > 0.05); however, the results of the post-test indicated that students in the experimental group achieved significantly higher learning gains in chemical kinetics than students in the control group (t (81)= - 11.47, p < 0.001). Moreover, in response to teaching, students in the control group (average 17.2%). The significance of these findings for further research, and for policy and practice relating to science teaching, are discussed.

S4.9.2 Concurrent Enrollment in General Chemistry Lecture and Laboratory Decreases Withdrawal Rates and Increases Final Grades in the Lecture

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ABSTRACT: Laboratory experience plays an important role in general chemistry education. At large universities, though, laboratories are often decoupled from their corresponding lectures. As a result, students oftentimes enroll in the lecture and laboratory during separate terms, or even neglect to enroll in the laboratory altogether. Here, we investigated whether the timing of enrolling in the laboratory affected students' final grades in or withdrawal rates from the lecture. Data was collected from more than 6,000 students who had enrolled, either concurrently or non-concurrently, in general chemistry lecture and laboratory at a large, Midwestern university. Students were partitioned into groups based on K-means clustering and evaluated using regression analyses. We report that concurrent enrollment positively affected students' final lectures grades by up to 0.282 grade points. Additionally, we report that concurrently enrolled students were 237% more likely to be retained in the lecture than non-concurrently enrolled students. While many methods have been researched with the hope of improving learning or retention in general chemistry, this analysis shows that final grades and retention in the lecture are significantly impacted simply by concurrently enrolling in the lecture and laboratory.

S4.9.3 Academic Performance in Organic Chemistry: A Longitudinal Examination

Evan Szu, Stanford University, eszu@stanford.edu Kiruthiga Nandagopal, Stanford University Richard J. Shavelson, Stanford University Enrique J. Lopez, Stanford University Geannine W. Hill, Pacific Graduate School Maureen Scharberg, San Jose State University

ABSTRACT: Successful completion of organic chemistry (O-Chem) is a prerequisite for many graduate and professional STEM programs. Yet the failure rate for this course sequence is notoriously high, particularly for women and underrepresented minorities. To date, few studies have examined why some students succeed while others have difficulty in O-Chem. This study examines factors related to student O-Chem course performance. Results indicate that high-achieving students, as measured by course grades, score higher on measures of conceptual performance and problem-solving while seeking assistance and engaging in practice problems earlier in the semester. Case studies illustrate how students engaging in such behaviors can overcome poor prior grades while those not engaging in such behaviors can perform poorly despite strong prior grades. Overall, study behaviors and conceptual understanding outweigh prior academic standing in predicting final course grades. These analyses suggest potential intervention targets for students at risk for poor O-Chem performance.

Strand 6: Science Learning in Informal Contexts S4.10 SC-Paper Set: Investigations of Affect in Informal Settings 2:45pm – 4:15pm, Conference Room 406

ABSTRACT:

S4.10.1 High School and College Students' Evaluations of Scientific Media Reports: Questions Asked and Knowing What to Do with the Answers

Connie A. Korpan, Grande Prairie Regional College, ckorpan@gprc.ab.ca

ABSTRACT: It can be argued that the most common means through which citizens stay current on scientific research is through media reports. In order to make sound decisions, consumers must evaluate these reports from a critical standpoint. One hallmark of critical thinking is having the ability and tendency to ask questions in order to get more information. Also important is the ability to understand the answers to such questions—exactly how does the information help determine whether the report is valid? In this study, 83 high school students and 166 college students were presented with four media briefs reporting scientific research, each ending with a conclusion. For each report, participants were asked to generate a list of questions they would want answered to determine whether the conclusion is accurate. They were also asked to generate a justification for each question; specifying how the answer would help them evaluate the conclusion. Each question was classified into one of six categories: Social Context, Theory, Methods, Data, Relevance, and Related Research. The variety of questions generated increased with science education, but the scope remained limited. Also, students frequently had problems explaining how the information acquired would help with their evaluation. Curricular implications are discussed.

S4.10.2 Raising Interest in Science Careers through Informal After-School ExperiencesRaising Interest in Science Careers through Informal After-School Experiences

Lorraine Savage, Temple University, lorraine.savage@temple.edu

Diane Jass Ketelhut, Temple University

Susan J. Varnum, Temple University

Judith Stull, Temple University

ABSTRACT: There is a need to halt the decrease in interest in scientific careers across the K-12 years. One avenue that has shown to increase interest in scientific careers is informal education. This presentation will report on a two-year informal education project called Science in the City. An overview of an NSF-funded middle grades curriculum project aimed at improving student interest in

scientific careers will be given. In particular, the framework of the two- year project will be described, and longitudinal findings from students on the impact of this program on student interest in science careers will be discussed.

S4.10.3 Changes in Views of Scientists and Nature of Science: A Case Study of Middle School All Female Science Camp

Kristen J. Molyneaux, National High Magnetic Field Laboratory, molyneaux@wisc.edu

Roxanne Hughes, Florida State University

Pat Dixon, National High Magnetic Field Laboratory

ABSTRACT: The focus of this paper is to determine how a two week middle school science camp affected young women's interest and perceptions of science, science careers, and scientists. The participants and teachers responded to pre and post surveys and participated in semi- structured interviews. The student surveys included an open ended and quantitative portion that asked for their views of the nature of science and scientists. The parents of the students were given a survey on the last day of camp. The authors acted as participant observers throughout the camp. The pre and post data demonstrates that the camp had a positive effect on students' perception of scientists. The survey data also indicates that misconceptions like scientists work in sterile laboratories also had a significant change toward the positive. The initial data reveals that some misconceptions regarding science remained, however, all of the participants saw the scientists that they worked with in the camp as a possible mentor. This study highlights how exposure to real scientists and careers in science can change students' perceptions and views of the nature of science, despite the nature of science not being explicitly stated.

S4.10.4 When Was the Last Time You Saved a World? Children's Informal Science Learning in a Multi-User Virtual Environment (MUVE)

Sherman Rosenfeld, The Weizmann Institute of Science, ntsher@weizmann.ac.il

Ron Blonder, The Weizmann Institute of Science

ABSTRACT: Young children spend a great deal of time playing in MUVEs (Multi-Users Virtual Environments). Under what conditions might MUVEs promote informal science learning? We are investigating this question in a specific MUVE, designed for children aged 8-12, which focuses on ecology and the natural environment: children are challenged to save a planet from a variety of environmental problems. Each player navigates using his or her own avatar in order to solve quests, play games and interact with other players in the world. Scientific content is transmitted via the quests, games, an online newspaper and participation in "community events". Using an educational data-mining methodology, we are correlating user baseline data and game use with outcome data regarding cognitive, affective and behavioral goals. As only one example, we analyzed the results of a "community event" in which players are asked to donate money for the construction of a proper dump site. Focusing on a large sample (N=1,907 players) we found statistically significant correlations (p<.0001) between a player's level of donations and his/her game level and weeks playing in ekoloko. These results suggest that the more time players spent in this MUVE, the more likely they will behave in an ecologically-responsible way.

Strand 7: Pre-service Science Teacher Education

S4.11 SC-Paper Set: Features & Effects of Pre-Service Teacher Education Reform 2:45pm – 4:15pm, Conference Room 407

S4.11.1 Can a UTeach-type Teacher Preparation Program Reduce Science Expert Blind Spot by Teaching the Inquiry Cycle? David E. Kanter, Temple University, dkanter@temple.edu

Teressa Chen, Temple University

ABSTRACT: Undergraduate science majors who are pre-service science teachers in TUteach, Temple University's UTeach type teacher preparation program, may have science expert blind spot (EBS) wherein their teaching is more organized around the structure of the discipline than students' ideas. We hypothesize that TUteach students' learning the 5E inquiry cycle instructional model (5EICIM) in their first two courses may decrease their science EBS. The 5EICIM puts student-centered Engagement, Exploration, and Explanation before discipline-focused Elaboration and Evaluation. Knowledge of 5EICIM was determined using the Inquiry Cycle Questionnaire. An approach to measure science EBS was developed wherein students sequenced activities for teaching about electric circuits (Ohm's Law). Sequences were scored for more or less science EBS using a set of rules. TUteach students' initial science EBS after their first course and sustained through their second course. However, while increased knowledge of 5EICIM was found to correlate with decreased science EBS overall, this did not account for TUteach students' decreased science EBS of TUteach students. Instead, these students' repeated practice using the 5EICIM may be what is reducing their science EBS.

S4.11.2 The Impact of Critical Learning Experiences on Science Teacher Development

Monica J. Young, Syracuse University, moyoung@syr.edu John W. Tillotson, Syracuse University Glenn R. Dolphin, Syracuse University Lauren Jetty, Syracuse University

ABSTRACT: Prior teacher education research studies have paid little attention to how teachers' knowledge and practices are influenced by what they experience in teacher education programs and even less attention to how teachers are affected over time by their preparation. The purpose of this study was to examine the perceptions of science teachers (N=151 total) participating in the NSF-sponsored IMPPACT Project researching the impact of specific preservice program learning experiences on the development of the teachers' epistemological beliefs about effective science teaching and learning and their classroom practices. Graduates from three science teacher education programs representing geographically diverse regions of the United States were surveyed using the National Survey of Teacher Education Program Graduates (NSTEPG) to determine the perceived role that each of these three teacher education programs played in providing them with the requisite knowledge and skills to be successful as a science teacher. Graduates rated their preservice program experiences as strong (Mean 5.40 on a 7-point scale), though the ratings of a number of specific experiences were significantly different between the sites. Graduates also rated the adequacy of their skills as more than adequate (Mean 2.21 on a 3-point scale).

S4.11.3 Systemic Reform in Pre-Service Science Teacher Education and Its Impact across the K-16 Educational Continuum

Margaret G. Shroyer, Kansas State University- College of Education, gshroyer@ksu.edu

Amanda R. Morales, Kansas State University-College of Education

Cindi K. Dunn, Office of Educational Innovation and Evaluation

Cecilia Hernandez, Kansas State University

ABSTRACT: This paper discusses the findings of an evaluative case study of a systemic reform initiative in pre-service science teacher education involving faculty and administrators from a college of education, a college of arts and sciences, three community colleges, and five K-12 school districts. This collaborative multi-institutional reform initiative fostered the simultaneous renewal of teacher education as well as K-16 teaching and learning, particularly for the growing English language learner (ELL) populations in the Midwest. The theoretical frameworks that serve as the basis of this study are the 2001 report from the Committee on Science and Mathematics Teacher Preparation on professional development and science education reform and Goodlad's model for simultaneous renewal (1994). This integrated framework supports the broad-based goals of this systemic reform and the complex nature of the collaborative process. From the data, the researchers identify the key reform initiatives that made the greatest impact on teaching and learning across the partnership, K-16, and provide recommendations for future systemic reform in the Midwest.

S4.11.4 Teaching About Teaching Science: What do Science Teacher Educators do and Why?

Amanda K. Berry, Monash University, amanda.berry@education.monash.edu.au

Jan H. van Driel, ICLON, Leiden University, The Netherlands

ABSTRACT: Given the absence of studies on teacher educators' expertise on how to prepare science teachers to teach subject matter, this study thus aimed to make explicit science teacher educators' purposes underpinning their practice. A small scale, in depth descriptive study was conducted, during which experienced science teacher educators (n=5) were interviewed about what they do in their science teacher education classes, and asked to explain the reasoning behind the various experiences they provide. The study revealed some similarities and differences in the approaches of science teacher educators in the context of methods courses. An important common issue concerned their focus on promoting innovative practices of science teaching, and the tension with current practice in schools which seems to stimulate pre-service teachers to adopt traditional strategies. The study also made clear how each teacher educator's personal background seemed to shape how these emphases are played out quite differently in their pedagogy of teacher educators' knowledge and practice of teaching about teaching science will stimulate both the theory and practice of science teacher education.

Strand 8: In-service Science Teacher Education S4.12 SC-Paper Set: Knowledge, Practice and Content 2:45pm – 4:15pm, Conference Room 408

S4.12.1 Meeting Teachers Where They Are and Helping Them Integrate Geospatial Technology into Their Teaching

Nancy M. Trautmann, Cornell University, nmt2@cornell.edu James G. MaKinster, Hobart and William Smith Colleges

ABSTRACT: This study examines the use of the "flexibly adaptive model" of teacher professional development, which was developed in the GT-Science project (pseudonym) to enable secondary science teachers to incorporate a variety of geospatial applications into wide- ranging classroom contexts. Impacts on participating teachers were assessed using project application materials, curricular resources developed and implemented by each teacher, written reflections, and questionnaires. Pre/post questionnaire responses showed significant growth in teachers' perceived expertise, interest, and self-confidence with regard to integrating geospatial analyses into their science teaching. When viewed from the perspective of the Technological Pedagogical Content Knowledge (TPACK) framework, teachers grew in technological content knowledge and in the extent to which this knowledge intersected with their pedagogical and science content knowledge as they learned new ways to apply geospatial technology

in their teaching. Research is needed to create validated instruments for measuring teacher beliefs, self-efficacy, and knowledge for teaching with geospatial technology and for measuring associated student learning outcomes.

S4.12.2 Addressing Numeracy in a Science Lesson: A Case of Lesson Study

Maurice DiGiuseppe, University of Ontario Institute of Technology, maurice.digiuseppe@gmail.com Isha DeCoito, York University

ABSTRACT: In lesson study, teachers work collaboratively to plan and teach research lessons with the overall goal of improving student learning. The case of lesson study reported in this paper involved a group of four experienced high school science teachers focused on improving student cross-curricular numeracy. In particular, the team planned, implemented, and studied a lesson on the metric system in the context of a curricular unit on motion. In this study, we attempt to answer the following research questions: 1. How do secondary science teachers understand the nature of lesson study? 2. How does lesson study affect teacher professional development? 3. What are some benefits and drawbacks of lesson study? Team members' classroom observations of the research lessons, and their reflections on, and critiques of, their individual and shared contributions to the lesson study process resulted in the elucidation of several major themes, including planning with time constraints, student engagement versus concept/skill development, collaboration strain, and teacher confidence.

S4.12.3 Facilitating Teacher Development towards a Tetrahedral Orientation in the Teaching of High School Chemistry

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Brian Lewthwaite, University of Manitoba

Harvey Peltz, River East-Transcona School Division

ABSTRACT: This presentation reports on the initial outcomes from the fourth year of a five year research and professional development project to improve chemistry teaching among three cohorts of chemistry teachers. The project responds to a new curriculum introduction advocating a tetrahedral orientation (Mahaffy, 2006) to the teaching of chemistry. The project in its entirety is based upon several theoretical models in fostering chemistry teacher development, in particular Bronfenbrenner's bio-ecological model. These models are described, as is the progress made by teachers based upon the use of a Chemistry Teacher Inventory and associated teacher responses and observations. Overall, statistical analysis of perceptions of their own teaching and comments made by teachers suggests they are showing limited development towards a tetrahedral orientation albeit in a manner consistent with the curriculum. Ongoing research-based activities in this project are also described.

S4.12.4 Teachers' Understanding of Context in Teaching Thermodynamics within a Construction Context

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Sue DeChenne, Oregon State University

ABSTRACT: Middle and high school science and career technical education teachers participating in a three-day professional development workshop, designed instruction using the context of the everyday, engineered environments in which students live. Researchers used teacher talk, presentations, and focus groups to examine how the change in context influenced perception of instructional purpose and design and the science content teachers thought students would learn. The workshop included specially designed video cases studies of professionals working on affordable, energy efficient residential housing. Teacher experiences included discussions of the pilot case studies, in-depth discussion of "useful" versus merely "relevant" science, and hands-on, investigative activities based on a modified version of the 5E instructional model. There was a tension between what the science standards expected and the science embedded in the construction context. Teachers reacted to the differences among how science is expressed in the standards, in a construction context, and in everyday life. Additionally teachers' were unsure whether the students would be able to generalize concepts from the construction context.

Strand 8: In-service Science Teacher Education

S4.13 SC-Paper Set: STS, Curriclum and Science Teacher Professional Development 2:45pm – 4:15pm, Salon C

S4.13.1 Teachers' Integration of Science and Social Issues Using an Avian Influenza Curriculum Module

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Marcelle A. Siegel, University of Missouri

William L. Romine, University of Missouri

ABSTRACT: The purpose of this study was to determine how secondary science teachers understand and conceptually integrate science content and social relevance in their classrooms. Ten biology teachers from four underprivileged school districts participated in a professional development opportunity centered on an avian influenza curriculum module. During two consecutive summer institutes, we collected data from a wide variety of sources including applications for the institute, reflections, observations, end of institute feedback, and semi- structured interviews. Findings show that teachers were generally able to conceptualize the integration of the science content and social issues from this module in their classrooms. These teachers were able to articulate how they planned to implement their ideas and felt that the integrating the science with the social relevance would engage students in the science content.

Follow up interviews showed that the H1N1 swine flu pandemic increased student interest in these topics. Our findings indicate that high school biology teachers at underprivileged schools are able to conceptualize the integration of science with social issues and this is an effective way to help teach their students.

S4.13.2 Surveying K-12 Science Teachers' Needs from Scientists for Curriculum Materials

Timothy F. Slater, University of Wyoming, timslaterwyo@gmail.com

Stephanie J. Slater, University of Wyoming

ABSTRACT: Much of the last two decades of education reform calls students to have authentic science inquiry experiences that mimic scientific research using real scientific data. In order for professional planetary scientists to provide the most useful data and professional development for K-12 teachers in support of science education reform, an extensive, national survey of nearly 800 "alpha teachers" was undertaken to determine how teachers are currently using planetary science data and, if not, why not. Although teachers had considerable awareness of online data resources, few report frequent use of online data for authentic inquiry and analysis in the classroom. Teachers' primary use of the Internet for data is to download images to share with students. Only one-quarter of teachers report that they ever use any online data in the form of large WWW data sets, real data, or virtual data to engage students in inquiry or data analysis and virtually no teachers reported using data- sets delivered on CD-ROMS. These results suggest that the most influential role for the community of scientists is to support professional development on a limited number of existing data products rather than creating or expanding new products and to focus PD on implementation rather than creation.

S4.13.3 Opportunities for Science Teacher Learning Through Approximations of Whole-Class Discussions

Andrew H. Falk, University of Michigan, ahfalk@umich.edu

LeeAnn M. Sutherland, University of Michigan

ABSTRACT: Structured approximations of carefully chosen instructional activities have been indicated by previous research as a potentially powerful vehicle for teacher learning (Grossman et. al., 2009; Lampert & Graziani, 2009). However, relatively little is known about the nature of the opportunities for learning created by these experiences, or the kinds of support that learning might require. This study investigated how seven 7th grade science teachers' approximation and debriefing of two specific instructional activities created opportunities to learn about important aspects of teaching science. Evidence from video records and associated artifacts showed that the approximations resulted in rich representations of classroom practice that afforded opportunities to learn about multiple aspects of science teaching, including teachers' content knowledge, representations of content, student thinking, and instructional strategies. However, teachers' analysis in the debriefings did not examine the full range of these opportunities. Teachers primarily analyzed representations of content and instructional strategies, and generally did not examine students' alternative conceptions or problematic content. The findings support the potential of this approach for teacher learning, but suggest that additional scaffolding and facilitation are required.

S4.13.4 Science Teachers' Knowledge of, and Decisions on Integrating Science, Technology and Society (STS) Issues in the Science Curriculum

Azza A. Hashem, University of Exeter

Nasser Mansour, University of Exete

ABSTRACT: The failure of much curriculum innovation has been attributed to the neglect by innovators of teachers' perceptions. Following an explanatory research framework, this study examines how science teachers' conceptions, beliefs, knowledge, and judgments affect their decisions about integrating STS issues in the current curriculum. Using a random sample of science teachers from Gharbiyya Governorate in north-eastern Egypt, data was collected through a questionnaire and interviews. The entire questionnaire sample was random, covering a variety of teacher qualifications and specialisms, and a range of teaching experience, age, and school locations. The study investigated the attitudes and perceptions of teachers towards STS issues in an attempt to identify the factors determining the successful implementation of such issues. Findings suggest that the teachers' lack of knowledge concerning some STS issues determined their rating of the priority and importance of these issues for inclusion in science curricula. Further, formal education (university level) appeared to contribute very little towards making teachers knowledgeable about STS issues This being the case, educators and policy-makers in science education will need to be more informed in their attempt to explain, predict, and account for the factors that impede or facilitate the implementation of STS issues throughout the science curricula.

Strand 9: Reflective Practice

S4.14 SC-Paper Set: Teacher-Based Instructional Design

2:45pm – 4:15pm, Conference Room 409

S4.14.1 Inquiry Into Teacher-initiated Curriculum Reform Work at the Illinois Mathematics and Science Academy

Tang Wee Teo, University of Illinois (Urbana-Champaign), tteo2@illinois.edu

ABSTRACT: A chemistry teacher at the Illinois Mathematics and Science Academy (IMSA) initiated changes to the advanced chemistry course to make it more inquiry-based and less "Advanced Placement". Scientific inquiry has become a buzzword in science national standard documents, textbooks, and journals, but its definition is fluid as it is a highly contextualized term. In this inquiry into

teacher-initiated reform work, I want to critically examine "inquiry" set against the background of a science curriculum for gifted and talented students in a specialized mathematics and science school. This will, in turn, construct a lens for examining the tensions in doing reform work in this socially, culturally, and politically privileged ground consisting of a heteroglossic social system of 'power players'. Narratives were selected from interviews, inquiry-based lessons, and informal conversations and analyzed for the embedded meanings of inquiry and to identify existing and possible tensions, hence valuing the 'voices' of this teacher and his role as the key power broker in reform work. The findings of this study will inform researchers and practitioners interested in reform work and interpretations of scientific inquiry.

S4.14.2 Teachers' Interpretations of the Design and Implementation of Inquiry Activities

M'nica M. Baptista, Centro de Investigação em Educação, mlmbaptista@gmail.com

Ana M. Freire, Universidade de Lisboa

ABSTRACT: In Portugal, the curriculum for teaching science in middle school has a constructivist focus, values the scientific inquiry approach, and promotes the Science-Technology-Society- Environment perspective. These guidelines point to the educational approach of engaging pupils in inquiry activities. However, many of the teachers are resistant to the implementation of innovative ideas. To overcome the problem, two researchers designed, in collaboration with schoolteachers, a set of inquiry activities that were implemented in their classroom. Taking this into account, the present study aims at describing what the teachers' interpretations are when they are involved in this process. This paper is part of an extended study that involved schoolteachers implementing inquiry activities. The research reported is qualitative, adopting an interpretative orientation. Two types of methods of data collection were used in this study: interactions among researcher and teacher during the design of inquiry activities, and interviews at the end of each lesson, during the inquiry activities implementation. Data analysis took place using the constant comparison method. This study shows that teachers' interpretation of the design and implementation of inquiry activities are influenced by their own backgrounds, knowledge and skills.

Strand 10: Curriculum, Evaluation, and Assessment

S4.15 SC-Paper Set: National Science Curriculum and Assessment Reforms 2:45pm - 4:15pm Conference Boom 410

2:45pm – 4:15pm, Conference Room 410

S4.15.1 Linking Physics Textbooks' Content and the Content Validity of Nationwide Tests

Hendrik Haertig, University Duisburg-Essen, Germany, hendrik.haertig@uni-due.de

Alexander Kauertz, University of Education, Weingarten Germany

Knut Neumann, Leibniz Institute for Science Education, Germany

Hans E. Fischer, University Duisburg-Essen

ABSTRACT: Test items have to deal with content if they do not assess general abilities, but in many large- scale assessments content validity was neglected. Often expert ratings are used to ensure content validity, even if this method is shown as problematic. Thus, a valid model to ensure content validity would close a gap of research. As we know about the relationship between textbooks' structure and the newly built cognitive structure of students, our aim is to develop a valid method for representing the content structure of whole textbooks into concept maps to use them as guideline constructing test items. The procedure is shown as a reliable and measurable way to analyze textbooks. Using the centrality of concepts in the maps to get to a validity-value for items leads to satisfying results. To validate the model professors and teachers of science education were asked to rate the curricular validity of 15 items and teachers to rate validity with respect to their teaching in addition. The correlation between both ratings of the teachers (ρ =.830; p<.001) is pretty high, meanwhile the correlation between professors and teachers (ρ =.587; p=.021) is as high as between concept-map approach and teachers (ρ =.575; p=.025).

S4.15.2 Science and Mathematics Curriculum Reform in Senior Secondary Education in the Netherlands: First Results of a Comprehensive and Longitudinal Evaluation Study

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Elvira Folmer, Netherlands Institute for Curriculum Development

Wout Ottevanger, Netherlands Institute for Curriculum Development

Lucia Bruning, Netherlands Institute for Curriculum Development

ABSTRACT: Science and Mathematics Curriculum Reform in Senior Secondary Education in the Netherlands: First Results of a Comprehensive and Longitudinal Evaluation Study Like in many other countries, the chemistry, physics, biology and mathematics curricula for senior secondary education in the Netherlands (grades 10-12 in the USA) contend with poor coherence within and across subjects, and with a lack of content relevance for many students. In addition, most programs are overloaded. In an attempt to do something about these persistent problems, the Dutch Ministry of Education established Committees for the reform of senior secondary chemistry, physics, biology respectively mathematics education, each with the mandate to develop new examination programs based on a context-based approach. The reforms have been organized around subject-specific pilots, with the involvement of several schools for secondary education. The pilots for the science subjects started in August 2007, those for mathematics began two years later. The curriculum proposals and their implementation are subject to a comprehensive and longitudinal evaluation, the first

results of which will be presented in the paper. Its main purpose is to provide science and mathematics educators as well as policymakers with an answer to the question whether the intended curriculum reforms result in programs that are feasible for both teachers and students or not. The main target group consists of teachers and students of pilot schools. Data collection includes documents analysis; interviews, the administration of teacher and student questionnaires, and case studies. The paper describes and discusses evaluation results as regards the chemistry, physics, and biology pilots in grades Secondary 4 and 5 in 2008 and 2009.

S4.15.3 Multiple Aims in the Development of a Major Reform of the National Curriculum for Science in England

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Indira Banner, University of Leeds, UK

ABSTRACT: We examine the development of a major reform of the late secondary school science curriculum in England. We describe activities influencing the formation of the reforms and the professional roles of those involved. We focus particularly on the aims ascribed to the reforms by different stakeholders. Many of the activities examined represent an attempt to generate an 'aims-based' science curriculum. There is a strongly instrumental view of such aims with a resultant focus on future outcomes rather than the process of education itself. Our analysis identifies different stakeholders exercising a range of demands, e.g. economic, political, social and individual. This results in some significant tensions within the reforms. Furthermore, professional scientists do not feature as central players in the activities described here. This reflects a previously identified shift in 'ownership' of the science curriculum since the latter half of the 20th century away from professional scientists. By contrast university -based science educators do feature prominently. Drawing upon a cyclical model of the policy process we suggest that teachers' initial classroom experiences as they 'recreate' curriculum innovations needs to be seen as an inevitable feature of the development of curriculum reform.

S4.15.4 Re-Conceptualization of Scientific Literacy for the 21st Century in Korea

Kyunghee Choi, Ewha Womans University, hlee25@ewha.ac.kr

Sung-won Kim, Ewha Womans University, Korea

Hyunju Lee, Ewha Womans University, Seoul, Korea

Joseph S Krajcik, University of Michigan

ABSTRACT: This study is a part of a 5-year research project, entitled to 'establishment of education system of enhancing scientific literacy for the 21st century' supported by the Korean Ministry of Education, Science, and Technology. In order to enhance scientific literacy of students, teachers, and the general public in Korea, we plan to develop coherent and consistent curriculum materials and education programs, well-planned teacher training programs, and a technology-enhanced education environment. This year, as an initial step, we re-conceptualized scientific literacy that would be necessary for the 21st century global society. In order to suggest a conceptual framework, we reviewed dozens of related literatures, published in major international and Korean science education journals from 1950s to 2008, and identified major dimensions and elements that constitute scientific literacy for the globalized society. In addition, we gathered the educational visions from science teachers and experts in science education on this. In our conceptual framework of scientific literacy, we highlighted 1) collective social practice, 2) constructive process of social values, and 3) development of character as global citizens. It is composed of four dimensions; 1) knowledge, 2) process skills, 3) humanistic aspects of science, and 4) orientation, and each dimension includes major elements.

Strand 11: Cultural, Social, and Gender Issues

S4.16 SC-Paper Set: Students, Teachers, And Scientists From Underrepresented Groups: Where Does Success Lie?

2:45pm – 4:15pm, Conference Room 411

S4.16.1 Islam, Evolutionary Science, and Education: Paradoxes and Challenges in Muslim Cultures and Societies

Anila Asghar, The Johns Hopkins University, anila.asghar@jhu.edu

Saouma BouJaoude, American University of Beirut

Jason Wiles, Syracuse University

Brian Alters, McGill University

ABSTRACT: This study seeks to explore the intersections among religion, science, and education in diverse Islamic countries and cultures. Specifically, it examines the ways in which the scientific theory of evolution is understood by Muslim university faculty and high school biology and science teachers in light of their Islamic belief of creation since very little is known about the evolution/creation controversy in Islamic countries and communities. Data was collected from 85 high school science teachers and scientists and professors from various schools and universities in Canada, Egypt, Lebanon, Indonesia, and Pakistan. Qualitative interviews and focus group discussions were conducted to probe participants' epistemic understanding of evolution and how they address the evolution/creation controversy in teaching. Muslim science teachers mostly accepted evolution of living beings except human beings because human evolution contradicts their Islamic beliefs. The science teachers mostly lacked a clear understanding of biological evolution. Most were in favor of teaching the religious and scientific perspectives in their science courses. Muslim scientists generally did not perceive any major conflict between Islam and evolution theory; most tried to reconcile evolution with religion. This

study has implications for teacher development and science education; Muslim science teachers need better training opportunities in evolution education.

S4.16.2 Informing Science Teacher Retention and Attrition in the Rural Black Belt Region of Georgia

Georgia W. Hodges, University of Georgia, georgia.hodges@gmail.com

Steve Oliver, UGA

Deborah J. Tippins, UGA

ABSTRACT: Staffing schools with qualified teachers receives vast attention from policymakers, researchers and the general public. Multiple reports, including the Glenn Commission on Mathematics and Science Teaching for the 21st century, reports from the National Research Council and the National Academy of Sciences illuminate the shortages specifically in mathematics and science education. Although turnover of science teachers approximates that of other subjects, such as English or social studies, science does not have an overabundance of new teachers to replace those lost, complicating the issue of science teacher retention. This study, situated in the Black Belt region of Georgia, addresses the issues of teacher retention, attrition and the impact of policy on each. Using qualitative methods, including life story interviews, participant observation, interviews, focus groups and document analysis of archival data, researchers illuminated multiple tensions that science teachers in the rural black belt region of Georgia face. Using grounded theory analysis, researchers have constructed a bottom-up, teacher centered perspective, which offers a different view of the daily life of the teacher to understand that often studied problem from a different perspective. This paper discusses the primary tensions as well as the cultural myths that impact teacher retention and attrition.

S4.16.3 From Access to Success: Comparing Black Students' and Black Scientists' College Going Experiences

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

Bryan Henderson, Stanford University

Salina Gray, Stanford University

ABSTRACT: This project explores how contemporary perspectives on minority students' matriculation into science careers explain the current lack of Blacks working in science careers. We compared the 57-item Likert scale questionnaire responses of a database of current college students (n=214) and currently practicing scientists (n=238) to identify any potential differences. Through the development of a web-based questionnaire, we analyzed the both groups' reflections of their educational experience, interactions with racism, and their discussions of their achievement. We engaged in a mixed method analysis and written answered short-answer questions to provide qualitative and quantitative data. Both groups identified how race place a major role in experiences. The differences in the results of the students and scientists was found in how the scientists adopted an achievement ideology associated performance, while students had perceived race as a limitation to entering the job market. The results call attention to the need to reconsider the notions of ethnic representation and cultural inclusiveness in science education.

S4.16.4 To Iron or to Do Science: A Storied Life of a Latina from Scientist to Science Teacher

Sarida Hoy, Georgia State University, shoy1@student.gsu.edu

Geeta Verma, Georgia State University

ABSTRACT: This study examined the career transition of a former Latina scientist from a research scientist to a high school science teacher. Her lived experiences that influenced her career transition were examined using interpretive biography through a feminist theory lens. The following question guided the study: How have the lived experiences of the participant as engaged through cultural, historical, and social interactions influenced a transition in career from a research scientist to a classroom teacher? Reform initiatives argue for making science accessible to all children regardless of age, sex, cultural and/or ethic background, and disabilities. Science for all argues for finding ways to bridge students' experiences outside of the science classroom and being inclusive of the cultural resources that student's household's offer. A former Latina scientist and her family participated in this study to facilitate the documentation, narration, and interpretation of her career transition. Data collection included in-depth interviews with the participant and her family and reflexive journals over a period of five months. Data were analyzed using socio-cultural thematic approach to identify snapshots and to develop emergent themes. Data analysis revealed that the participant's cultural socialization conflicted with the Eurocentric/Androcentric culture of science found in both the university and research laboratories.

Strand 15: Policy S4.18 SC-Paper Set: Schools and University Partnerships for K-12 Science: Working Together for Change and Improvement

2:45pm – 4:15pm, Conference Room 415

S4.18.1 Strand Zero: A Request to De-Balkanize the Strands Structure within NARST

John Settlage, University of Connecticut, john.settlage@uconn.edu

ABSTRACT: The interplay between science teaching practice and science education research has been jeopardized by an organizational policy of compartmentalizing research. The basis for this presentation is an empirical mixed–methods study that

examined the relationships among school structures, administrative process, curriculum delivery, and social capital in order to uncover causal factors that would explain exemplary science learning. Further, the contexts of this study were schools demonstrating the capacity to mitigate science achievement gaps associated with race, ethnicity, social class, and English fluency. Because the multi–site study cuts across multiple strands, its rich ecological methodology places it at risk by not falling into a single, artificial category. Despite explanations based on logistics (i.e., efficiently distributing reviews and decisions), sorting research projects into strands effectively fragments the discipline and isolates its discourses. Consequently there is de facto segregation at the annual meeting as participants are sorted into special tribes according to specious territorial boundaries. This is a perilous situation with damaging consequences for the individual scholar as well as the entire research organization. Starting with a practice–to–research/research–to– practice project, we offer an alternative: a synoptic category of science education research called Strand Zero.

S4.18.2 What is a Partnership?

Andrea Burrows, University of Cincinnati, stepgrantcoor@gmail.com

ABSTRACT: I review the term "partnership" through the National Science Foundation (NSF) educational program solicitations over the last decade using archival research. The term "collaboration" I reason to be the predecessor, and now often parallel, of the term "partnership" and as such it is included in the history. Only program solicitations that include universities, K-12 schools, and the terms "partnership" and/or "collaboration" are considered in this account. Funding issues are considered as well. I propose the "IDEA" grounded theory where concepts are III Defined, Expected, and Accepted. I demonstrate how the two terms investigated are currently used in NSF program solicitations and proposal abstracts to fit this theory. Additionally, I work in a partnership that incorporates several secondary schools and several university groups. This partnership is explored with the results of the archival research referenced earlier.

S4.18.3 Effect of STEM Faculty Engagement in the Math and Science Partnership Program

Xiaodong Zhang, Westat, xiaodongzhang@westat.com

Joseph McInerney, Westat

ABSTRACT: The presentation explores the effect of the engagement of university science, technology, engineering, and mathematics (STEM) faculty in the Math and Science Partnership (MSP) program. The findings suggest that K–12 teachers benefited from the engagement in terms of improved approaches to teaching and learning, increased knowledge of subject matter content, and increased confidence; STEM faculty benefited from new ideas about teaching and learning, insights into research, more knowledge of the K–12 education system, and a broader understanding of education overall. Student achievement also improved although direct attribution to faculty involvement is somewhat unclear. Furthermore, in the short run at least, it appears that few benefits extend beyond those faculty who are direct participants, and few systemic changes have been made in institutions of higher education (IHEs).

S4.18.4 Trends and Outcomes of NSF Stem Education Grants at the City University of New York: Implications for Policy, Practice, and Future Initiatives

Angela M. Kelly, Lehman College, amk66@columbia.edu Serigne Gningue, Lehman College Jinlin Chen, Queens College Subash Shankar, Hunter College

Rathika Rajaravivarma, New York City College of Technology

ABSTRACT: The purpose of this research project is to synthesize and analyze recent NSF grant awards related to mathematics and science education at the City University of New York. Researchers at CUNY have been quite successful in securing funding for such projects in recent years, and this report seeks to examine outcomes of past awards to highlight major impacts as well as potential theoretical gaps in funded projects. The primary goal of this project is to disseminate information on funded proposals for the purpose of guiding future NSF submissions, with the intention that these projects will have an increased likelihood of securing funding for innovations in science and mathematics education. Research is necessary to synthesize core aspects of newly created program designs in order to highlight effective practices that may be institutionalized for the purpose of sustaining positive impacts through improved teacher education. Faculty and researchers may look towards this research to craft proposals that take existing models and further improve and broaden their impacts, and they may also utilize this synthesis to identify gaps that have not been addressed in the recently funded projects. The report will identify aspects of recently funded NSF submissions that were instrumental in their success.

S5.1 Administrative Symposium: The NARST Digital Archives Project: A Repository and Resource for the History of Science Education Research

4:30pm - 6:00pm, Salon C

Fouad Abd-El-Khalick, University of Illinois at Urbana-Champaign, fouad@ad.uiuc.edu

John L. Rudolph, University of Wisconsin-Madison

Nancy Ruggeri, University of Wisconsin-Madison

ABSTRACT: Over the past two years, scholars at the NARST Digital Archives Project have been working on gathering, processing, cataloging, and digitizing the historical records of the National Association for Research in Science Teaching. The collection, as it

currently stands, consists of full-text searchable electronic images of over 3 cubic feet of archival materials. In this presentation, we will provide an overview of the process of collection development, describe the scope and content of the primary categories of materials available in the collection, and demonstrate the use of the webbased, electronic interface that individuals can use to search and access documents. Following the unveiling and demonstration of the Digital Archives, we intend to solicit feedback related to future directions and projects we might undertake in the area of archives development as well as engage in a discussion about the usability of the electronic interface in order to make improvements and prepare the project for the next stage of electronic access.

Equity and Ethics Committee Sponsored Session

S5.2 Administrative Symposium: Learning to Participate in the Culture of Science through Connecting Research and Practice: Equity and Access in Science Education

4:30pm – 6:00pm, Conference Room 501

Presenters:

Doris Ash, University of California, Santa Cruz, dash5@ucsc.edu Bryan A. Brown, Stanford University Pauline Chinn, University of Hawaii, Manoa Noah R. Feinstein, University of Wisconsin, Madison Sumi Hagiwara, Montclair State University Maria S Rivera Maulucci, Barnard College

ABSTRACT: The science that is taught has sometimes been couched as culturally neutral and thus immune from the need to come from a culturally relevant perspective. The paradigm that guides this thinking operates on the assumption that if all students have to learn the language, epistemology, and knowledge of science, then why does science teaching bear the responsibility of culturally relevant instruction? We know from real classrooms and informal learning institutions that such views do not fit reality. The issue of learning how to participate in and become part of the culture of science, then, is the central framework for this session. We will examine this issue from multiple viewpoints and diverse research perspectives. The five panelists are interested in a wide range of research including but not limited to urban school students and discursive identity, native Hawaiians and place based learning, Japanese- American immigrants' views of science in school, informal institutions and issues of access, and the role of critical science pedagogy in teacher education. The goal is to present a well- rounded cross section and lively discussion of scholars working in a variety of settings with diverse populations toward achieving equity and access in science education.

Research Committee Sponsored Session S5.3 Poster Symposium: Science Research Institute 4:30pm – 6:00pm, Salon D

S5.3.1 Beginning Secondary Science Teachers' Pedagogical Content Knowledge and Their Use of Instructional Resources Krista Adams, Arizona State University

ABSTRACT: Science teachers are asked to implement inquiry lessons into their instruction. The lesson selection is influenced by the teacher's subject matter knowledge, pedagogical knowledge, and knowledge of the students. This is often referred to as an amalgam called pedagogical content knowledge (PCK). This knowledge base acts as a springboard for a teacher choosing instructional resources from which to select activities for the classroom. This process is not an easy task for the new teacher. They may turn to textbooks and other resources that often lack insight into how to deal with student conceptions or inadequate for implementing inquiry-based activities. This study of beginning secondary science teachers (N = 114) investigates the correlation between a teacher's PCK and their choice in instructional resources.

S5.3.2 Science Teachers' Voices: Eliciting Students' Knowledge during Instruction

Comfort Atheh, University of California, Davis

Cynthia Passmore, University of California, Davis

ABSTRACT: Formative assessment (FA) can increase access to high-quality science education for all students (National Research Council, 2001). Researchers have explored how teachers can enact FA in their classrooms as well as adapted research findings into concrete approaches to developing and enacting FA in the classroom (Furtak, 2009). However, there is minimal research on teachers' knowledge on their FA practices. This study attempts to close this gap by exploring science teachers' elicitation practices. Twelve science teachers were video taped as they taught their classes followed by a video stimulated recall (VSR) interview (Calderhead, 1981). The VSR interview gave the teachers an opportunity to describe thought processes underlying their decisions to elicit students' knowledge as well as the challenges in doing so. The interviews were audio taped, transcribed and coded based on themes that emerged from the data. Findings indicate that teachers access diverse knowledge in making decisions on eliciting students' knowledge, not all of it related to assessment practices. An understanding of teachers' elicitation of students' knowledge can inform science teachers and educators on programs that will enhance science teachers' formative assessment practices.

S5.3.3 Teachers' Perceptions of Implementing a Food Chemistry Unit within a National Chemistry Curriculum Reform

Shirly Avargil, Technion - Israel Institute of Technology

Orit Herscovitz, Technion - Israel Institute of Technology

Yehudit Judy Dori, Technion - Israel Institute of Technology

ABSTRACT: In order for an educational reform to succeed, teachers need to adjust their pedagogical perceptions to the reform's new curricula and strategies. As part of an Israeli national reform for high school chemistry, a new study unit, Taste of Chemistry, was developed with focus on context-based learning and developing higher order thinking skills and chemical understanding. The study was aimed at (a) determining teachers' perceptions regarding advantages and difficulties they experience while teaching in context, (b) characterizing ways in which teachers infuse thinking skills into their instruction, and (c) adjusting students' assessment to align with the unit objectives. Based on interviews and classroom observations over two years of teaching, we found that teachers' confidence level in teaching the unit evolved from insecurity to a sense of gained experience. Regarding thinking skills and assessment they moved from skepticism to recognition of the importance of implementing adapted methods to suit the needs of this teaching approach. These findings are relevant to science educators as they can provide guidelines for science teachers to cope with new teaching and learning approaches. The research outcomes might be valuable for decision makers who contemplate new reforms in science education in general and chemical education in particular.

S5.3.4 From Gatekeepers to Dreamkeepers: Exploring the Role of Teacher Identity in Improving Cultural Competency for Science Teachers

Edith L. Blackwell, Morgan State University

ABSTRACT: In the mid-1980's the Department of Education recognized the need to reach more minority students and teachers in the fields of science and mathematics rather than focusing on an elite group. Standardized testing scores for African American students in science are still lower than any other group of students. If we are to increase the number of minority students majoring in science, we must first improve the way we teach science to African American students. Gloria Ladson Billings has long trumpeted the necessity of a culturally relevant pedagogy, and refers to the teachers who are prepared to teach across cultures as Dreamkeepers. Ladson Billings (1997) defines culturally competent teachers as those who know what is necessary for all students to achieve academically and that their students do not have to lose their identities to succeed (Ladson-Billings, 1997). This collective case study will explore the role of teacher positional identity of four high school science teachers in the context of race, gender and community and how it is reflected in teaching science to African American students. It will also encourage cultural competence by challenging them to become Dreamkeepers.

S5.3.5 Mirror, Mirror & Preservice Teachers Reflect on their Initial Teaching Experience Using Video Analysis: A Cultural-Historical Explanatory Perspective

Elisebeth Boyer, Pennsylvania State University

ABSTRACT: This paper investigates how preservice teachers make sense of their own teaching through reflection and how this fits into the system of learning to teach science. Participants, referred to as "interns", are primarily 20-22 year old females enrolled in their final year of an undergraduate elementary education program. Data sources include teaching artifacts, lesson plans, interviews and teaching analysis videos prepared by the interns using StudioCode; a new tool for digital video analysis. Cultural-Historical Activity Theory (CHAT) is utilized as an explanatory theoretical framework. By considering the interns' actions within a series of networked activity system for learning to teach science, this research uncovers key contradictions which influence how the interns reflect on their initial teaching experiences. It also proposes how those contradictions can be leveraged by the science teacher educator to improve how pre-service teachers reflect on and develop from their initial teaching experience. This study influences activity-theoretical research by utilizing CHAT as an explanatory framework for developmental research in science education. This entails a comprehensive alignment of theory, data collection, and analysis/coding as well as using CHAT as a lens to understand and explain findings.

S5.3.6 Elementary Teachers' Science Practice, Beliefs and Content Knowledge During and Following a Reform-based Professional Development Program

Dina Drits, University of Utah

ABSTRACT: This study examines the beliefs, content knowledge, and practices of 15 upper-elementary teachers from three highneed, diverse schools who participated in a yearlong, reform-based professional development program. A longitudinal, mixed model design, which integrates both quantitative and qualitative data, is used in this two-year study. This methodology facilitates an examination of pattern development in teachers' inquiry-based beliefs, practice, and physical science content knowledge during the professional development program year and the following year. Examples of potential patterns include an immediate, substantial change toward more reform-based beliefs and practice that is sustained over time; a gradual change over the two years; an initial change followed by a return to baseline; or no change. This methodology also enables investigation of the contextual and personal factors that facilitate or impede the maintenance of teacher learning in the year following the program. The process of deciding whether and how to implement and sustain new practices, and the reasons for these decisions, ultimately determines the success of reform-based professional development in science education. The significance of the study for science teaching and learning along with its contribution to the interests of NARST members are discussed.

S5.3.7 Beliefs about Teaching and the Nature of Science of Certified and Non-Certified Secondary Science Teachers

Jonah Firestone, Arizona State University

Julie A. Luft, Arizona State University

ABSTRACT: In recent years, scrutiny of teacher certification programs has increased. As part of a larger study examining beginning secondary science teachers' experiences in various types of induction programs, we compared certified (N=33) to non-certified (N=32) teachers in their beliefs of how to teach science and their understanding of the nature of science. The authors employed Hierarchical Linear Modeling (HLM) to construct individualized growth models of the certified and non-certified teachers. The result of this analysis indicated that both groups' responses converged over time in regards to their beliefs about teaching science. In addition, both groups' responses became significantly more positivist in their understanding of the nature of science.

S5.3.8 Science, Technology, and Pedagogy: Exploring Secondary Science Teachers' Uses of Technology Selcen S Guzey, University of Minnesota

ABSTRACT: This study was designed to explore the knowledge, beliefs, personality, and classroom practices of science teachers who are technology users. Research has shown the positive effect of using technology on student learning (Songer, 2007). However, there are few science teachers use technology in their teaching. In this study, three beginning science teachers were followed to investigate the factors that facilitate their use of technology. Interviews, classroom observations, and classroom artifacts were the data collection instruments. Preliminary findings showed that teachers who use technology hold positive beliefs about the effectiveness of technology on student learning, have high level of motivation to use technology, and have well-developed technology knowledge. To increase the use of technology in science classrooms, pre-service teacher education programs should assist teachers in developing positive attitudes toward the use of technology in classroom instruction. Furthermore, to improve teachers' knowledge about technology more content-specific technology courses should be offered in pre-service teacher education programs.

S5.3.9 An Exploration of Urban Elementary Teachers' Perspectives on Science Education Reform

Jessica Hammock, Emory University

ABSTRACT: This exploratory study examined urban elementary teachers' perspectives on science education reform and the relationship between school reform context and teachers' views on science education and reform. Elementary teachers implementing both comprehensive school reform and a district-wide science education reform initiative responded to an online survey comprised of a short questionnaire, open-ended response items, and two previously developed instruments: the Context Beliefs About Teaching Science Survey (Lumpe, Haney, & Czerniak, 2000) and the Reform Instrument (Czerniak & Lumpe, 1996). Through the survey, teachers provided both qualitative descriptions of science teaching and learning in their schools and classrooms and quantitative data on relevant aspects of science education reform including: time devoted to science instruction, the necessity of various approaches to science education reform, the frequency with which reforms are implemented in teachers' classrooms, the extent to which various environmental factors are thought to enable effective science teaching, and the likelihood that these factors will occur at teachers' schools. Quantitative and qualitative data analyses were conducted to identify potential differences and patterns in teachers' responses within and across schools and comprehensive school reform models. Implications for science education reform, teacher professional learning, and policy implementation are discussed.

S5.3.10 A Beginning Researcher's Narratives on Learning How to Do Research through the NARST Summer Research Institute

Hosun Kang, Michigan State University

ABSTRACT: This study describes a beginning researcher's experiences at the 2009 NARST Summer Research Institute (SRI). The purpose of this study is to show how a beginning researcher's experience at SRI has influenced her research and her identity development as a researcher and educator. Data includes the research proposals developed before and after the SRI and the narratives on her experiences. This study indicates that the SRI helped her to develop knowledge and practice of educational research through posing many critical questions around her research design. Moreover, the SRI supported her identity development as a researcher and educator by having her take her positions toward the research community, be aware of her values regarding research of teacher learning, and find role models that she want to be like. Implications to research community will be addressed.

S5.3.11 Affordances of Mass Media as Teaching Tools in the Science Classroom: Perspectives from Secondary Science Teachers

Michelle Klosterman, University of Florida

ABSTRACT: This presentation will share the results of one portion of a larger study aimed at investigating secondary science teachers' uses and conceptions of mass media in the science classroom. Interviews were used to probe teachers' ideas about their selection and use of mass media resources in the science classroom. Teacher interviews were analyzed using the constant comparison method under the ground theory approach. In addition to the identification of general themes and sub-categories related to teachers' reported selection and use of media resources, "episodes" of teachers' use were identified and coded for four elements: 1) affordances of media, 2) type of media used to mediate affordance, 3) how the medium was used to mediate the affordance, and 4) elements that either increased or decreased the teachers' ability to mediate the affordance. Teachers reported using a variety of mass media resources to teach science, and identified several barriers to their use. Five main affordances of media were identified by the teachers.

Teachers reported using media in a variety of ways to mediate these affordances, and identified both elements of media and elements of the teachers' context that influenced their ability to use media as an instructional tool in science.

S5.3.12 Transformations of Intentions in State Educational Policy: An Analysis of Science Teacher Professional Development Policy

Michele H. Lee, University of Missouri

ABSTRACT: Given calls for improvement in student science achievement and concern about teacher quality, teacher professional development is currently one federally endorsed policy lever. Prior policy research indicates discrepancies, conflicts, and unintended consequences during the policy process such that original intentions of the policy initiators change. This longitudinal qualitative study investigates a state-level policy – Improving Teacher Quality Grant (ITQG) program – over several annual funding cycles to consider the policy process and what occurred with state policy intentions for science teacher professional development in the state of Missouri. The policy analysis is anticipated to provide insights for future professional development policy, research and practice.

S5.3.13 Using Activity Systems Analysis to Evaluate the Implementation of Science Curriculum at Multiple Illinois Schools Jason McGraw, Northern Illinois University

Lisa Yamagata-Lynch, Northern Illinois University

ABSTRACT: This research investigated how various school contexts affected the implementation process of a new curriculum in urban ecology. We used activity systems analysis to identify specific factors in each school that cause tension in the curriculum interpretation process. By comparing teacher's classrooms in several area schools, we are able to isolate specific situational tensions for each teacher that impaired the implementation. At this time, the data has been collected, coded, and preliminary findings are available. They show that some of the teachers were impaired in their implementation by factors that were not under their control both inside and outside the classroom. Some examples are the teacher's content and pedagogical knowledge, the student's orientation to science, and other characteristics of the particular school. This research has implications for the design and implementation of science reform initiatives.

S5.3.14 Remediation of University-Based Science Teacher Education

Deborah Morrison, University of Colorado at Boulder

ABSTRACT: This study employs cultural-historical activity theory to gain insight into the practices of science students in an undergraduate teacher education course designed to recruit students into science teaching. This study was conducted in two sections of the course and involved 27 students and two instructors. Qualitative methods, such as a questionnaire, interviews, focus groups, artifact analysis and participant observations, were used in this study to collect and analyze data. The results indicate that there are common science teaching practices such as classroom discussions, physical and technological tool usage and lesson planning. Student participation in these practices is promoted through a variety of mediating artifacts within the course such as: team structures, hybrid discourse, and the lesson planning process. Students experience a variety of outcomes from the course due to the differences in the way in which mediating artifacts play out among the students. This work is significant in that it highlights the impact of these mediating artifacts through the practices of class discussions, tool usage and lesson planning; illustrating practical examples of the potential for increased participation in the practices of science teaching and the promotion of expansive learning for early career educators.

S5.3.15 Beliefs and Practices of a Beginning Science teacher of ELLs: A Longitudinal Study

Irasema B. Ortega, Arizona State University

ABSTRACT: For the past decade, the public school system in the United States has experienced a steady increase in the number of English language learners (ELLs). This study examines the beliefs and practices of one beginning science teacher who worked with ELLs over a three-year period. During the three year period, observations, general and beliefs interviews, as well as monthly interviews were made of this teacher. In addition, we examined documents such as teacher evaluations and artifacts used by the participant in her classroom. The analysis of this data revealed that during the first and second years of teaching Victoria implemented inquiry lessons. In year three she was out of field and this impacted her implementation of inquiry activities. In addition, she utilized instructional materials that promoted language and science competencies amongst her ELLs and were relevant to her students. The participant beliefs were transitional for the first and third, whereas for year two there was a shift towards a more traditional orientation. The findings of this study indicate that with appropriate pre-service preparation, induction support, mentoring and professional development Victoria was able to modify her instructional classroom practices to better support the language and academic needs of her students. Furthermore, the findings also support previous research that indicates school context can impact a teacher's implementation of inquiry. This study has implications for collaborative efforts among science educators and school administrators in order to provide professional development that promotes inquiry and language practices for teachers who work with high numbers of ELLs.

S5.3.16 An Interpretive Case Study of How Elementary Science Students Use Science Notebooks During Science Instruction in Elementary Science Classrooms

Lori Petty, Texas Tech University

Ratna Narayan, Texas Tech University

ABSTRACT: Writing provides students with authentic opportunities to generate a personal response to investigations, clarify ideas, and construct new knowledge (Klentschy, 2008). One method of embedding writing activities, into science instruction, is through the use of science notebooks, science journals, or science learning logs (Campbell & Fulton, 2003). Science notebooks are a tool science teachers may choose to use to help students learn science. The purpose of this interpretive case study was to explore how elementary science students use science notebooks in second through fourth grade science classrooms. In this research the data came from student interviews, classroom observations, and science notebook analysis. The two science topics being observed were "force and motion" and "properties of matter." This research offers a unique perspective regarding the use of science notebooks during science instruction at the elementary level. This study explores the use of science notebooks across two different science concepts– force and motion and properties of matter, taught at three different grade levels (2-4). Therefore, this study provides data pertaining to the use of science notebooks grade wise and topic wise.

S5.3.17 Middle School Science Teachers' Reflections on Video Cases about Their Use of informal Formative Assessments (IFA)

Asli Sezen, Pennsylvania State University

Gregory Kelly, Pennsylvania State University

ABSTRACT: Considering teachers' central role on implementation of effective assessment activities, this study aims at understanding teachers' challenges while using Informal Formative Assessments (IFA) and helping teachers to develop their own IFA models through reflections on their video cases. The study tries to answer how science teachers' practices and perspectives on using IFA changes via technology mediated reflections and how their own models of IFA (emerged from their experiences) contribute to science teacher education research. The first part of the data will be the video records of the teacher-student interactions from two seventh grade classrooms with two different experienced science teachers working at a local public school. The second part will be collected during the researcher's meetings with the same teachers when they are reflecting on the video cases selected by the researcher as an example to effective and ineffective use of IFA. Analytical tools from sociolinguistics (i.e. transcripts and event maps) will be used to analyze the data. Then, the transcripts of the practices will be coded by IFA model developed by the researcher and teachers. The transcripts of the reflections will be coded through emerging themes related to the use of IFA, an approach based on grounded theory.

S5.3.18 Action Research: How Science Teachers Integrate Educational Technology

Demetrice Smith, Morgan State University

ABSTRACT: The merge between science and technology has taken flight several decades ago. More recently, it has become apart of the dynamic K-12 Science classroom. Technology is central to the teaching and learning of science (Baird, 1999). The purpose of this case study is to examine the issues concerning educational technology implementation of science teachers as participants of a participatory action research (PAR) framework study. The PAR framework is a cyclical framework consisting of diagnosis, action, measurement, and reflection (James, Milenkiewicz, & Bucknam, 2008). Interviews, teacher and student artifacts, and questionnaires will be analyzed in this study. NIVIVO software will be employed to code the data. The results of this study will aid in understanding the decisions made by teachers to implement technology within science instruction. This is necessary to merging 21st century skills and technology.

S5.3.19 Contextualizing Instruction for Cultural and Social Relevance: Exploring Preservice Secondary Science Teachers' Beliefs, Knowledge, and Practices

Sara Tolbert, University of California - Santa Cruz

ABSTRACT: In this poster session, the presenter will describe her dissertation research study which focuses on the preparation of preservice secondary science teachers (PST) for culturally and socially contextualized science instruction in diverse classrooms. The study is designed to investigate PST beliefs, knowledge, and practices related to contextualized instruction as they participate in a year-long equity-based teacher education program (TEP). Preliminary results on preservice teachers' pre-teacher education program (TEP) beliefs and knowledge about contextualized instruction will be shared, and future steps for analyzing the practices of the participants in their student teaching and post-TEP beliefs and knowledge will be discussed.

S5.3.20 Teachers' Transformation of Nanoscience Subject Matter Knowledge

Emily Wischow, Purdue University

Lynn Bryan, Purdue University

George M. Bodner, Purdue University

ABSTRACT: As advances continue to be made in scientific research, science education often lags behind in preparing students to enter scientific careers and participate in the community as scientifically literate citizens. Incorporating modern science topics such as nanoscience into the secondary curriculum is an important step in updating our science curriculum. In order to design effective professional development programs that facilitate teachers' inclusion of new content into the curriculum, we must understand how teachers adapt novel content for their individual classrooms. This study will investigate high school teachers' transformation of nanoscience content knowledge using pedagogical content knowledge (PCK) as a theoretical framework. Six teachers will be

observed in the classroom and interviewed throughout the school year to determine which knowledge bases teachers draw on at various points in the implementation process. Case studies will be created for each teacher participant, and analysis will culminate in a cross-case analysis. Findings from this study will include a model of how components of teachers' PCK interact with new subject matter knowledge to impact teacher integration of nanoscience content throughout the first year of implementation.

S5.3.21 Developing a Dissertation Study: What Knowledge for Science Teaching Do University Science Instructors Use to Inform Their Planning and Teaching in Science Courses?

Stephen B. Witzig, University of Missouri

ABSTRACT: Developing a dissertation study is challenging. There are several aspects to consider: identifying a problem/topic to investigate; developing a conceptual framework to address the problem; devising/refining research questions that relate to both your topic and framework; outlining the methodological design of the study; and considering the contribution your study will have to science teaching and learning. To help facilitate the development of my dissertation study, I participated in the NARST summer research institute (SRI). The purpose of this poster is to share how the SRI facilitated my thinking about the development of my research design. The overall research question that guides my dissertation study is: What knowledge for science teaching do university science instructors use to inform their planning and teaching in science courses? The research is a case-study design with qualitative research methods and uses the pedagogical content knowledge framework to assist in data collection and analysis. The poster highlights how the SRI assisted in the development of my research design, including helping me refine my research questions while making sure they were aligned with the overall research design and conceptual framework.

S5.3.22 The Impact of Induction: Beliefs and Practices of Beginning Science Teachers

Sissy S Wong, Arizona State University

ABSTRACT: Little is known about the long term influence of different induction programs on beliefs and practices. In order to add to the knowledge in this area, this study followed two high school science teachers as one participated in a general induction program, while the other participated in a science specific induction program. The data collected consisted of observations of practice, reports of practice, and annual interviews on beliefs over a four year period. Analysis revealed that the teacher in the general induction program veered toward teacher-centered beliefs and practices over a four year period, while the teacher in the science specific induction program veered toward teacher-centered beliefs, but student-centered practices over the four year period. The insight gained from this study on beginning teacher beliefs and practices will lend more information on the role induction programs play on the development of beginning science teachers. Understanding the impact of different induction programs on beliefs and practices will assist science education researchers, practitioners and policy makers in making appropriate decisions pertaining to the types of induction programs that support reform-based beliefs and practices of beginning science teachers in the field.

Strand 1: Science Learning, Understanding and Conceptual Change

S5.4 Administrative Symposium: Representational Reasoning in the Teaching and Learning of Science 4:30pm – 6:00pm, Conference Room 409

Presenters:

Eric N. Wiebe, North Carolina State University James Minogue, North Carolina State University Michael Carter, North Carolina State University John C. Bedward, North Carolina State University Lauren P. Madden, North Carolina State University John K. Gilbert, The University of Reading Maurice Cheng, University of Hong Kong Peggy Van Meter, Pennsylvania State University Zhihui Zhang, University of California, Berkeley

ABSTRACT: This symposium will provide an opportunity to bring together leading researchers in science education and educational psychology to discuss the current state of research in representational reasoning as it relates to the practice of science education. The presented work will cover both theoretical frameworks and current empirical work around the use of verbal and visual representations—both by themselves and how they interact with each other. Of particular interest is students' interactions with these representations through both their production and discourse. Wiebe and colleagues will outline a new ontological framework to use to analyze elementary student inscriptions in science notebooks and strategize about instructional approaches that will support conceptual learning. Gilbert and Cheng report on a recent study concerning the interaction of verbal and visual representations in teaching and learning and their differential role in supporting robust mental models of science and technology concepts. Van Meter will discuss her model of learning with multiple representations. Finally, Zhang will discuss how differences in approaches to student representation of their ideas about hydrogen combustion by working with sequences of images can influence learning. The discussant, Lynn, will undertake the task of synthesizing these theoretical frames and empirical findings, point to how practice has informed this work and how this research can, in turn, inform science instructional practice.

Strand 1: Science Learning, Understanding and Conceptual Change S5.5 SC-Paper Set: Childrens' Learning about Science

4:30pm – 6:00pm, Conference Room 401

S5.5.1 Large-Scale, Reandomized-Cluster Design Study of Reform-Based and Traditional/Verification Curricula to Support Student Science Learning

Ellen M. Granger, Florida State University, granger@bio.fsu.edu Todd H. Bevis, Florida State University Yavuz Saka, Florida State University Sherry A. Southerland, Florida State University **ABSTRACT:** This research explores the relationship between ref

ABSTRACT: This research explores the relationship between reform-based curriculum and the development of students' knowledge of and attitudes toward space science. Using a quasi- experimental design, the effectiveness of Great Exploration in Math and Science (GEMS) Space Science Curriculum Sequence was compared with the effectiveness of more traditional curriculum in supporting 4th and 5th grade students' learning of and attitudes toward space science. GEMS employed an inductive approach to content (learning cycle), explicit use of evidence, and attention to scientific inquiry. The comparison group experienced traditional, verification means of teaching. Randomization occurred at the level of the teacher assignment to treatment group (not at the student level). The sample included 60 treatment and 59 control teachers working with 2572 4th and 5th grade students. Students in the classrooms in which GEMS was employed demonstrated a statistically significant increase in content knowledge and attitudes toward space science: Students in classrooms in which the traditional curriculum was employed did not show these increases. The GEMS effect on student achievement was greater for students in classrooms in which the teacher experienced a greater increase in content knowledge. Implications of the study are discussed.

S5.5.2 Small Group Interviews: Gaining Valuable Insights into Elementary Students' Astronomy Understandings and Thinking

Timothy R. Young, The University of North Dakota, tim.young@und.edu

Mark D. Guy, The University of North Dakota

Brent Miller

ABSTRACT: Eight fifth graders participated in small group interviews before and after instruction on the causes of moon phases. Two groups of four students (each group had two boys and two girls of mixed ability levels) were interviewed about their understandings of the cause of moon phases. The interviews followed the same protocol and involved open-ended questions of the causes of moon phases, the use of balls to simulate the Earth-moon-sun, moon phase graphics, drawing a moon phase, and role-play dialogue by the researchers. The findings revealed that, despite evidence of scientific understanding, several students expressed subtle or novel concepts during the post interviews that were essentially at odds with a scientific understanding of moon phases. These related to such ideas as: 1) Perspective; 2) Scale; and 3), Light & Shadow. Some examples that emerged in the study during the were: the continued exaggerated slant to the orbit of the moon (scale issue), earth's rotation leading to different phases (scale and perspective), new moon phase and eclipses (light & shadow). The authors suggest that the socially dynamic nature of the group interview fostered discussions that uncovered these ideas as students reflected on the views of others and offered their own.

S5.5.3 Student Understanding of Scale: From Additive to Multiplicative Reasoning in the Construction of Scale Representation by Ordering Objects in a Number Line

Eun Jung Park, Northwestern University, eun-park@northwestern.edu

Su Swarat, Northwestern University

Greg Light, Northwestern University

Denise Drane, Northwestern University

ABSTRACT: Size/scale is a fundamental concept to explain various phenomena. Its importance as a unifying concept crossing all science domains has been addressed in the National Science Education Standards. In spite of its importance as a big idea interweaving various science domains, few studies have been conducted and there have been more studies in mathematics relating the nature of numbers and representation of magnitude. In order to understand how students grasp the idea of size/scale in a science context, a task-based interview was conducted with students who were in a high school or a university. Students were asked to choose the most appropriate scale representation for ordering objects of various sizes and to provide reasons for their selection. A modified typology from Swarat et al's study was used to identify student conceptions. The current study reveals types of reasoning for constructing a numeric scale in scientific contexts. In particular, conceptual variation and a hybrid conception reflect the historical development of a number line in mathematics and conceptual development of understanding scale in a scientific context. Findings of this study can help us to develop a learning progression for size/scale and suggest areas of difficulty in the learning of size/scale.

S5.5.4 Children's Conceptions of Shadows

Robert Louisell, St. Ambrose University, louisellrobrert@sau.edu Francis Kazemek, St. Cloud State University Jennifer Wilhelm, University of Kentucky
ABSTRACT: We explored children's understandings of shadows during early and middle childhood. The influences of the children's personal experiences as well as the narratives of their cultures were examined. In what ways are children's conceptions influenced by their sociocultural context; e.g., by family, peers, literature, and media? When children revert to their naive conceptions (Gardner, 1991) from more schooled ones (Vygotsky, 1962), are their ideas influenced by 'spontaneous' thinking or by cultural influences? We conducted a Piagetian interview (Piaget, 1927) with each child and followed by having the child creatively interpret a poem about shadows. Parents and teachers were also interviewed (Similar interviews were presented at previous NARST conferences concerning the child's ideas about the moon). Next, we engaged each child in a hands-on lesson about shadows and asked the child to write about shadows. After an interval of at least a month, we conducted another interview with an eye towards assessing the impact of the lesson. Implications included: 1. Lessons that relate to a child's ideas about the topic may influence that child's conceptual change, but not necessarily in the way teachers have intended 2. Parents and teachers can provide important insights about the experiences influencing a child's ideas.

Strand 1: Science Learning, Understanding and Conceptual Change S5.6 SC-Paper Set: Models and Modeling in Science

4:30pm – 6:00pm, Conference Room 413

S5.6.1 Development of Students' Mental Models of Electrochemistry Using Multiple Model-Based Approaches

Mei-Hung Chiu, National Taiwan Normal University, mhchiu@ntnu.edu.tw

Shiao-Lan Chung, National Taiwan Normal University

ABSTRACT: In the past twenty years, science education has been reformed and the value of models and modeling confirmed (AAAS, 1993; NSC, 1996). In the area of models and modeling, Gilbert (1993) suggested that models are mediate products to integrate learning experience and scientific thinking in which modeling and scientific explanations are bound together to support learning in science. According to several researchers, students have difficulty in understanding the concepts of scientific models as well as the importance and value of modeling processes (Saari & Viiri, 2003; Gilbert 1997; Franco et al., 1999). Are teachers aware of the importance of cultivating students' modeling ability via innovative approaches in teaching strategies? Could the structure of chemical knowledge held by students be changed via model-based approaches? We bear these questions in mind and try to design a theoretically-based approach to investigate students' learning in electrochemistry. Keywords: modeling, mental models, conceptual change, electrochemistry

S5.6.2 High School Students' Modeling Knowledge

David Fortus, Weizmann Institute of Science, david.fortus@weizmann.ac.il

Sherman Rosenfeld, Weizmann Institute of Science

Yael Shwartz, Weizmann Institute of Science

ABSTRACT: A learning progression for scientific modeling has been developed (Schwarz et al., 2009) but validated only with upper elementary and middle school students. We investigate the modeling knowledge and the content dependency of this knowledge of high school students majoring in science and non-science majors. Eleventh grade students were interviewed twice, once on the use of models in the subject in which they were majoring and once in a different scientific subject. All the interviews were designed to assess students': A) prior knowledge of the scientific content, B) conception of what is a scientific model, C) ability to use models to explain phenomena, D) evaluation of scientific models, advantages and limitations of models, and E) revision of scientific models. Interim findings indicate that students demonstrated high levels of modeling knowledge in multiple categories, regardless of whether they were familiar or not with content. This provides evidence that the upper levels of the MoDeLS learning progression are attainable and reasonable goals for K-12 education. It also raises the question whether it is advisable to expend much time and effort in helping middle school students develop modeling knowledge, as the high school students we interviewed appeared have constructed it without explicit instruction.

S5.6.3 The Effect of Linear Versus Branching Depictions of Evolutionary History on Students' Interpretations of Evolution as an Anagenic Process

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Courtney K. Shade, Vanderbilt University

Kefyn M. Catley, Western Carolina University

ABSTRACT: A persistent misconception in students' understanding of evolution is that species arise through anagenesis, a transformational process in which one species undergoes changes that lead it to turn into another species. There is little evidence to support this process. Rather, new species are formed when a parent species is split into two populations through a process known as cladogenesis. The present study tested the hypothesis that linear depictions of evolutionary history, as opposed to branching depictions, privilege interpretation of evolution as an anagenic process. College students (N = 108), equally divided between those with weaker versus stronger backgrounds in biology, answered questions about the evolutionary relationships among several hominid taxa and several equine taxa. Across subjects, each set of taxa was presented in one of three diagrammatic formats: a noncladogenic diagram found in a contemporary biology textbook or a cladogram in either the ladder or tree format. As predicted, the textbook

diagrams, which contained linear components, were more likely than the two branching cladogram formats to yield anagenic responses. Although such responses were less frequent in students with stronger backgrounds in biology, both groups showed the same effects of diagrammatic format. Implications of these results for evolution education are discussed.

S5.6.4 What is a Model? Experienced Students' Beliefs about the Nature and Purpose of Scientific Models Across Modeling Contexts

Brandy L. E. Buckingham, Northwestern University, brandy@northwestern.edu

Brian J. Reiser, Northwestern University

ABSTRACT: This study uses interview data involving a variety of modeling contexts to investigate eighth grade students' beliefs about the nature and purpose of scientific models. The participants have engaged in the scientific practice of modeling in a variety of contexts over the past three years, allowing us to ask questions in a variety of familiar modeling contexts as well as in a novel context introduced during the interview. Preliminary results indicate that, overall, students' responses are more consistent when reasoning about familiar modeling contexts than novel contexts, although some students do give very consistent responses across all contexts. All students were able to talk about previous models they had worked with and articulate similarities across them. Students are most likely to talk about models as showing processes and explanations; no students mentioned prediction as a purpose of models during these interviews.

Strand 2: Science Learning: Contexts, Characteristics and Interactions S5.7 SC-Paper Set: Science Learning Within and Beyond the Classroom

4:30pm – 6:00pm, Conference Room 402

S5.7.1 Examining the Relationship between Students' Connections to Out-of-School Experiences and Learning Outcomes

Natalie A. Tran, California State University - Bakersfield, ntran6@csub.edu

ABSTRACT: This study examines the relationship between students' out-of-school experiences and learning outcomes in science. It involves the use of survey questionnaire, science assessment, and student interviews and features two-level hierarchical analyses of students nested within classrooms (N = 1,014). The results indicate that controlling for student and classroom factors, students' ability to make connections between in-school and out-of-school experiences science is associated with positive learning outcomes such as achievement, interest in science, careers in science, self-efficacy, perseverance, and effort in science learning. Teacher practice using students' out-of-school experiences is associated with a decrease in student achievement. However, teacher practice connecting to students' out-of-school experiences can close the gaps in learning outcomes between students who can make connections and those who fail to do so. Student interviews indicate that female students tend to associate cooking and cleaning to science related activities while male students identify activities that involved explosives and engines to their out-of-school experiences. For both female and male students, television programs serve as an important medium for students to learn science. While students expressed interests in spending time in the outdoors, many students identified limited opportunities to learn science in the community settings.

S5.7.2 The Influence of Context-Oriented Learning in Biology Education

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Angela Sandmann

ABSTRACT: Context-oriented learning in biology education recently gained in importance which can be shown by the increasing number of implementation and evaluation projects. Besides developing and evaluating context-oriented tasks and materials, research is required to investigate their effects on interest and achievement, especially as previous results on achievement were ambiguous. This experimental study investigated the influence of context-oriented tasks on interest and achievement by paper and pencil data as well as process data via video recording. 96 students participated in the study and were randomly selected to one of the two conditions (context-orientation versus content-orientation). In the intervention phase, students build biological models about the heart and the blood circulation in collaborative learning groups during four consecutive sessions. During the learning phase, students were videotaped. Subsequent to every learning session in the intervention week, the students completed an achievement test as well as a questionnaire concerning their situational interest on the actual learning task. Results of the study show that students learning with context-oriented materials showed higher interest, talked more about context but did not achieve better. The analysed video data indicate more talk about contexts but not about content information in the context-oriented treatment.

S5.7.3 Aspects and Outcomes of a Research Apprenticeship: Perspectives of High School Student Participants

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Troy D. Sadler, University of Florida

Jamie E. Mann, University of Florida

ABSTRACT: Research apprenticeships for secondary students provide an authentic context for learning science that is more difficult to achieve in the traditional science classroom. Research indicates the existence of desired outcomes associated with these research apprenticeships. Among these outcomes are increases in science content knowledge, deeper understandings of the nature of science,

and aspirations for science oriented career plans. What specific factors of the research apprenticeships result in these desired outcomes? This question is addressed in the context of a seven-week residential research apprenticeship for high school students. Data used to answer this question includes interviews of student participants and student generated concept maps. Results indicate that student interest in their specific topic of research and the collaborative nature of the lab in which they have been placed are key determinants in producing desired outcomes for these students. Implications for the design of research apprenticeships for secondary students are discussed.

S5.7.4 Opportunities-to-Learn at Home: Profiles of Students with and without Reaching Science Proficiency

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Melinda Whitford, State University of New York at Buffalo

ABSTRACT: This study examines the relationship between opportunity-to-learn (OTL) at home and students' attainment of science proficiency. The data set used was the 2006 PISA science US national sample. Data mining was used to create patterns of association between home OTL variables and student attainment of science proficiency. It was found that students who fail to reach science proficiency tend to be those who have fewer than 10 books at home, may require out-of-school teacher help, and have school science lessons fewer than 4 hours a week. On the other hands, students who reach science proficiency tend to be those who have more books at home, do not require out-of-school teacher help, have fathers and mothers of above high school education levels, computers at home, and science lessons in school at least 4 hours a week. More books at home (e.g. more than 100) could compensate the effect of not having enough science lessons in school, and one-to-one out-of-school lessons could compensate the effect of not reading science articles regularly. These findings have important implications for accountability decisions and for developing comprehensive science achievement improvement measures in the classroom and school.

Strand 3: Science Teaching--Primary School (Grades preK-6): Characteristics and Strategies S5.8 SC-Paper Set: Developing Teacher Knowledge

4:30pm – 6:00pm, Conference Room 403

S5.8.1 How Long-Term Teaching Practices Foster Teacher Learning In Inquiry-Based Environments

Mohammad A. Basir, mohammad-ahmadibasir@uiowa.edu

Brian Hand

Lori Norton-Meier

ABSTRACT: Teacher practice in the classroom has a decisive influence on teacher learning. In this study, we have analyzed the fiveyear transformation of a teacher from the time she started to practice an inquiry-based approach to the time she became an exemplar teacher. The teacher participation in the inquiry-based classroom environment has been analyzed in three levels: personal level, analysis of the teacher's talks in the class about science inquiry; interpersonal level, analysis of the interaction between the teacher and students while students were doing inquiry; community level, analysis of the transformation of classroom science language as a whole. We are reporting changes in these three levels respectively as following: first the teacher's view about science inquiry has changed from positivist picture of science toward more tentative view of science. Second, her role could be more frequently described by supporter, facilitator, inquirer, motivator, and exited rather than commander, judger, corrector, and lecturer. Third, the classroom community adopted inquiry science language. We conjecture that indeterminate and spontaneous nature of teaching practice in inquiry-based environments is an influential factor on teacher learning.

S5.8.2 The Teachers' Pedagogical Content on Inquiry that Conducts Science Activities in Basic Education

Flor Reyes, Universidad Nacional Aut'noma de México, Facultad de Química, florreyes@gmail.com Andoni Garritz, Universidad Nacional Aut'noma de México

ABSTRACT: This paper discusses the research on science teachers PCK concerning on Inquiry (PCK-I) of the program PAUTA in order to improve the science learning process. We believe that the instructor PCK-I is important to document in order to understand what the instructors known about inquiry, activities with these characteristics, and how to promote the development of abilities. The methodology used in this research is based on known methodology to document the PCK, which is known as CoRe (Content Representation) offered by Louhran et al (2004) and a set of central ideas and activities that PAUTA's teachers should know. A documental research (Schwab, 1978; NRC, 1996; Bybee, 2006; Lederman, 2006; and Khan, 2007) was made to determine what the central ideas and activities the teachers use while guiding their students with inquiry activities. The analysis of the information obtained by the CoRe-I allow us to understand and know what information the teachers know. The information review let us to identify the conceptions that teachers have alike and the ones that are closer to inquiry. This settles an opportunity to enrich the content in the training courses with the staff in order to improve science education.

S5.8.3 Elementary School Teachers' Perceptions of Science Teaching

John M. Reveles, California State University, Northridge, jreveles@csun.edu

ABSTRACT: This study examines teachers' perceptions about how well their teacher education credential program prepared them to teach science in connection with perceptions of what is expected of them by the state of California regarding teaching science at the

K-6 grade levels. Two focus groups interviews were conducted with participating teachers from an elementary school district located in a small city on the outskirts of Los Angeles, California. The research employed three types of ethnographic analyses including: a) video analysis of focus group interviews, b) artifact analysis of teacher written responses, and c) discourse analysis of focus group interviews, b) artifact analysis of teacher written responses, and c) discourse analysis of focus group interviews, b) artifact analysis of teacher written responses, and c) discourse analysis of focus group interviews, b) artifact analysis of teacher written responses, and c) discourse analysis of focus group interaction. Research analyses revealed significant findings regarding teachers' perceptions of teaching science. Overall, the participating teachers indicated that they felt well qualified to teach science to their students regardless of which elementary grade level they taught. However, while the teachers expressed feeling adequately prepared to teach science utilizing inquiry-based approaches, they also indicated feeling that they were not taught how to align inquiry-based science teaching practices with mandated state science standards. Time was also desired to develop science curriculum that could be integrated into the core curriculum taught at all grade levels. Implications are drawn for instruction in elementary science.

Strand 4: Science Teaching--Middle and High School (Grades 5-12): Characteristics and Strategies S5.9 SC-Paper Set: Inquiry-Based Science Teaching and Student Learning

4:30pm – 6:00pm, Conference Room 404

S5.9.1 Teacher Effects in a Comparative Study of Direct and Inquiry Science Instruction Efficacy

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David Schuster, Western Michigan University

Betty Adams, Western Michigan University Adriana Undreiu, The University of Virginia's College at Wise

Brandy A. Skjold, Western Michigan University

Brooks Applegate, Western Michigan University

Cathleen C. Loving, Texas A&M University

Janice D. Gobert, Worcester Polytechnic Institute

ABSTRACT: This paper reports on an experimental investigation of the efficacy of science inquiry instruction vis-à-vis direct instruction for middle school science, with specific reference to teacher effects. Science education standards reflect a commitment to the teaching of science as inquiry across the K-12 grades. Nevertheless there remains educational and political debate about instructional approaches, across a spectrum from didactic direct instruction through degrees of guided inquiry to open discovery learning. The science education community has overwhelmingly adopted a guided-inquiry perspective. Since the science curriculum projects of the 1960s, teachers, researchers, curriculum developers and policymakers have had an interest in knowing the effectiveness of inquiry-based curricula and instruction. Proponents of inquiry point to studies which support it, but critics counter that little of this research is comparative, controlled or unconfounded. The lack of convincing research evidence in favor of inquiry is thus of concern, and hence our group has designed and undertaken an experimental study to test the question: is inquiry instruction superior to direct, for science conceptual development? In this paper, we report additional data on the question of instructional efficacy, and document the critical question of to what extent findings are influenced by a teacher effect.

S5.9.2 The Relationship between Teachers' Knowledge and Beliefs about Science and Inquiry and Their Classroom Practices Saouma BouJaoude, American University of Beirut, Lebanon, boujaoud@aub.edu.lb

Rayana F. Saad, American University of Beirut, Lebanon

ABSTRACT: The purpose of this study was to investigate relationships between teachers' attitudes toward science, knowledge and beliefs about inquiry, and science classroom teaching practices. Specifically, the study addressed three questions: What are teachers' beliefs and knowledge about inquiry? What are teachers' teaching related classroom practices? Do teachers' knowledge and beliefs about inquiry relate to their science classroom practices? The sample consisted of 34 teachers drawn randomly from schools in the city of Beirut. To answer the first question, teachers responded to two questionnaires: Views of Science Inquiry which gauged teachers' views about science and how science is conducted and Attitudes and Beliefs about the Nature of and the Teaching of Science which measured teacher's attitudes and beliefs about the nature of and the teaching of science. To answer the second question, classroom observations documented actual teaching practices. Results from the questionnaires and the observation were used to construct individual teacher's profiles which were used to identify relationships between teachers' beliefs, knowledge, and teaching practices. Results showed that most teachers had restricted views of nature of science and unfavorable beliefs and attitudes about inquiry. Moreover, no consistent relationships between teachers' beliefs, views of nature of science, and classroom practices.

S5.9.3 Taking Science Outside the Classroom: A Study of Teachers Enacting Urban Ecology Field Investigations

Amanda P. Jaksha, University of Arizona, ajaksha@email.arizona.edu

Christopher J. Harris, SRI International

ABSTRACT: Connections between students' lives and their urban science classrooms can be a powerful mechanism for learning. Field investigations are one promising way to connect the science that students are doing at school to the communities in which they live, thereby increasing the likelihood that students will find relevance and meaning in the science tasks and activities they perform. This study closely examined how teachers enacted field investigations with their secondary students during a yearlong urban ecology course. Video records and observation notes taken during field investigations were used to create case studies to explore how teachers

managed their students' field inquiry experiences and supported students' learning. Findings revealed that effectively managing for learning during field investigations required teachers to thoughtfully scaffold students to ensure that important science ideas were at the forefront of students' thinking during outdoor activities. Our findings suggest that teachers and students who already have an inquiry stance will more easily transition to field investigations. These findings offer important contributions to our understanding of how teachers can effectively orchestrate field science with high school students. Moreover, findings can inform developers of field-oriented science curriculum materials and suggest areas of focus for teacher professional development.

S5.9.4 The Relationship of Teacher Facilitated Inquiry-Based Instruction to Student Higher-Order Thinking

Jeff C. Marshall, Clemson University, marsha9@clemson.edu

ABSTRACT: Commissions, studies, and reports continue to call for inquiry-based learning approaches in science and math that challenge students to think critically and deeply. While working with a group of middle school science and math teachers, we conducted more than 100 classroom observations, assessing several attributes of inquiry-based instruction. We sorted the observations into two groups based on whether students both explored underlying concepts before receiving explanations and contributed to the explanations. We found that in both math and science classrooms, when teachers had students both explore concepts before explanations and contribute to the explanations, a higher percent of time was spent on exploration and students were more frequently involved at a higher cognitive level. Further, we found a high positive correlation between the percent of time spent explaining concepts and the cognitive level of the students, and a negative correlation between the percent of time spent explaining concepts and the cognitive level of the students of an explanation between the percent of time spent explaining concepts and the cognitive level of the students of inquiry-based instruction, then we are better able to develop professional development experiences that help teachers transition to more desired instructional patterns.

Strand 5: College Science Teaching and Learning (Grades 13-20) S5.10 SC-Paper Set: Beliefs and Teaching Practices of College Science Faculty 4:30pm – 6:00pm, Conference Room 405

S5.10.1 Assessing University Students' Perceptions of the Physics Teacher's Pedagogical Content Knowledge Using a Developed Instrument

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

ABSTRACT: Ongoing professional development for university teachers has been much emphasized. However, previous research on learning environments has seldom addressed university students' perceptions of teachers' PCK. This research aimed to evaluate university students' perceptions of the case physics teacher's PCK development using a developed instrument and workshop intervention. A mixed method design was employed incorporating both quantitative and qualitative techniques. The survey "Assessing Students' Perceptions of College Teachers' PCK was adopted as the instrument of research. It was conducted twice in this study; with the pre-test carried out during the mid-term exam and the post-test, in the last week of the semester. The results showed that only SMK and IRS showed significant difference in four categories of the survey, while IOC and KSU did not. Furthermore, the survey reflected that the case teacher's homework and tests are difficult, and the teaching pace is fast. The workshops organized helped the case teacher understand better students' prior conceptions of the subject matter and learning difficulties, and further facilitate her changing of instructional strategies. The limitations of this study were discussed and suggestions for improvement were also provided.

S5.10.2 The Analysis of Speech Acts of University Science Teachers

Roeland M. Van der Rijst, ICLON - Leiden University, rrijst@iclon.leidenuniv.nl

Jan H. van Driel, ICLON - Leiden University

ABSTRACT: Studies on classroom discourse suggest that teachers' speech influences student learning. University teachers have diverse ways of lecturing, which is reflected in their speech act repertoire during their classes. Patterns of 12 university science teachers' speech acts sequences were examined. Teachers with similar patterns were clustered, and associations with the methods of instruction and approaches to teaching were analyzed. University teachers, whose approaches to teaching showed a high emphasis on student learning, used directive speech acts such as questions and instructions. Teachers, who focused on transmitting ideas, used more assertive acts such as giving information and predictions. The presented framework can be applied as a window into teachers' speech act repertoires.

S5.10.3 Examining College Science Teachers' Belief Systems about Inquiry-based Teaching in the Context of a Faculty Development Program

Kristen L. Hutchins, Howard Payne University, khutchins@hputx.edu

Patricia M. Friedrichsen, University of Missouri

ABSTRACT: The purpose of this study was to investigate how college science teachers' belief systems about inquiry-based teaching changed through their learning experience in a faculty development program. The program was designed to support new college science teachers in learning about inquiry and incorporating an inquiry-based approach to teaching laboratories in their courses. Using a constructivist approach, we used a case study method for data analysis and constructed individual profiles for the five participants.

Data sources included three semi-structured interviews, observations during the program and during teachers' implementation in their courses, artifacts, and a researcher's journal. The cross- case assertions indicated that through the faculty development program, participants' knowledge and beliefs about inquiry-based teaching shifted, placing more value on student- directed learning and classroom inquiry. Participants who were internally motivated to participate and held incoming positive attitudes towards the inquiry-based approach were more likely to incorporate the approach in their future practice. Students' responses played a critical role in participants' belief systems and their decision to continue using the inquiry-based format. The findings from this study have implications for college science education research, faculty development design, and graduate education policies for future science faculty members.

Strand 6: Science Learning in Informal Contexts S5.11 Symposium: Facilitating Informal Science Learning: People, Places and Technologies 4:30pm – 6:00pm, Conference Room 406 Heather T. Zimmerman, Penn State University, heather@psu.edu Lynn U. Tran, University of California at Berkeley Cathlyn D. Stylinski, University of Maryland Catherine Eberach, Rutgers Kathleen Fadigan, Pennsylvania State University Lisa Bouillion Diaz, University of Illinois at Urbana-Champaign Lynn D. Dierking, Oregon State University Heather King, King's College London ABSTRACT: In this special symposium, structured as an interactive poster session, learning sciences and informal science education authors bring together diverse perspectives about informal education pedagogy, broadly considered as facilitation of learning. Through

Abstract: In this special symposium, structured as an interactive poster session, fearing sciences and informal science education authors bring together diverse perspectives about informal education pedagogy, broadly considered as facilitation of learning. Through connecting findings from research on informal teacher education, technology-supporting learning, parent-child interaction, and children and adults learning in community-based organizations, we can better understand forms of informal pedagogy across various settings to support science learning. In this symposium, authors first present findings from empirical studies. Then the authors come together to talk across all papers around four questions related to facilitation of learning in out of school STEM environments: What is "good" pedagogy, beyond classroom walls? Are there teaching principles that apply across settings or do we learn most by studying facilitation within carefully constrained settings whose dimensions we can describe? How do practice, preparation, and professional development play out in these diverse contexts? How can we begin to develop a theory of teaching, very broadly construed, that is powerful and detailed enough to inform practice?

Strand 7: Pre-service Science Teacher Education

S5.12 SC-Paper Set: The Influence of Identity and Attitude on Pre-Service Teachers' Knowledge and Practices 4:30pm – 6:00pm, Conference Room 407

S5.12.1 Toward Retaining Second Career STEM Teachers: The Influence of Transitioning Professional Identities

Carol C. Johnston, Mount Saint Marys College Los Angeles, cjohnston@msmc.la.edu

Jeanne M. Grier, California State University Channel Islands

ABSTRACT: This longitudinal cross-case study analysis explores the relationship between professional identity and retention of five STEM career changers in teaching. Three main factors were found to have influenced the STEM career changers: support as a teacher, engagement in professional activities, and changing views of teaching. For each of these influences the career changers' transitioning professional identity played a role. The career changers in this study experienced changes in their professional identity as they transitioned from STEM professional to professional teacher. However, each had their own journey and held on to their persisting STEM identities in different ways.

S5.12.2 A Grounded Theory Analysis of the Career Paths of Math and Science Teachers in High Need Schools

Allison L. Kirchhoff, University of Minnesota, reese098@umn.edu

Frances Lawrenz, University of Minnesota

Anica Bowe, University of Minnesota

ABSTRACT: High-poverty schools typically have higher levels of attrition than other schools, particularly in math and science. Financial incentives have often been used to attract teachers to high-need schools and subjects. Despite extensive investments in these incentives and extensive research regarding recruitment and retention, little is known about how these areas interact with one another over a teacher's career. The purpose of this study is to address the lack of integration of these areas by investigating the career paths of 38 Noyce scholars. Acceptance of the Noyce funding requires teaching in high-need schools for two years. Grounded theory methodology was guided by the research question: What are Noyce scholars' reasons for the decisions made on the career path of becoming and remaining teachers in high-need schools? Analysis resulted in an explanatory model of the "pathway to retention in

high-need schools". The model indicates that the career paths of teachers in high-need schools are complex and interactive. Interactions among the reasons the scholars chose to enter teaching, their school setting, community, teacher education and the Noyce funding appear to play a role in their eventual satisfaction and retention. The study has implications for the recruitment and retention of teachers in high-need schools.

S5.12.3 "If You Struggle, You Turn Away From It": Finding Connections between Pre-service Elementary Teachers' Struggles as Science Learners and Their Orientations to Science Teaching and Learning

Rachel E. Wilson, The University of Georgia, rewilson@uga.edu

Julie M. Kittleson, The University of Georgia

ABSTRACT: Elementary teachers have an awesome responsibility as educators because early learning experiences provide a foundation for future learning. Research on the beliefs of pre-service elementary teachers about science teaching and learning needs to address how they understand the benefits of learning for conceptual understanding. In an effort to understand how to prepare pre-service teachers to implement science lessons that address the development of concepts, as opposed to an accumulation of facts, this qualitative study involved pre-service elementary teachers enrolled in a science methods course. We chose four participants because their cases were illustrative of a continuum of beliefs and experiences described by other pre-service teachers in the course. In our own study, we found that pre-service elementary teachers who took personal responsibility for their own learning as a result of academic struggles thought about how hands-on activities could help students learn science concepts, whereas teachers who viewed learning as a passive activity developed lessons that focused on factual accumulation and avoided any kind of struggle for students. These results have implications for teacher preparation courses, as researchers have found students recognize tensions between methods promoted at universities and at elementary schools and in their own learning experiences.

S5.12.4 Cognitive and Attitudinal Predictors Related to Line Graphing Achievement among Pre-Service Elementary Teachers

Sebastian Szyjka, Central Michigan University, szyjk1s@cmich.edu

Frackson Mumba, Southern Illinois University Carbondale

Kevin Wise, Southern Illinois University Carbondale

ABSTRACT: The purpose of this study was to determine the extent to which cognitive and attitudinal variables predicted pre-service elementary teachers' performance on line graphing. Predictors included basic skills sub-component scores in reading comprehension and mathematics, logical thinking performance scores, as well as measures of attitudes toward science, mathematics and graphing. Ninety-four pre-service elementary education teachers enrolled in two different elementary science methods courses participated in this study. Stepwise Regression Analysis with backward removal was conducted in order to generate a parsimonious and precise predictive model. This procedure allowed the researcher to explore the relationships among the affective and cognitive variables that were included in the regression analysis. The results indicated that mathematical and logical thinking ability were significant predictors of line graph performance variable. Partial correlation coefficients indicated that mathematics ability accounted for 20.5% of the variance on the line graphing performance variable when removing the effect of logical thinking. The logical thinking variable accounted for 4.7% of the variance on the line graphing performance variable when removing the effect of mathematics ability. Implications for practice and research are discussed.

Strand 8: In-service Science Teacher Education

S5.13 SC-Paper Set: Literacy and Elementary Science Education

4:30pm – 6:00pm, Conference Room 408

S5.13.1 Exploring Connections between Learning Science and Mathematics Content and English Language Acquisition: A Literacy Framework for English Language Learners

David J. Carrejo, University of Texas at El Paso, dcarrejo@utep.edu

Judy Reinhartz, University of Texas at El Paso

ABSTRACT: This paper presents research results that contributed to the development of a conceptual framework for science and math teaching that presents relationships between learning content and acquiring English language skills. Thirty-five elementary and fifteen middle school teachers participated in a comprehensive professional development program (CPD) whose goals included improving STEM learning outcomes for English Language Learners (ELLs). The CPD involved an integrated science and math curriculum, based on modeling, and a modified 5E pedagogy. Given improved ELL outcomes on state tests, we examined possible relationships between learning science and math and acquiring English language skills. Constructivist Grounded Theory was employed to analyze in-person and videotaped observations of teachers as they implemented modeling activities in their classrooms. Qualitative analysis revealed two theoretical categories representative of teacher practice: 1) perspectives on developing academic language, and 2) perspectives on learning through modeling. Our framework rests on the conjecture that learning science and mathematics content through modeling is necessary to support the co-development of English language and academic content language that, in turn, develops science and mathematics literacy. We argue that professional development in STEM should be

designed to assist teachers in understanding and working from a models and modeling approach to inquiry-based science and mathematics for the benefit of all students, including ELLs.

S5.13.2 Integrating Literacy into Elementary Science: Moving from Questions and Challenges to Solutions and Successes Jerine M. Pegg, University of Alberta, jerine@ualberta.ca

ABSTRACT: Many have argued that an integrated approach to science and literacy can benefit student learning in both domains. However, little research has been conducted on the issues that teachers encounter as they incorporate these new practices into their classrooms. This study utilized the Stages of Concern framework (Fuller, 1969; Hall & Hord, 2006) to characterize teachers' concerns and examine the nature of change elementary teachers' experienced as they implemented an integrated approach to science and literacy. Specific issues that teachers encountered and ways in which they moved from questions and challenges to solutions and successes are discussed.

S5.13.3 Combining Research and Practice to Investigate What Young Children Know and Can Do in Science

Robert A. Williams, University of Texas at Austin, rivers40@yahoo.com

Mary E. Hobbs, 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 second year, and the first year of data collection, the project involves 50 pre-kindergarten teachers from multiple backgrounds and in a variety of settings, with an emphasis on including classrooms where students are culturally and economically diverse. Twenty-five 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.

S5.13.4 Evidence-Based Practice in Science Literacy for All: A Case Study of NSTA Articles as Self-Directed Professional Development

Larry D. Yore, University of Victoria, lyore@uvic.ca

Susan Jagger, University of Toronto

ABSTRACT: This case study addresses two central issues: (1) professionalism in science teaching informed by evidence-based practice and (2) NSTA journals' promotion of literacy in science instruction and the foundation of these recommended practices. We were interested in determining if the professional literature commonly used as self-directed professional development after the introduction of the science education reforms reflected professionalism, evidence-based practice, science literacy, and learning. Literacy in science articles found in the NSTA journals (1998-2008) were located, inspected, and analyzed. Many articles justified and anchored their recommendations to the national standards while lesser numbers of articles were anchored to other recommended practices, empirical research findings and theoretical foundations. Surprisingly, the most highly regarded science education and science teacher education research journals were not referenced frequently. More of these articles referenced literacy, reading, and education research journals. Many science literacy strategies claimed to be supported by the science literacy for all goal but did not explicitly define how their recommendations link to the appropriate standards. The implications of this study explore the validity of the language in science recommendations, the variety of sources used to support evidence-based practices, and strategies to accomplish these suggestions.

Strand 10: Curriculum, Evaluation, and Assessment S5.14 SC-Paper Set: Developing Reform-Based Science Curriculum Materials 4:30pm – 6:00pm, Conference Room 410

S5.14.1 Curriculum Coherence: A Three Year Study of Middle School Students Understanding of Chemical Concepts

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Kathryn F. Drago, University of Michigan

LeeAnn M. Sutherland, University of Michigan

Joseph S Krajcik, University of Michigan

ABSTRACT: Curriculum coherence, "presenting a complete set of interrelated ideas and making connections among them explicit", is a characteristic of curriculum in high-achieving countries, The Investigating and Questioning our World through Science and Technology (IQWST) curriculum coherently presents a set of related and increasingly sophisticated big ideas of science. In this study,

we examine the coherence of the chemistry strand (6th, 7th, and 8th grade). Pre- and posttest measures were used to assess how this coherent curriculum supported building deep, integrated understandings of chemistry ideas in a cohort of approximately 3000 students as they moved through middle school. We found that students experienced significant learning gains with substantial effect sizes after participating in each of IQWST chemistry units. In support of the argument for curriculum coherence, we also found that students who participated in two units experienced greater learning gains than their peers who only participated in one unit. These data might suggest that earlier chemistry IQWST units help students to lay a conceptual foundation on which they can build during later units. Therefore, translating research about curriculum coherence into practice in classrooms can substantially improve students' science learning.

S5.14.2 Local Instructional Design in High School Science: A Distributed Leadership Perspective on the Practice of Curriculum Innovation and Adaptation

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ABSTRACT: Science curriculum has long been instrumental in supporting standards-based instruction. Local instructional design is the commonly occurring practice of adapting or developing science curriculum to local situations. Sometimes these adaptations reflect the principles of reform, but other times they do not. Learning scientists studying local instructional design have focused on the role of teachers and classrooms in influencing adaptation, but these studies eschew the powerful influence of organizational practice on curriculum. This case- based study shows, in fact, that local instructional design is a distributed practice taken up by multiple actors located within and beyond high schools. Given that instructional design is not solely the responsibility of curriculum designers or teachers, curriculum designers and instructional leaders might consider how local design can be structured to allow for adaptation and fidelity to the principles of science reform.

S5.14.3 Stuck in the Margins? The Place of STSE Themes in Québec Junior High School Textbooks

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Amanda Imbriglio, Concordia University

Kamran Sheikh

ABSTRACT: STSE themes occupy a prominent place in the reformed Québec junior high school science curriculum. However, studies have demonstrated that STSE curriculum reforms are often not translated into meaningful changes in classroom practice. Although there are multiple possible reasons for this gap between curriculum theory and teaching practice, one reason that is especially worthy of investigation is the fidelity of the curriculum materials that are provided to classroom teachers. Do the available textbooks convey the STSE curriculum goals, or is the STSE content effectively relegated to the sidelines? This analysis attempts to resolve this question using traditional content analysis techniques as well as a critical qualitative approach. We find that although the texts manage to address STS goals to some extent, there are significant difficulties that remain outstanding.

S5.14.4Comparing Children's Simple Machines Learning in LEGO-Engineering Design-Based and Non-LEGO Engineering Design-Based Science Environments

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Kristen Bethke Wendell, Tufts University - Center for Engineering Education and Outreach (CEEO)

Linda Jarvin, Tufts University

Chris Rogers, Tufts University

Christopher G. Wright, Tufts University

ABSTRACT: This paper compares how children's simple machines science performance changes over the course of science instruction based on an engineering design task. We studied six fourth-grade classrooms (89 students) who participated in LEGO-engineering design-based science instruction with the goal of constructing a model people mover that utilized at least three simple machines. Six control fourth-grade classrooms (103 students) that participated in simple machines science instruction without LEGO-engineering were also studied. Students' simple machines science learning was assessed by pre-post tests. The pre-post tests contained eleven questions (six open-response and five multiple choice) and were matched forms. The mean gain score of the engineering-based science students (24.6%, N=83) was significantly greater than that of the control students (13.6%, N=89, p<0.001). In addition, the engineering-based students improved more than the control students on test items that involved identifying and explaining simple and complex machines and describing the use of simple machines in everyday situations (p<0.001 and p<0.01, respectively). The project as a whole is one of few quasi-experimental assessments of elementary school engineering design-based science curricula. Results can help educators understand the impact of engineering curricula in the elementary school grades.

Strand 11: Cultural, Social, and Gender Issues

S5.15 SC-Paper Set: Cultural Perspectives on the Science Pipeline in Middle and High School 4:30pm – 6:00pm, Conference Room 411

S5.15.1 Competing or Complementary? Home and School Identity Formation of Haitian Youth in South Florida Neporcha T. Cone, neporcha@yahoo.com

ABSTRACT: This paper explores factors which contribute to the identify formation and academic success of Haitian students in science. Results showed that whiel some Haitian students wished to become "Americanized" in the sense of "fitting in" with their peers, they were also confronted with the fact that much of what is valued in the traditional Haitian culture was undermined by perception of more liberal American mores and values.

S5.15.2 Sociocultural and School Contexts of High Performance: Finnish and South Korean Cases

Nam-Hwa Kang, Oregon State University, kangn@science.oregonstate.edu

Miyoung Hong, Korea Institute of Curriculum & Evaluation

Jari Lavonen, University of Helsinki

ABSTRACT: This study examined science education contexts and science teachers' teaching practices in Finland and South Korea in search for possible connections between teaching practice and student performance. Document, observation and interview data were collected and analyzed. Findings revealed some commonalities in sociocultural and school contexts between the two countries. These commonalities such as the high value of education, relatively easy consensus from people of culturally homogeneous backgrounds, and the national curriculum might be related to high student performance in the two countries. They also had differences that suggested how teaching practices were mediated by its contexts. For example, the large class size in South Korea might be related to lower student performance than Finland. Korean students were hidden in a crowded class and had less opportunity to be responded to by their teachers. From a different perspective, however, it might be viewed that class sizes might be less relevant to student performance because even in the most crowded classrooms Korean students performed very well on the PISA. At the same time, even with less than a half the students in a class, Finnish students were more reactive than active. This study revealed the intricate relationships among sociocultural and school contexts, teaching practice, and student performance.

S5.15.3 Gender, Socioeconomic Status and Race/Ethnicity Interactions for Factors Affecting Urban 12th Graders' Aspirations to Major in Science in College

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Shiqi Hao, Michigan Department of Education

Marilyne Stains, University of Massachusetts Boston

ABSTRACT: Sizable gender, racial/ethnic, and socioeconomic disparities persist in every stage of educational pipelines to sciencebased careers, with one critical transition point being high school to postsecondary education. Using a theoretical framework built on studies of external (perceived expectations, instruction, study habits, participation in programs) and internal (self-concept, selfefficacy) factors affecting students' performance, aspirations, and expressed interests with relation to science and related careers, we developed and administered a survey in a high minority, high poverty school district. We collected data from seniors (N=892) at sixteen high schools selected by stratified random sampling. Data were analyzed using descriptive, correlational and inferential quantitative methods. We report on interactions between gender, SES and race/ethnicity factors and perceived expectations by others, self-concept and self-efficacy. Our results indicate that gender-by-SES differences exist for intent to major in science and health sciences. Males exhibited higher scores for internal factors, while females had higher scores for external factors. Asian students achieved significantly higher scores on most measures than Black, Hispanic and White students. SES effects were small but significant, also suggesting differences in internal vs. external factors. We discuss implications these findings may have in helping postsecondary institutions improve retention of these populations in the sciences.

S5.15.4 How Does Science Feel to High School Students? A Comparison by Gender and Subject Area

Jennifer A. Schmidt, Northern Illinois University, jaschmidt@niu.edu

ABSTRACT: The general goal of this paper was to explore the ways that gender and subject area contribute to high school students' subjective experience in their science classrooms. In an effort to further our understanding of longstanding gender gaps in science interest and persistence, students' in-the-moment reports of engagement, anxiety, boredom, activity relevance, challenge, competence and learning were examined in 4 different science subject areas (general science, biology, chemistry, and physics). Analyses tested for main effects of subject area and gender, and for interaction effects on all variables of interest. There were no gender or subject area differences in the level of perceived challenge in science courses. Females reported greater anxiety and boredom compared to males across all subject area interactions, indicating that males and females perceived different science subject areas differently. Findings are discussed in terms of implications for science teaching.

Strand 12: Educational Technology S5.16 Related Paper Set: Examining the Classroom Implementation of Using Geospatial Technologies to Teach Science

4:30pm – 6:00pm, Conference Room 412

S5.16.1 Understanding the Use of Geospatial Technologies to Teach Science: TPACK as a Lens for Effective Teaching

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Nancy M. Trautmann, Cornell Lab of Ornithology

ABSTRACT: Technological Pedagogical Content Knowledge, or TPACK (pronounced t-pack), is a theoretical framework to examine how a specific technology creates meaningful opportunities for teaching and learning. For three years we engaged three cohorts of teachers in a sustained professional development project entitled GT-Science. GT-Science helped teachers identify ways to teach science using geospatial technologies. This chapter presents a case study of one GT-Science teacher's use of Google Earth and ArcView software to teach students about watershed concepts and issues. In the watershed case study, Google Earth enabled students to explore a 3D representation of their local watershed, change their view or perspective as needed, and access supplementary information that helped them to interpret the landscape. Using ArcView they measured various attributes of the watershed, which required them to understand individual scientific concepts and the interrelatedness of those concepts. TPACK provided a framework for analyzing both the types of teacher knowledge required to successfully implement technology- based science learning and the pedagogical choices necessary to achieve intended learning outcomes. Ultimately, TPACK provides researchers with a knowledge framework for research on the use of geospatial technology to teach science.

S5.16.2 Lonely Trailblazers: Examining the Early Implementations of Geospatial Technology in Science Classrooms

Tom Baker, Environmental Systems Research Institute (ESRI), tbaker@esri.com

Joseph Kerski, Environmental Systems Research Institute (ESRI)

ABSTRACT: Before widespread professional development programs were created to support classroom adoption of GIS technology and methods, a small but vital handful of science teachers not only learned how to use GIS, but found ways of using it to drive deep scientific inquiry in the classroom. Because these educators were few in number, largely working on their own, and were innovators, they can be thought of as "lonely trailblazers." This paper explores the technical and pedagogical commonalities, implementation patterns, strategies of success, and habits of mind that these isolated yet pioneering teachers share. A combination of an online survey and telephone interviews showed that these educators worked collaboratively with their students to create original, scientific research projects that leveraged the latest visualization and geospatial analysis tools. These science teachers were at the forefront in the K-12 community in bringing GIS and other geospatial tools to national attention in education. Their 20-year heritage is a cornerstone of the work done today. The challenges and triumphs of these educators are identified, providing parallels to today's educators.

S5.16.3 Examining the Implementation of a Geospatial Information Technologies-supported Energy Unit in an Urban Middle School

Violet A. Kulo, Lehigh University, violet.kulo@lehigh.edu Alec M. Bodzin, Lehigh University David J. Anastasio, Lehigh University Tamara Peffer, Lehigh University Dork O. Sahagian, Lehigh University Lori Cirucci, Lehigh University

ABSTRACT: This paper describes the implementation of an interdisciplinary Energy unit developed for diverse middle school students. The Energy unit takes advantage of geospatial information technologies (GIT) including Google Earth and GIS to support student understanding of the world's energy resources while promoting spatial thinking skills. The Energy unit focuses on the world's energy resources and their impacts on the environment, energy use and misuse practices, and ways to sustain the future of our environment with alternative energy sources. The learning activities address common student misconceptions and knowledge deficits about energy concepts. The study was implemented in five eighth-grade classes in a culturally diverse urban middle school. Data were collected through daily classroom observations, daily reflective meetings with the teacher in addition to weekly curriculum design team meetings, and student artifacts. Findings revealed that implementing GIT in an 8th grade science Energy unit helped students construct relevant science knowledge and develop spatial analysis skills. Students were highly engaged with the learning activities and analyzing data using GIT helped students apply energy content knowledge to real-life applications.

S5.16.4 What Happens After the Professional Development: Case Studies on Implementing GIS in the Classroom

Bob Kolvoord, James Madison University, kolvoora@jmu.edu

Michael Charles, Pacific University

Steve Purcell, James Madison University

ABSTRACT: This paper describes a series of case studies of teachers implementing geospatial technologies, such as geographic information systems (GIS), global positioning system (GPS), and remote sensing in the classrooms. Each of the teachers had participated in one of a series of professional development workshops at a comprehensive university. We analyze the classroom implementation using the framework developed by the Apple Classrooms of Tomorrow (ACOT) project. We find that teachers with a background and interest in project-based learning are effective in implementing geospatial technologies with their students. We discuss our findings and suggest possibilities for further research.

Strand 15: Policy

S5.17 SC-Paper Set: Ferment of Accountability: Leadership and Legal Issues

4:30pm – 6:00pm, Conference Room 415

S5.17.1 Where Theory and Law Meet: An Inquiry into the Impact of U.S Federal Court Rulings on the Presentation of Evolution and Religion in K-12 Science Curriculum

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Sherry A. Southerland, Florida State University

ABSTRACT: On May 1 of 2009 Federal District Court Judge James Selna ruled in the case of Farnan v. Capistrano Unified School district, that A. P. European History teacher James C. Corbett transgressed the first amendment rights of one of his students by expressing disapproval of religious beliefs regarding creationism. In analyzing the rationale employed by Judge Selna in this decision this paper draws upon 41 years of federal court rulings concerning creationism and evolution as well as research on the nature of science (NOS) in an effort to answer two important questions that confront science educators as they attempt to present controversial topics such as evolution to students: 1. What types of statements concerning religion and/or evolution are and are not legally permissible according to judicial precedent and what tests do the courts routinely employ in arriving at these determinations? 2. What is the degree of correspondence between the research on Nature of Science (NOS) (Lederman, 2007) and its presentation in national and state curriculum documents, and the language of federal court rulings concerning evolution and creationism?

S5.17.2 A Principal's Instructional Leadership in Science: What Factors Influence Teacher Acceptance of Instructional Change?

Kimberly S Lanier, Florida State University, ksl9403@garnet.acns.fsu.edu Sherry A. Southerland, Florida State University

ABSTRACT: Reform documents clearly convey teachers are central to reform efforts in science. However, within the school's context, science education and educational leadership reform developers and researchers also recognize the importance of the principal in sustained reform. As such, reform is calling for principals to be instructional leaders, assuming a more active role in the decisions made in the science program. For this, the principal was observed for seven months as an elementary school underwent a change in the approach to science teaching, although the approach did not align with the national vision. Despite this, teachers accepted and worked to implement the changes the principal proposed. Teachers' rationales for accepting changes had little to do with the quality of teaching and learning in science. Although teachers perceived the principal to be an effective instructional leader, based on the researcher's engagement with these participants, effectiveness was predicated on communal relationships, principals/teacher trust, and a genuine sense (from teachers) that the principal cared about them as professionals and individuals. We argue that if principals indeed influence instructional decisions in science programs, they must have a minimal if not robust understanding of the national agenda and what constitutes reformed science practices.

S5.17.3 Teachers Goals for Education and the Confluence of Beliefs, the National Reform Documents, and Accountability

Todd L. Hutner, The University of Texas at Austin, thutner@mail.utexas.edu

Sherry A. Southerland, Florida State University

Victor Sampson, Florida State University

ABSTRACT: The competing nature of three goals for education—democratic equality, where education for civic participation is favored; social efficiency, where education for future market roles is favored; and social mobility, where the production of academic elites is favored—has been identified as leading to educational change without difference. The leading reform documents, Science for All Americans and The National Science Education Standards, promote education for democratic equality. However, much of the science teaching throughout the country follows the mobility or equality goals. Attempting to help explain the lack of implementation of these documents, science teachers in Florida high schools were surveyed using a science specific scale developed along these three goals. Surprisingly, in determining which goals of education science teachers favor, the vast majority believe in democratic equality. This is contrary to what was anticipated based upon the traditional approach still employed in many science classrooms. We postulate that this dichotomy may arise due to the pressures of the current climate of accountability, which arises from the efficiency and mobility goals. The implication being that a policy environment more friendly to democratic equality and the reform documents must be pursued in order to achieve the goal of science for all.

S5.17.4 Support Programs for New Science Teachers Can Increase Student Test Scores: Policy Implications

Donna R. Sterling, George Mason University, dsterlin@gmu.edu

Wendy M. Frazier, George Mason University

ABSTRACT: This six-year study examined the effect of support factors on the success of uncertified, in- service middle and high school science teachers and led to a series of policy recommendations. Using a quasi-experimental treatment-control group design, 59 uncertified teachers in 35 schools in three urban-suburban school districts were randomly assigned to a treatment or control group. The New Science Teachers' Support Network provided treatment teachers with support for two years including basic and advanced science methods courses, in-class coaching support by retired science teachers, mentoring by fellow teachers and science professors, and a website. Data were collected through online surveys, interviews, focus groups, observations, state science achievement tests

(5,839 students) and science course grades (10,367 students). Policy recommendations stem from findings illustrating that (1) students enrolled in classes of teachers who received support performed significantly better on state-wide science tests than students enrolled in classes of a comparable set of new science teachers who did not receive support, (2) treatment teachers' instructional skills improved over their two years in the program, and (3) the most vital forms of support for new science teachers were supportive working conditions, supportive school culture, in- classroom support, and quality courses in how to teach science.

Strand 6: Science Learning in Informal Contexts

Symposium: Informal Science Education Research and Practice at NSF

6:15pm – 8:00pm, Conference Room 406

Presenters:

David A. Ucko, National Science Foundation, ducko@nsf.gov Sylvia M. James, National Science Foundation Alphonse DeSena, National Science Foundation

Larry E. Suter, National Science Foundation

Angela Calabrese Barton, Michigan State University

ABSTRACT: The session will include presentations by NSF program directors and a discussion by a leader in science education about the current status of ideas and money for the Informal Science Education program. The symposium is intended to demonstrate how the funding by the NSF program of informal science has affected the direction of the field of informal science and the presenters will discuss significant new directions of informal science practices and research as indicated by recent trends in the proposals submitted and decisions made by peers and program directors.

Plenary Session

A European Perspective on Science Education: A Multi-National Challenge

8:30am - 10:00am, Salons E and F

Presider: Dana Zeidler, University of South Florida

Presenter: Doris Jorde, University of Oslo, Norway, doris.jorde@ils.uio.no

ABSTRACT: Changing the way teachers teach science is a priority with the EU. An emphasis on inquiry based science teaching is suggested in policy documents as well as funding agencies. Best practice for teacher professional development within and between countries provides the background for new developments within European science education.

Strand 1: Science Learning, Understanding and Conceptual Change

S6.1 Poster Session

10:30am - 11:45am, Conference Room 401

S6.1.1 Kindergarteners' Idiosyncratic Representations of Linear Motion

Jason Kahn, Tufts University, jason.kahn@tufts.edu

ABSTRACT: In this study, the kindergartener's invented external representations of linear motion are explored in order to gain grater insight into the children's resources for inventing representations and how the children construct and structure understanding of movement, an omnipresent phenomenon, from the physical world around them. Ten kindergarteners from a University lab school participate individually in semi-structured clinical interviews. In the interviews the children complete several tasks asking them to externally represent motion phenomena describing a car moving in relation to them. Children in the study use various mechanisms for representation depending on the phenomena. An icon near universally represents the car. However, the origin is not universally represented. While children who do represent the origin typically use icons, those who do not express that their own physical body is a point of reference and does not need to be represented. These children are representing in a propriocentric manner, as the representation is an extension of themselves. Children also invent various ideographic mechanisms for relating direction and speed of the car, and occasionally invent representations that build meaning from internal relationship of space. Educators can utilize these patterns to enrich children's scientific inquiry.

S6.1.2 Students' Conceptions of Heredity: Levels of Understanding

Philipp Schmiemann, University of Duisburg-Essen, philipp.schmiemann@uni-due.de

Angela Sandmann, University of Duisburg-Essen

ABSTRACT: In order to foster students' development in understanding biological ideas, it is necessary to have knowledge about their actual conceptions of these certain ideas. The focus of our study is the understanding of heredity, an important topic in Biology research and education. Taking into account typical misconceptions and findings from think-aloud protocols, we postulate a two-dimensional model. The first dimension describes five hypothetical levels of understanding of heredity. The second dimension takes into account the enormous importance of terminology in this context. To validate this model we developed multiple choice test items for an achievement test. About 3000 students of different class levels took part in this test. A one parameter Rasch model was used for parameter estimation. Based on the empirical findings, we had been able to confirm just three of our five expected levels of understanding. But the postulated crucial influence of terminology was validated by the data. So finally, we have a model of understanding consisting of six combined levels. It gives deeper insights in students' conceptions of heredity and helpful suggestions for Biology education.

S6.1.3 Crafted Experience: The Interplay between Manipulative Tools and Conceptual Learning in Science Classrooms Ji Shen, University of Georgia, jishen@uga.edu

ABSTRACT: Innovative learning materials are carefully crafted by educators and designers to help students learn complex science concepts. Students' learning is shaped and confined by these materials and associated activities. Such prescribed experience in a goaloriented formal learning environment, or crafted experience termed in this paper, may prevent students from more generative learning. How can students move beyond crafted experience? One popular approach is to have students invent their own learning tools including abstract representations, physical models, and computer visualizations. Another approach may draw upon the social interactions in classrooms where students share with each other different perspectives and learn from each other. What is advocated here is yet another approach based on a post hoc analysis of two empirical cases. In the small-scale cases I documented how some elementary teachers came to understand the concepts of balance and buoyancy in organized activities. The structure and characteristics of learning tools and the interaction between the learners and the learning materials are examined to explain how the key conceptual transitions occurred or were hindered. Using a transformative modeling perspective, I discuss how learning tools should be constructed, presented, and used in science classrooms to move students beyond crafted experience.

S6.1.4 Middle School Students' Ideas about Transpiration and Stomata

Jacqueline Wong, UCLA, writejackie@gmail.com Melissa S Cook, UCLA Suna Ryu, UCLA William Sandoval, UCLA

ABSTRACT: Students have many intuitive ideas about plants that are often incorrect or incomplete. A number of studies have begun to examine students' misconceptions about plants, particularly their ideas about photosynthesis and respiration. The processes of transpiration and gas exchange at stomata are key to understanding photosynthesis and how plants function, yet existing research on students' misconceptions about plants pay little or no specific attention to these important processes. We examined students' openended written responses and multiple-choice answers from a content test before and after a guided inquiry unit on plant biology. This paper identifies a range of student ideas about transpiration, roles of stomata, and the interdependence of photosynthesis, transpiration, and plant adaptation.

S6.1.5 Cognitive Architecture of Common and Scientific Concepts

Paul Tarabek, College of Applied Economical Studies, Czech Republic, didaktis@t-zones.sk

ABSTRACT: The model of the cognitive architecture of concepts shows a specific structure of common and scientific concepts and their semantic frames as components of conceptual knowledge systems, which may be external or internal (mental). Four developmental levels of common and scientific concepts are presented in the model: primitive, empirical, exact, and formal. The primitive and empirical are provided as levels of the common concepts. The exact and formal are provided as levels of the scientific concept theory, Fillmore's semantic frame, the semantic triangle, Hestenes' Modeling Theory, and on widespread ideas of the structuring of concept development has shown that some misconceptions in mechanics are developmental states of human cognition at the empirical level, i.e. preconceptions or 'CS misconceptions' as are described in the Hestenes' Modeling Theory [1]. [1] D. Hestenes: Notes for a Modeling Theory of Science, Cognition and Instruction. Proceedings of the 2006 GIREP conference: Modeling in Physics and Physics Education, p. 34- 65.

S6.1.6 Using Analogy and Model to Enhance Conceptual Change in Thai Middle School Students

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Somsan Wongyounoi, Srinakharinwirot University, Thailand

Parin Chaivisuthangkura, Srinakharinwirot University, Thailand

Precharn Dechsri, The Institute for the Promotion of Teaching Science and Technology, Thailand

ABSTRACT: This study examined conceptual change of Thai middle school students after learning photosynthesis with analogy and model. The analogy mapped key features from the analog (cooking food) to the target concept (photosynthesis). Modeling photosynthesis activity provided the opportunity for students to understand how plants use sugar to build cellulose and starch. To determine student's prior knowledge, the photosynthesis questionnaire developed by Marmaroti and Galanopoulou (2006) was administered to 58 Grade 7 students of urban school. The result revealed that students held alternative conceptions in many aspects including the origin of plant nutrients, the substances required for photosynthesis, the products of photosynthesis and the role of chlorophyll. After the instruction, the students were post-tested in order to determine how students' conceptions had changed. The result indicated that the students displayed better comprehension than they did in the pre-test. Moreover, the percentage of students who change their ideas to be the scientific one are reported and discussed. The present study has implication for both science educators and science teachers who are interested in teaching with analogy and model.

S6.1.7 Revealing the Science Learner: Examining Middle School Students' Use of Evidence in Revising Scientific Models

James A. Hagerty, University of Michigan, haijs@umich.edu

Elizabeth A. Davis, University of Michigan

Sarah Clowes, University of Michigan

ABSTRACT: While students are engaged in the constructing and revision of scientific models, they must make decisions based upon what they will include or exclude based upon the evidence they have experienced through pivotal cases. We inquire as to the ways middle school students revise scientific models based on evidence and how their revised models reflect more of a mechanistic explanation of the phenomenon. In doing so, we examined students who engaged in constructing and revising models of the particulate nature of matter as it relates to the phenomenon of smell. Their initial, revised, and final models along with other data were assessed according to the MoDeLS learning progressions of scientific models as changeable and generative entities. Students showed movement toward revising their models toward more evidence-based and mechanistic understandings of the phenomena. This study has implications for curriculum designers, teachers, and researchers who wish to use models for student science learning.

S6.1.8 Using Open-Ended Questions to Diagnose Student Understanding of Inter- and Intramolecular Force

Patcharee Rompayom, Srinakharinwirot University, Thailand, patcharee_swu@hotmail.com Chinda Tambunchong, Srinakharinwirot University, Thailand Somsan Wongyounoi, Srinakharinwirot University, Thailand

Precharn Dechsri, The Institute for the Promotion of Teaching Science and Technology, Thailand

ABSTRACT: The purpose of this study was to investigate Grade 10 students' understanding of inter- and intramolecular force. Research evidence suggests that students may use inappropriate alternative explanatory principles- when water is boiling, it become oxygen and hydrogen gas. Previous research has shown that high school students in the United Kingdom, Australia, and Singapore had difficulty understanding the concepts involved in covalent bonding concerning inter- and intramolecular force. 64 Thai-grade-10-students were elicited by administered open-ended questions after finishing normal instruction on chemical bonding. The open-ended questions determined if grad 10 students (15-16 years old) had similar alternative conceptions to those of other studies. Like previous studies, the study found that Thai high school students had difficulty understanding on inter- and intramolecular force. Even though they had learned these conceptions in chemistry class, the students was not able to distinguish between inter- and intramolecular force. The implications of this research are that making students understand chemistry concepts and principles is not an easy task. There are numerous ways in which students can misconstruct concepts and principles. Teachers must be aware of the various conceptions; otherwise, these alternative conceptions will be the obstacle to understand more complex conceptions on learning chemistry.

S6.1.9 Third Grade Elementary African American Students' Views of the Nature of Science

Leon Walls, University of Vermont, lwalls@uvm.edu

ABSTRACT: How different cultures, races and ethnicities see science differently is critical. However, the NOS views specific to African American teachers and learners have gone largely unresearched. The views of a purposeful sample of African American third grade children reported in this study contribute to efforts to make science equitable for all students. Conducted in two Midwest urban settings, within the students' regular classrooms, three instruments were employed. Views of NOS Elementary (an interview protocol), Enhanced Draw a Scientist Test (a drawing activity supplemented by an explicating narrative), and Identify a Scientist Test (a simple select-a-photo technique supported by Likert-measured sureness). Twenty-three students' responses were coded using qualitative content analysis in three main categories. Science – is governed by experimentation, invention and discovery teach us about the natural world, school is not the only setting for learning science; Scientists – intelligent, happy, studious men and women playing multiple roles, with distinct physical traits working in laboratories; Students – capable users and producers of science and who view science as fun. This study advocates for: use of such instruments for constant monitoring of student views using the knowledge of these views to construct inquiry based science lessons, and increased research involving students of color.

S6.1.10 Facilitating Transfer as Students Solve Context - Based Physics Problem

Bijaya Aryal, Lake Superior State University, baryal@lssu.edu

ABSTRACT: This study reports the effectiveness of hands-on activities versus textbook problems prior to students' solving the related context-rich problems. An experiment was designed using two different sequences of activities involving conceptually related physics problems. A group of students solved a textbook problem followed by context-rich problems and another group of students solved a problem involving hands-on activity followed by the same context-rich problems. Results indicate that students who worked textbook problems often had difficulty planning and executing the solutions of context-rich problems. However, the students who participated in the hands-on activities were able to transfer multiple expert-like problem solving strategies when solving the context-rich problems. Moreover, we observed that a significant portion of the students completing the hands-on activity spontaneously noticed the conceptual similarities between the activity and the context-rich problem, while the students who solved textbook problem did not notice the similarities.

S6.1.11 Project-Based Science and the Driving Question: Supporting Students as they Make Connections Between Science Content and Everyday Life

Nonye M. Alozie, University of Michigan, Consuelo Morales, University of Michigan Jennifer Eklund

ABSTRACT: Project-based science deviates from traditional transmission methods of learning, and has the potential to enhance subject-matter knowledge and thinking in science classrooms (Krajcik, Blumenfeld, Marx, & Soloway, 2000). Project-based science learning environments encompass five essential features, including (a) a driving question, (b) situated inquiry, (c) collaborations, (d) technology, and (e) the creation of artifacts (Krajcik & Blumenfeld, 2006). The driving question is relevant to students' lives, contextualized in familiar events, and anchored in real-life issues. While project-based science and the use of a driving question, emphasize the connections between content learning and the real-world, there is little research on how or whether students understand the links between the driving question, the science content, and the real-world. Using interview and pre/post test data, this study investigates whether and how students demonstrated understanding of the science content, they struggled to effectively relate it to the driving question or their community. We also offer suggestions of ways to improve and expand supports that help students overcome the challenge of relating scientific content to the driving question and the real-world.

Strand 2: Science Learning: Contexts, Characteristics and Interactions

S6.2 Poster Session 10:30am – 11:45am, Conference Room 402

S6.2.1 Effects of a Collaborative Learning Model vS a Traditional Apprenticeship Model on Undergraduate Student Self-Efficacy and Achievement during a Summer Research Experience

Shari L. Britner, Bradley University, sbritner@bradley.edu
Phillip Gagne, Georgia State University
Melissa K. Demetrikopoulos, Institute for Biomedical Philosophy
Karen L. Falkenberg, Concept Catalysts, Inc.
John L. Pecore, Wake Forest University
Brian A. Williams, Georgia State University
Laura L. Carruth, Georgia State University
Chris Goode, Georgia State University
Robert L. DeHaan, Emory University
Kyle J. Frantz, Georgia State University

ABSTRACT: Our 4-year research project uses an undergraduate summer research program to test the hypothesis that a collaborative learning experience in a dedicated teaching lab will positively affect students' research skills self-efficacy, mastery of science content and process skills, and long-term career progress in science-related careers to the same or greater degree than a traditional research apprenticeship model. A primary goal of our program is to recruit and train the next generation of neuroscientists, with emphasis on success among underrepresented minorities and females. To date our results partially support the hypothesis. Program outcomes were positive for all participants, with gains in self-efficacy, no change in initial low levels of anxiety, and strong performance outcomes. In terms of comparisons between program models, students in the collaborative experience reported greater and faster gains in self-efficacy than the apprentices, and also scored higher on some aspects of the final research paper. Identification of a novel and cost-effective approach to developing the confidence and skills necessary for careers in research will enable more students from various backgrounds to pursue their interests in science, and will ultimately increase diversity in the U.S. scientific workforce.

S6.2.2 Students' Views of a Project-Based Elementary Science Intervention

Lucy Avraamidou, University of Nicosia, Cyprus, avraamidou.l@unic.ac.cy

Maria Evagorou, University of Nicosia, Cyprus

ABSTRACT: The purpose of this study was to examine a group of elementary students' views of a 11-week long intervention they engaged into where they investigated a local problem on water quality. An urban, fifth-grade, European elementary school classroom with 8 girls and 7 boys defined the context of this study. The research data consisted of classroom observations, videos of the students engaging in activities, interviews with the students and the teacher, students' presentations, various worksheets and assessment materials. Analysis of the data illustrated that students' perceived specific characteristics of the intervention as particularly critical, such as the nature and context of the investigation, the use of handhelds in collecting, organizing and sharing of data and the collaboration with the scientist.

S6.2.3 Using Photographs in Discussion-Oriented Pedagogy for the Concepts of Day-Night and Cause of Seasons

Hyunju Lee, University of Massachusetts Amherst, hyunju@educ.umass.edu

Allan Feldman, University of South Florida

ABSTRACT: This paper reports preliminary results from a study of middle school astronomy classes in which the teacher implemented discussion-oriented pedagogy using photographs and classroom response systems (CRSs). Modern technology has brought us the convenience of using various types of visual representations, but photographs are still the one that we most commonly meet in our daily lives. There have been many studies about the use of visual representations in science education. However, only few have focused on the use of photographs in science teaching and learning. The pedagogical roles of using photographs in science class are still in need of investigation. In our study we identify the various types of discourse that students used while they were participating in classroom discussion with the use of photographs and a CRS. We also present data that shows what the students learned through the new pedagogy, and their opinions about it.

S6.2.4 Hands-On and Online: Student Experimentation in a Distance Learning Environment

Mary V. Mawn, SUNY Empire State College, mary.mawn@esc.edu

ABSTRACT: Laboratory experiments are often considered the defining characteristic of science courses. Such activities enable students to extend their learning of scientific concepts; to develop an understanding of the nature and methods of science; to foster analytical and critical thinking skills; and to become more interested in science (Ottander & Grelsson, 2006). In recent years, an increasing number of campuses have moved their instruction to the online learning environment. Consequently, in the sciences there is a growing need to develop best practices related to the integration of lab-based activities with online science coursework. This research study explores how experimentation can be integrated with content in an online environment. Study findings reveal that hands-on labs can be done by online students enrolled in three science courses. Students conducted experiments from their own

locations using materials provided through course kits and/or purchased at local stores. They recorded and analyzed their findings through the use of journals, reports, and discussions. They identified variables as they designed and carried out experiments. They developed models to explain their observations, and made connections between their observations and scientific concepts. This study provides evidence for the learning of both science content and process through online environments.

S6.2.5 Reading Scientifically: Practices Supporting Intertextual Reading Using Science Knowledge

Mark T. Enfield, Elon University, menfield@elon.edu

ABSTRACT: This study examines discussions around informational and narrative texts in two elementary classrooms. The classrooms were situated in one school in an urban district. Video recorded discussions were analyzed for intertextual connections, inquiry statements, and factors that supported engaging in first-hand investigations based on discussions around texts. Findings support and extend on earlier research about the role of the teacher in facilitating discussions around texts. Findings also suggest that there are additional considerations when thinking about integration of science and literacy goals, especially as we think about inquiry oriented science instruction. These findings have implications in terms of thinking about taking research and implementing it in practice.

S6.2.6 Occupational Orientation – A Foreign Concept to Chemistry Lessons

Nina Bertels, Freie Universtät Berlin Didaktik der Chemie Takustr, nina.bertels@web.de Claus F. Bolte, Freie Universtät

ABSTRACT: Apprenticeships in the sciences seem to be uninviting for young people. How can this be explained? To find answers to this question, we developed a questionnaire and offered it to students (who are mostly not willing to start a science-related apprenticeship) and to trainees (who have already chosen a job in chemical industry). Thus we have the opportunity to compare the results of the two groups and to analyze differences between the students' and trainees' answers regarding the variables of our research interest. In general, we are investigating the influence of chemistry classes regarding adults' choices of career. Specifically, we ask: Are there differences in the assessments of the motivational learning environment between the two groups? How has chemistry instruction supported trainees in coping with their developmental tasks compared to students? What prototypes have students and trainees got because of or in spite of their chemistry classes and how do prototypes influence their choices of career. Insights into these topics of research may help to optimize chemistry education, hence leading to recommendations of how to develop science classes which are more occupationally oriented and support students more in coping with their developmental tasks of adolescence.

S6.2.7 The Impact of Epistemological Beliefs on Scientific Reasoning among College Science Students: Comparing Two Epistemology Assessments

Ava A. Zeineddin, Wayne State University, ava.z@wayne.edu

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

ABSTRACT: Epistemological beliefs play an important role in scientific reasoning. However, the type of instrumentation used to assess dimensions of personal epistemology could either uncover or blur the relationship between epistemology and reasoning. This 2x2 quasi-experimental factorial study investigated the impact of epistemological beliefs on the quality of college students' scientific reasoning related to buoyancy in liquids. Prior knowledge was incorporated as an intervening factor. Two epistemology assessments were used and compared: (a) Hofer's (1997) Likert-scale questionnaire, and (b) scenarios specifically designed to reveal epistemological beliefs related to justification of knowledge claims. Two- way analysis of variance (ANOVA) revealed significant differences in quality of reasoning between groups with varying levels of prior knowledge and epistemological beliefs. Furthermore, correlations of epistemology assessments indicated that focusing on specific dimensions of epistemology—such as appreciation of consistency of theory and evidence, could be a more useful and accurate methodological approach.

S6.2.8 Learning in the Prairie: Using Fieldwork Experiences to Promote Understanding of Ecological Concepts

Meredith L. Beilfuss, Butler University, mbeilfus@butler.edu

Li-Ling Yang, Roger Williams University

ABSTRACT: Secondary students were assessed for their understanding of prairie ecological concepts using a multiple-choice test, conducted before and after a fieldwork experience. Students' attitudes towards the fieldtrip were also assessed. Results indicate an increase in understanding of prairie ecological concepts and a positive attitude toward the field experience, which incorporated the use of digital photography and field sketching as data collection methodologies.

S6.2.9 Expressions of Student Agency in the Context of a Climate Change Curriculum: Possibilities and Challenges

Azza Sharkawy, Queen's University, sharkawa@queensu.ca

Richard Reeve, Queen's University

ABSTRACT: There is widespread agreement that helping students develop agency (i.e., the ability to affect change), including increasing their capacity to become agents in their education (i.e., become self-directed learners) (Scardamalia & Bereiter, 1991) and furthering their ability and commitment to use their learning to take action that contributes to creating a more environmentally sound and socially just society (Friere, 1994; Pedretti & Hodson, 1995) is an important outcome of science education. In this paper we report

on the analysis of the exploratory phase of year one of our study during which we tracked the curriculum (e.g. materials, activities and classroom processes) employed by a classroom teacher and her grade five students (n=18) as they approached the topic of climate change using the Knowledge Building Communities model (Scardamalia & Bereiter, 2006). The focus of our analysis is specifically on the various ways that students expressed their agency as it related to their learning experiences (i.e., how they helped direct their learning) and the personal and social changes they pursued related to climate change. We explore classroom practices that may have facilitated these expressions of agency and reflect critically on the possibilities, challenges and limitations they represent for upper-elementary science education.

S6.2.10 Analyzing Science Argumentation in a Knowledge Building Environment

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Yew-Jin Lee, National Institute of Education, Nanyang Technological University

ABSTRACT: One means of improving argumentation in science classrooms is to enculturate students knowledge building (Jimenez-Aleixandre & Erduran, 2008). Involving the use of content specific knowledge, collaborative processes of interaction and construction of the rhetorical structure of a science argument, knowledge building is concerned with producing, justifying, evaluating and legitimizing knowledge claims. However, the multiple dimensions involved in knowledge building makes the traditional methods of analyzing argumentative discourse difficult. We suggest a multi-level analysis which draws upon the framework of systemic functional linguistics to understand the knowledge building process in a science classroom. Drawing from the interconnectedness between science and language, we propose the use of register analysis to understand the development of content, interpersonal relationship and organizational structure of text. We illustrate the use of the analysis framework with an argumentative discourse taking place between two students.

S6.2.11 Cross-sectional Study on Conception and Perception of Evolution According to Creationism Concern

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Heeyoung Cha, Korea National University of Education

Seulae Ku, Korea National University of Education

ABSTRACT: This study aimed to compare the concept-development of the theory of evolution among groups according to the agreement level of creationism. Questionnaires employed were divided into three sections- human, animals, and plants, with five explanatory hypotheses- creationism, teleology, internal will, use-disuse and natural selection after mutation. Another questionnaire unveiled perception on creationism and evolutionary evidence as well as interest and belief in evolution of human, animals and plants, and was measured by 5 steps Likert scale. Students (1,540) from elementary, middle school and high school participated in the study. As evident in the result, there is associated positively between the intensity of consenting to creationism and educational level; favored opinion on creationism strengthened as educational level increased. Moreover, a gap regarding perception on evolutionary evidence among groups rose according to school level. In addition, the group that agreed with creationism possessed stronger creationism, interests, and beliefs in the topic with human as the subject. This gives a conjecture that anthropocentric thought well- appeared in religion influenced students' conception on creationism. Therefore, in consideration of this study, new teaching strategies on evolution should be designed for those who had positive attitude towards creationism to make them rationalize things with scientifically-acceptable justification.

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

S6.3 Poster Session

10:30am - 11:45am, Conference Room 403

S6.3.1 Exploring Elementary Science Teachers' Perceived Self-Efficacy toward Pedagogical Content Knowledge for Science Teaching

Ying-Tien Wu, National Taichung University, Taiwan, ytwu@mail.ntcu.edu.tw

ABSTRACT: This study was conducted to explore 295 elementary science teachers' perceived self- efficacy towards pedagogical content knowledge (PCK) for science teaching. To this end, an instrument consisted of five scales ("Orientation to teaching", "Knowledge of science curricula", "Knowledge of students' understanding science", "Knowledge of assessment in science", and "Knowledge of instructional strategies") was developed. Through a series of exploratory factor analyses, it revealed that the instrument was deemed to be sufficiently reliable for assessing elementary science teachers' self-efficacy towards PCK for science teaching. This study showed that the teachers, on average, perceived relatively higher self- efficacy toward "knowledge of students' understanding science", while they had relatively lower self-efficacy toward "knowledge of instructional strategies". Moreover, gender differences on teachers' self-efficacy towards PCK were found. In this study, the participants of were further divided into four different teaching experience groups, and significant differences on self-efficacy toward PCK were found among the teachers with different teaching experiences. Besides, the teachers with master degree perceived significantly better self-efficacy toward PCK than those with undergraduate degree. This study suggests that, to meet science teachers' needs in professional development, science teacher educators should take teachers' various self-efficacy toward PCK into account when designing and implementing professional development programs.

S6.3.2 Books and Stories in Children's Science. The Findings of the BASICS Project

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Julian G. Greenwood, Stranmillis University College Belfast Northern Ireland

ABSTRACT: We report on an innovative continuing professional development (CPD) programme, Books And Stories In Primary Science (BASICS Project). The project involved an initial teacher education institution and a cluster of six primary schools. The introduction of the Revised Curriculum in Northern Ireland has required schools to adopt a more integrated approach to classroom teaching and introduces a Foundation Stage where a more play-centred approach to learning is adopted. Data was collected by questionnaires, semi-structured interviews and classroom observation. It was found that the use of books and stories within science enhanced pupils' level of engagement, observation, communication skills, confidence , decision making and problem solving. Both fiction and non-fiction genre can be used effectively to support learning during the introduction, where children's ideas can be accessed within the secure and child-centred context of the story. The story can also help provide structure to the plenary and facilitate the consolidation and the transfer of learning. By using books and stories science is made relevant and accessible to young children. This approach allows teachers to build on children's 'basic' love of story and innate curiosity about the world around them.

S6.3.3 Examining Elementary Science Teacher Identity through Science Notebooks: A Case Study of Three Exemplar Teachers

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ABSTRACT: Recent calls have been made to improve elementary science instruction, specifically by incorporating more inquirybased instructional strategies. Research shows that the likelihood for a teacher to adopt instructional innovations is linked to certain aspects of teacher identity. Using the frame established by Gee (2000-01), this study seeks to describe similarities in the professional identities of three exemplary elementary teachers of science. After receiving training on the use of an interactive science notebook model, the three target teachers were observed teaching science 2-4 times and interviewed about their instruction, teaching philosophies, and scientific background. An analysis of student science notebook entries also took place, comparing notebook entries created in lessons taught by the teachers who attended the professional development with those from lessons of teachers who did not. The results revealed similarities among the target teachers across multiple aspects of teacher identity including type of discourse used with students and colleagues, and strong interest science. Additionally students produced more sophisticated science notebook entries in the lessons taught by target teachers. These findings have implications for designing identity-focused professional development efforts and using student work as a lens for examining teacher identity.

S6.3.4 Introducing an Elementary Atomic Model to Primary Education (Sixth Grade) – Maintaining the Particulate Perspective, but also Introducing the Concept of Electron Cloud

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Paraskevi Dalaouti, Primary State Education, Ioannina, Greece

ABSTRACT: It is known that the Bohr model is the dominant school model of elementary theory for atomic structure. This type of model is presented already in primary education, and the same representation is repeated at high school. In this paper, we report on a study to introduce an elementary atomic model at the primary level (sixth grade). The model is based on the hydrogen atom, in which we retain the particulate aspects, but also we introduce the concept of the probability of locating the electrons and of electron cloud. We supply an intuitive spatial perception of the atom, in which there is no concept of electron orbits, but we introduce states of the atom of varying total energy, specified by quantum numbers. To construct the electron configurations of atoms, we employ an analogy/algorithm borrowed from the literature. We seek to identify students' mental models about atom and electronic cloud, and the relation of atom and energy; also we are interested in students' performance in algorithmic exercises. Our ultimate aim is to find whether an elementary non-deterministic atom model without orbits, helps primary students develop mental models consistent with the scientifically accepted one.

S6.3.5 The Scientific Thinker Project: A Design-based Research Study of Teaching and Learning Concepts of Evidence and Nature of Scientific Evidence in Primary School

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ABSTRACT: Current curriculum materials for primary school science students and teachers fail to provoke the following essential questions during science instruction: What is evidence? Why do you need evidence? The goal of this multi-year study is to develop instructional materials in order to reorient teaching and learning actions and focus students on building conceptual models of scientific evidence within the context of real-world problems. Using a design-based research approach, we are investigating the promise of curriculum modules that feature contemporary issues, methods and ways of thinking in science. The modules are based on three principles of teaching-learning derived from Activity Theory: (1) the object of learning should be related to the everyday knowledge and interests of schoolchildren, (2) learning outcomes depend on providing the students with tools for theoretical (conceptually based) generalizations which allow students to orient in a systemic way in the studied subject, and (3) primary school students can master theoretical concepts if these are provided within a context where their practical relevance is revealed. We present our current findings on how primary school students interact with the materials, build conceptual models of evidence and formulate answers to questions about the nature of scientific evidence.

S6.3.6 Influences on Pre-Service Elementary Science Teaching Self-Efficacy: A Professional Development School Collaboration Pilot Study

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ABSTRACT: Increased attention is being given to the teaching of science as inquiry. Yet, elementary teachers continue to struggle to understand what inquiry is and how to effectively plan and implement activities that support high levels of inquiry. Collaborative learning experiences that take place under a university-school partnership may support the development of beginning elementary science teachers by positively contributing to their science teaching self-efficacy. The purpose of this pilot study is to explore how the collaboration of in-service and pre-service teachers enhances beginning teachers' self-efficacy regarding their ability to incorporate inquiry-based science lessons in their future classrooms. Participants include those pre-service elementary teachers enrolled in a one-semester elementary science methods course. Partnered with self-selected K-6 in-service teachers from the university's PDS Network, they attended collaborative instructional sessions devoted to more fully understanding inquiry as outlined by the NSES and applied to the elementary classroom. Together, the pre-service and in-service teachers' classrooms during one instructional unit. Self-efficacy beliefs are measured pre-and post-instruction with the Teaching Science as Inquiry (TSI) instrument. Results of the pilot study will inform subsequent investigations.

S6.3.7 Understanding Taiwanese Elementary Science Teachers' Professional Conceptions, Competencies, and Needs

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ABSTRACT: This study's purposes were to identify the conceptions of good teaching, existing competencies, and professional needs of Taiwanese elementary science teachers, to explore the relationships between conceptions, competencies, and needs, and to examine the effects of demographic variables. A set of questionnaires of an Elementary Science Teacher Conception, Competence, and Need were distributed to 281 school teachers. The results of factor analysis indicated that 29 items in the questionnaires were divided into four categories. Descriptive statistics were employed and the results showed that teachers indicated that "curriculum" was more important than other factors and they had better competencies and required more knowledge and skills on it. The correlations between teacher conceptions, competencies, and needs were found to be small. This study also indicated that teacher demographic variables had no or little effects on predicting their conceptions, competencies, and needs.

S6.3.8 The Use of Analogies in the Topic "The Food is a Source of Energy" in Texrbooks and by Primary Teachers

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Adrianna G'mez-Galindo, Cinvestav Unidad Monterrey

Huang Xiang, Cinvestav Metodología de la Ciencia

ABSTRACT: In this investigation we analyzed how three teachers of fourth grade present in their classrooms an analogy present in science a textbook between the source of energy in cars (gasoline) and the source in humans (food). The data was video-recordings of class sessions taught by teachers. In this qualitative study we characterize the analogy proposed in the textbook lesson and how the teacher though it to the classroom. In the textbook we found the analogy is incomplete; the analogue is not developed and it is assumed the analogue is well known by the students. At the same time the target is over-developed incorporating many scientific terms. Related to the teachers, they do not develop the analogue in their classes, but performed a mapping of structural similarities between analogue and target, in which students express their ideas alternative conceptions. Furthermore, we identified an extensive use of everyday language related to energy. The results indicate that the analogy developed by teachers does not satisfy the function for generating new knowledge and is not useful for understanding how and where the humans get energy from food.

S6.3.9 Navajo and Anglo Students' Perceptions of Their World: Implications for Classroom Practice

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ABSTRACT: This exploratory study sought to find out how students in grades K-7 from schools in Arizona, Colorado, New Mexico and Utah perceive the world in which they live. Qualitative data were collected from draw-and-write assessments where students were asked to draw a picture of the place where they live and then were asked to write about how things in their picture were connected. Quantitative data were collected from multiple-choice tests where students were asked questions about basic concepts related to the living environment. Data were collected from 368 students. Of these students, 54% were male, 46% female; 58% Navajo, 38% Anglo and 4% "Other." Findings identify differences across grade bands and according to ethnicity which have implications for classroom practice.

S6.3.10 The Vision of the NSES and the Vignettes from Classrooms

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Byoung S Kim, Roosevelt University

Norman G. Lederman, Illinois Institute of Technology

ABSTRACT: The purpose of this research was to investigate students' understandings about inquiry and their abilities to do inquiry by using the Standards (NRC, 1996; 2000) as a frame of reference. A total of 123 students from 5th through 6th grade were purposefully selected and data collected from two questionnaires [the Understandings about Evidence-based Explanations (UEBE) and the Abilities to Develop Evidence-based Explanations (ADEE)] and a follow-up interview. It was clear that students usually do not have desired understandings about inquiry unlike NSES' expectations and the development of understandings about inquiry lagged behind the development of abilities to do inquiry. Findings also suggested that students' adequate understandings about inquiry would not guarantee their performance of a scientific investigation and vice versa. Implications include an explicit teaching for understandings about scientific inquiry to make a connection between abilities to do inquiry and understandings about it.

Strand 4: Science Teaching--Middle and High School (Grades 5-12): Characteristics and Strategies S6.4 Poster Session

10:30am - 11:45am, Conference Room 404

S6.4.1 Exploring Novice Teachers' Reflective Practices of Lifeworld Consideration

Miyoun Lim, Georgia State University, mlim@gsu.edu

John L. Pecore, Wake Forest University

ABSTRACT: This study, employing qualitative research approach, explores reflective practices of novice science teachers when student's lifeworld is brought into as a teaching concern. The study explores 1) in what ways novice science teachers make sense of lifeworld consideration within science teaching and 2) how the lifeworld consideration allows teachers to challenge cultural norms (e.g., roles, rules, expectations, and meanings) of science schooling. Findings will show 1) how the teachers tried to make sense of students' lifeworld in science teaching practices; 2) how the lifeworld consideration allowed teachers and students to challenge cultural norms in science classrooms; and 3) how the teachers were able to revisit and revise the meaning of student learning. The paper will further discuss lifeworld consideration as "funds of pedagogy" which guide novice teachers to critique, challenge, and address cultural norms of science schooling.

S6.4.2 Teachers' Use of Visual Representations in the Science Classroom

Michelle Cook, Clemson University, mcook@clemson.edu

ABSTRACT: In the current science education literature, most of the attention has been focused on understanding the impact visual representations in textbooks and multimedia materials have on students and their learning, but very few studies have focused on teachers' use of these graphics in the classroom. The purpose of this study is to investigate how high school science teachers use visual representations in their teaching. Specifically this research explores how course content, student characteristics, and resource availability affect how teachers select and use graphics in their science courses.

S6.4.3 Forging the Relationship to Science Content for Adolescents in Problem-Based Science

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Amy E. Trauth-Nare, Indiana University

Kristin L. Cook, Indiana University

ABSTRACT: The purpose of our portrait was to document the interactions and experiences of a middle school teacher and her students as they engaged in relationships with one another and science content in the context of a problem-based unit. More specifically, we explored the formative assessment practices of the teacher in order to discern to what extent those practices promoted student relationships with the science content. Through our portraiture of a teacher's formative assessment practices, we revealed how the connecting of students to the science content took shape through the communicative relationship with their teacher. As problem-based science gains momentum because of its potential for increasing student engagement, it is essential that PBS reform efforts consider formative assessment practice as relational pedagogy which underscores student learning. As such, teachers should not only utilize formative assessment strategies to enhance their relationship to their own students and content, but be able to articulate and make explicit these practices so as to support other educators as leaders in their field. Our contribution to NARST members is to

provide a glimpse into an exemplar teacher's practice for whom embedded formative assessment strategies help to strengthen the learning experiences by students in her classroom.

S6.4.4 Preservice Secondary Science Teachers' Understanding of Testing Hypotheses

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Yeon-A Son, Dankook University

Seok Jun Hong, Dankook University

ABSTRACT: Inquiry teaching can be a powerful strategy in that it allows students to test whether their ideas work or not and to refine their explanations. To achieve this goal of inquiry teaching, science teachers should have an adequate understanding of testing hypotheses. The present study investigated 67 preservice secondary science teachers' understanding of testing hypotheses. The authors developed a questionnaire that included four questions in the context of middle school students' experiment on heat transfer. The analysis of participants' responses to the questionnaire reveals three main findings. First, preservice teachers' interpretation of the experiment episode was based on their personal understanding of a scientific concept rather than following the hypothetico-deductive reasoning. Second, preservice teachers did not take 'testing a hypothesis' into consideration in making a conclusion. They appeared to focus on providing a 'scientifically correct' conclusion by ignoring the given hypothesis. As a result, the majority of the participants failed to disconfirm students' hypothesis with the collected data. Finally, preservice teachers' understandings did not appear to be consistent, their responses to questions were often contradictory.

S6.4.5 Teachers' Practical Arguments in a Professional Discourse Community

David J. Grueber, Wayne State University, grueberd@msu.edu

Shamarion Green, Wayne State University

ABSTRACT: This is a case study of the professional development activities with three middle school science teachers. The science teachers' professional development is centered on the use of two unique resources: an innovative reform-oriented curriculum material, and a partnership with a science center. The professional development activities utilizes an approach to professional development that utilizes the experiences teachers bring through the analysis of their practical arguments which include the rationale, empirical support, and situational context of critical incidents in classroom instruction. This study raises questions about the role of professional discourse communities to support the learning of new instructional practices.

S6.4.6 Design, Implementation, and Assessment of a Geospatial Science-Technological Pedagogical Content Knowledge Professional Development Model

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ABSTRACT: This session describes the design, implementation and assessment of the Geospatial Science-Technological Pedagogical Content Knowledge Professional Development (GS-TPACK) Model. The model was applied to a professional development (PD) sequence aligned for a new technology-embedded Energy curriculum. The PD was designed to support teachers in the development of GIT technology skills and pedagogical content knowledge about environmental issues model related to energy. To gauge the efficacy of our 3-day Energy PD summer institute, we utilized a variety of data collection methods including the pre- and post-administration of the newly designed GS-TPACK instrument, ongoing observation and discussions during the PD sessions, and issues lists generated by the teachers after each session. Teachers demonstrated not only increased levels of GSPACK but developed positive attitudes about using GIT to investigate complex environmental issues. Our initial findings appear to demonstrate the efficacy of the PD model.

S6.4.7 Evaluation of Children's Literature

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ABSTRACT: The use of children's literature to teach science is not a new idea. However, there has been limited attention paid to the use of children's literature as a means to assist high school students to make the transition into more difficult higher reading level textbooks. This study reports on the evaluation of children's trade books using the classification schemes of several authors. The purpose of this evaluation is to set a baseline of criteria which could then be used to correlate the use of children's literature with improvement in students' literacy skills and a concomitant rise in content knowledge and understanding.

S6.4.8 Lessons Designed To Test Relative Effectiveness of Inquiry VS Direct Instruction

Betty Adams, Western Michigan University, basmada@aol.com Adriana Undreiu, University of Virginia's College at Wise David Schuster, Western Michigan University William Cobern, Western Michigan University

ABSTRACT: When it comes to science concept development, questions remain as to the benefits of inquiry science instruction over direct instruction. A true experimental design research project is underway, seeking unconfounded empirical evidence of their relative merit. Care has been taken to avoid the extremes of "open discovery" versus "didactic transmission," and to utilize the more realistic "guided inquiry" versus "active direct" modes. Approximately 100 middle-school students are participating voluntarily each year, over a period of four to five years, randomly assigned to mode, and their science concept acquisition is being assessed and separately reported. Instruction focuses upon a few physical science topics, including Dynamics (Newton's first and second laws) and Light (climate and seasons). An essential early stage of the project was the careful development of the parallel science content units, one taught directly and one taught by inquiry. This "interactive poster paper" discusses necessary considerations and challenges associated with optimizing "lesson design" for a "controlled experimental study"; it will present developed products of comparable "same but different" lesson plans with explicit excerpts from both direct and inquiry "parallel instruction" on both topics; and it will provide selected examples of learning assessment results for science concepts taught by contrasting modes.

S6.4.10 Examining the Impacts of the Science Writing Heuristic (SWH) Approach on 7th Grade Students' Achievements on Summary Writing and Oral Argumentation Tasks

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ABSTRACT: The purpose of this study is to examine impacts of implementation of the Science Writing Heuristic (SWH) approach on Korea 7th grade students' achievements on science reasoning test, national standardized achievement test, summary writing task, and oral argumentation. Science education in Korea has emphasized science literacy as the most important purpose of science education helping students to be a scientifically literate person who is able to make reasonable decisions. Realizing goals of science education in Korea, this study attempted to implement the SWH approach which was reported effective for students' constructing scientific arguments and learning science. The Science Reasoning Test (SRT) II, Korea National Standardized Achievement Test, Summary Writing Test (SWT), and oral argumentation task were implemented prior to and after the implementation. Participant students of this study were ninety-nine 7th grade middle school students in the second largest city in Korea. Results of this study indicate that the students in the SWH group than students in the control group significantly better performed at the Science Reasoning Test; better negotiate in summary writing providing with big ideas and scientific concepts; performed better at oral argumentation.

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

S6.5 Poster Session

10:30am - 11:45am, Conference Room 405

S6.5.1 Biochemistry Students' Thinking about Nucleic Acids as Revealed by Reading Questions

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Erika G. Offerdahl, North Dakota State University

Lisa M. Montplaisir, North Dakota State University

ABSTRACT: The purpose of this exploratory pilot study was to characterize the nature of students' reading questions submitted during a unit on nucleic acids, genes, and chromosomes in an undergraduate biochemistry course. Reading questions are student-generated questions submitted electronically to an instructor prior to class about the assigned reading from the course textbook. Other instructor-generated questions and are more teacher-centered. In contrast, reading questions do not restrict students to a predetermined set of topics and are more likely to provide a more detailed picture of students' thinking about a topic prior to instruction. Analysis of 75 student submissions resulted in characterization of student questions into nine categories. Moreover, analysis revealed student misconceptions and reasoning difficulties with a variety of topics from general biology, physics, and chemistry. Implications for biochemistry instruction in particular and undergraduate science instruction in general will be discussed.

S6.5.2 A Longitudinal Study of Undergraduates' Science Literacy: Exploring Responses to Policy-Driven Survey Items

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Jessie C. Antonellis, University of Arizona

Chris D. Impey, University of Arizona

ABSTRACT: Science literacy is an oft-cited goal for education in the United States and across the world for creating an informed citizen population. We explored undergraduates' responses to science literacy questions, derived from policy driven projects (e.g. NSF Science Indicators), from almost 10,000 surveys collected in introductory science courses from 1989 to 2009. This exploratory study investigated how students answered these commonly-used questions, and how those answers were related to both reported demographic information and to results of similar surveys reporting on US public science literacy. In this study, we took a close look at several different groups of reported majors, including students who indicated that they were education majors, and compared performance between groups and across the entire university sample over time. Our findings show that although the students in this

study (mostly entering the university or at the beginning of the science course requirements) performed higher, on average, than the average American as indicated by other national surveys, there is a stable trend over time showing that these university students' answers do not improve, similar to results reported by NSF.

S6.5.3 Learning to Write in Undergraduate Chemistry: The Impact of Argument-Driven Inquiry

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

Joi P. Walker, Tallahassee Community College

Katrina Dial, Florida State University

Jon Swanson, Florida State University

ABSTRACT: This study explores the impact of a new instructional model, called Argument-Driven Inquiry (ADI), on undergraduate chemistry student's ability to write in science. Student writing skills were examined over the course of a fifteen-week intervention. The intervention consisted of six laboratory experiences that were designed using the ADI instructional model. During these experiences, students designed and implemented their own investigation, engaged in scientific argumentation, wrote an investigation report, participated in a double-blind peer review of these reports, and revised these reports based on the results of these reviews. The results of this study suggest the reports students crafted improved substantially over the course of the semester, students provided good peer-reviews for each other, and the students valued the various activities we incorporated into the model. There were, however, several learning issues that arose through the analysis. The conclusions and implications of this research include several design strategies and activity structures that will be integrated into the ADI instructional model in order to address these issues and several recommendations for improving the teaching and learning of science.

S6.5.4 An Investigation of the Development of University Students' Science Process Skills and Reasoning Ability Through a Process-Oriented Chemistry Laboratory Curriculum

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Beverly Pestel, Indiana State University

Aeran Choi, Kent State University

ABSTRACT: The purpose of this study was to explore the ways in which a process-oriented introductory chemistry laboratory curriculum influenced the development of university students' science process skills and scientific reasoning ability. Based on the belief that an introductory chemistry laboratory course could best serve students by having them develop an understanding the nature of chemical knowledge and how chemical knowledge and products are acquired, we have developed a process-oriented chemsitry laboratory reports, which included the components of scientific argumentation (i.e. claims, evidence, and reflecion), from seventy-eight students over the course of two semesters. By analyzing the students' written laboratory reports, we identified process skills they developed and the levels of evidence they cited to support their claims. The results of this study showed that the university students developed various patterns of science process skills throughout the semester. The process-oriented curriculum also contributed to improving the students' ability to connect appropriate evidence to their claims regarding process skills, which might be considered as an improvement in theri reasoning ability within the domain of science.

S6.5.5 Evolution Acceptance and Epistemological Views of College Biology Students

Lisa A. Donnelly, Kent State University, ldonnell@kent.edu

ABSTRACT: Previous literature has documented relationships between students' epistemological views and NOS views and their NOS views and evolution acceptance. The present work seeks to explore how student views of evolution are related to their epistemological views. College biology students enrolled in an upper-level evolution course were surveyed with respect to their evolution acceptance and general epistemological views. A subset of these students was interviewed using the Reflective Judgment Interview and questions targeting their views of evolution and evolution learning. Although epistemological views and evolution acceptance were not related, the analysis of qualitative data suggests why this relationship may be complicated and possibly domain-specific.

S6.5.6. The Interaction of Who and Where You Are: How Context Interacts with Belief to Influence Undergraduate Faculty Members Engagement with Reform

Patrick Enderle, Florida State University, pje07@fsu.edu

ABSTRACT: Reform in undergraduate science education continues to develop and research into these efforts can highlight many challenges that university science faculty face as they personally endeavor at reform. The Teacher Centered Systemic Reform framework identifies the centrality of teacher thinking to any reform effort as well as acknowledging the critical influence of various levels of contextual factors on teacher thinking. This study sought to understand how four university science faculty members at a large, research extensive university engaged with notions of reform. More specifically, the research attempted to understand how each of the faculty members' unique departmental contexts influenced their ideas and efforts at reform. Findings reveal that departmental and collegial factors do shape faculty members' efforts at reform that are unique to their specific structures. Implications for undergraduate reform are discussed.

S6.5.7 Student Perceptions of the Role of College General Education Biology on their Learning: Comparing Problem-based Learning and Traditional Expository Instructional Models

John S Peters, College of Charleston, petersj@cofc.edu

Steve Fifield, University of Delaware

ABSTRACT: This paper explores how PBL and traditional content-driven/lecture-based teaching strategies affect college nonscience majors' views about 1) the role of science courses in a liberal arts education and their future lives; 2) independent learning; 3) instructional approaches that helped or hindered learning. Overall, students tended to have anthropocentric and instrumentalist views of the value of their biology course. The instructional methods used in the course strongly influenced their perspectives on the nature of independent learning. Traditionally-taught students tended to be skeptical of the value of scientific knowledge; expressed difficulty learning abstract and detailed biological concepts; viewed their learning as mainly the instructor's responsibility; expressed mostly extrinsic learning motivations (grades) and low learning confidence; and discovered independent learning (memorizing) strategies as a result of failing to learn from lectures. For PBL students the engaging and relevant nature of problems promoted more independent learning, and critical evaluation of knowledge. PBL students adopted more intrinsic motivations for learning (enjoyment, learning for problem-solving or informing/forming personal opinions, connections to other courses); expressed more awareness of new learning preferences; rarely discussed difficulties with detailed/deep exploration of concepts; and used these, often newfound traits, to justify the value of their science course experience.

S6.5.8 Exploring the Reading of the Uncertain Science Issue: An Eye Movement Approach

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I-Ju Tsai, National Taiwan Normal University

ABSTRACT: The purpose of the study is to explore the reading behavior of university students, using the eye tracking method, when they read a news report concerning the issue of earthquake prediction. The main behavior to be examined is readers' attentions on different parts of argumentation in the news report, such as claim, data, warrant and backing theory as defined by Tulmin's model of argumentation. Participants are 20 university students who came from two national universities in Taiwan. A non-intrusive and fully automated eye tracking system, FaceLAB 4, is employed to record eye movements. The eye movement data are analyzed by GazeTracker software that produce various eye-movement patterns including gaze/fixation modes and durations, eye locations, eye movement paths, pupil size, blink rate etc. as well as head movements. The study is in progress. In the current report, data of six participants are discussed. The preliminary result shows that university students adopted various cognitive approaches to process uncertain science information in text. And, the displays of different approaches are apparently related to background knowledge. More data and detailed analyses will be presented in the conference.

S6.5.9 Content in Evolution-Selective Traditions in Teacher Reasoning on Educational Content for Upper Secondary School Maria I. Petersson, Dalarna University, Sweden, map@du.se

ABSTRACT: Evolution is an important component of modern biology. It is complex and can be controversial. Teaching evolution is an area where alternative understandings are well documented. The content of the academic discipline and school subject can differ (Deng,2007) The aim of this study is to investigate which school educational content experienced teachers select, in order to make it possible to teach in upper Secondary School. In this study a survey with a list of concepts related to evolution, designed by influence from Skoog & Bilica (2002) and xx1 (2003) has been presented to experienced teachers. The teachers were asked to A) state if these concepts were presented in their Biology course and B) state which priority the themes had. In semi-structured interviews have a more rich description emerged. A core content and additional content were identified. Teachers reasoning varied both in complexity, deep and in which additional content they choose. This shows different selective traditions in how teachers give the content meaning. Results from analysis of the survey and the interviews formed four categories on how experienced teachers reasoned on the content they planned for in the Biology course. 1

S6.5.10 Beginning Chemistry College Students Notions of Basic Quantum Chemistry Concepts: A Qualitative Study with Concept Mapping as Qualitative and Quantitative Analytic Tool

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Georgios Tsaparlis, University of Ioannina Greece

ABSTRACT: We report the procedure and results of the second part of a broader study on the ideas of second year college chemistry students on basic quantum chemistry concepts (Schrödinger equation, atomic and molecular orbitals, the hydrogen atom versus manyelectron atoms, hybridization). Nineteen semi structured interviews with second-year college chemistry students was the raw material of the phenomenographic analysis of the first part. In this paper, we constructed nineteen concept maps (one for each participating student) using the data from each interview, and consequently we implemented quantification of the concept maps by applying criteria already set and evaluated by other researchers. It was found that the two methods end in compatible results indicating that the two criteria stated used in the phenomenographic analysis (level of models and levels of explanations) along with those stated in the quantification of the concept maps (number of correct links, number of false links, and number of misconceptions) may stand together as characteristics of the students' knowledge structures.

S6.5.11 Faculty Grading of Quantitative Problems: Are Values Consistent with Practice?

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Charles Henderson, Western Michigan University

Jacinta M. Mutambuki, Western Michigan University

Jeffrey A. Barney, Western Michigan University

ABSTRACT: Grading practices can send a powerful message to students about what is expected. Research in physics education has identified a misalignment between the goals of faculty instructors and their actual scoring of student solutions. This work identified three values that guide grading decisions: (1) a desire to see students' reasoning, (2) a reluctance to deduct points from solutions that might be correct, and (3) a tendency to assume correct reasoning. When values are in conflict, the conflict is resolved by placing the burden of proof on either the instructor or the student. In this study, we verified that this gap exists and that the same three values are present among chemistry and earth science faculty. Overall, we found that 33% of earth science and 60% of chemistry faculty placed the burden of proof on the student; we speculate that the nature of chemical problem-solving may account for this difference. Similar to the physics study, although all of the instructors stated that they valued seeing student reasoning, only 50% graded work in such a way that would actually encourage students to show their reasoning. This work may contribute toward a better alignment between values and practice in grading student work.

S6.5.12 Issues Effecting African American Students in Science Majors at Predominantly White Universities

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George E. Glasson, Virginia Tech

Brenda R. Brand, Virginia Tech

ABSTRACT: Issues Effecting African American Students in Science Majors at Predominantly White Universities guided the focus of this study. The study explored the perceptions of African Americans that were both persistent and non- persistent within with their scientific major in order to gain a better understanding of what steps could be taken for the retention and encouragement of more African Americans in these fields at a predominantly White university. The study explored other factors besides intelligence that inhibited or promoted the success of African Americans in scientific fields. The study was qualitative in nature and participant interviews provided the data for the study. Actor network theory was used as a theoretical framework for exploring the factors that caused students to persist or not persist within a scientific major with the major implications of the study being: (1) The persistence of students had more to do with the open and closed networks they participated in rather than their intellect; (2) The student development of networks aligned with their ability to overcome the negative images associated with them in science; (3) Students' development of closed networks were a means of protection.

Strand 6: Science Learning in Informal Contexts

S6.6 Poster Session

10:30am - 11:45am, Conference Room 406

S6.6.1 Science Fair Judges' Perceptions of the Benefits of Student Participation and Mentoring

Kathleen Fadigan, Pennsylvania State University, kxf24@psu.edu

ABSTRACT: Dating back to the late 1920's science fairs have been highly popular venues in science education, but very little research has been conducted regarding the participants and any potential benefits. This exploratory study provides a preliminary profile of science fair judges and their perceptions of the benefits of participation for students in a large urban science fair. The research explores the demographics of 545 science fair judges volunteering at a large urban science fair over a two-year period. Results show that judges believe that students benefit from their encouragement, the communication skills gained, and exposure to STEM careers. The judges tend to work in STEM-related businesses and university settings. One-third of the judges completing a survey had themselves been science fair participants as youth.

S6.6.2 A Case Study of Urban Student and Teacher Experiences Surrounding an Outdoor Environmental Science Field Trip Peggy L. Preusch, Towson University, ppreusch@umd.edu

ABSTRACT: Field trips provide opportunities for students to experience many different contexts beyond the classroom. Recent interest in learning that occurs at informal science education centers such as museums, zoos and aquariums has stimulated studies of the relationship between learning in and outside of schools. Although many studies focus on the teachers, the contexts, and/or the students during the field trip, only a few look at the entire process of learning by including the classroom setting before and after the field trip. This study was designed to develop understandings of the student process of learning during and surrounding an environmental science field trip to an outdoor setting. During the field trip, the students' active engagement with each other and the environment supported student remembrances of their field trip experiences during interviews. Students accurately described plants and animals they had observed in different habitats during the field trip. They made connections with their home life and prior experiences in the outdoors as they discussed the field trip. One implication of this study is that educational experiences in outdoor

natural environments are complex in ways that contribute to the potential for lack of continuity between science lessons and environmental science field trips.

S6.6.3 The Circularity of Teaching and Practice: Supporting Pre-Service Teachers by Removing Emotional Barriers to Quality Teaching in Informal Educational Environments

Steven B. Chapman, University of London, s.Chapman@ioe.ac.uk

ABSTRACT: During 2008 an investigation was made into the communications Pre-Service Teachers (PSTs) made with pupils during training visits to a national science museum. The discourse analysis of their conversations with children in both interactive and object-dominated galleries indicated that fear of inadequate behaviour management, prejudice regarding play and dread of loss of authority skewed their behaviour towards a transmission model. During 2009 these insights were fed into the training programme for that year's cohort. This extension of research into training practice reports on the feelings and aspirations of the 2009 cohort before and after their encounters with pupils in a museum. The PSTs were interviewed before and after a visit to the museum with a class of children. They were then asked to reflect on their initial and final comments. Before the visits the PSTs had groundless worries about logistical issues and subject knowledge authority. These broadly related to concerns with what the role of the teacher was. Afterwards the focus was on what the pupils had enjoyed and learned. In particular they mentioned activities supporting learning and a positive mood.

S6.6.4 Free-choice Family Learning Experiences at Telescope Observing Events

Matthew C. Wenger, University of Arizona, mwenger@email.arizona.edu

Christopher J. Harris, SRI International

Kathy Carter, University of Arizona

ABSTRACT: This study examined family learning experiences in the context of telescope observing events. Pre-selected "Expert" families were paired with families recruited on-site at night-time telescope observing events. Self-administered pre- and post-visit conversations were participant driven and guided by conversation cards provided by the researcher. At a follow-up meeting, participants were first asked to make a short video-blog style reflection video describing their experiences at the telescope event and then guided through a conversational style stimulated-recall interview using short video clips from the observing event. Analysis revealed that families felt empowered to make autonomous decisions independent of the researcher, indicating that these data may be representative of authentic family-directed experiences at observing events. Key findings of this study are that participants' expectations for event experiences were met or exceeded and that event facilitators are critical for helping visitors construct meaning.

S6.6.5 Exploring Middle School Students' Sense of Place and Engagement in Science Learning

Deborah E. Peck, University of New Brunswick, peck@nbnet.nb.ca

Karen S Sullenger, University of New Brunswick

ABSTRACT: Place based education highlights experiences and connections with aspects and attributes of a place as well as relationships that form with and through a place (Woodhouse, 2001; Ardoin, 2006; Green, 2007; Shepherdson et al, 2007). Experiencing a place within the context of science learning is a component of an afterschool program for middle school students called EcoAction. During their weekly meetings over a three year period, EcoAction students interacted with scientists to study and understand many and varied aspects about the science of a piece of land near their school. This resulted in them not only learning about the science of their study area but in them forming an emotional connection to the place. Because this was something we didn't foresee, we chose to explore the students' varied awareness of the place in more detail. We wondered how EcoAction students' would describe their piece of land after studying it with scientists and whether or not an emotional attachment to the place impacted students' engagement in learning about it. This article will explore middle school students' sense of place from the perspective of the science learning that is a transformation of their understanding of that place and their attachment to it.

S6.6.6 Car Cards for Carbon: Can Light Rail Mass Transit be Used to Teach Riders Science?

David S Lustick, University of Massachusetts Lowell, David_Lustick@uml.edu

Jill H. Lohmeier, University of Massachusetts Lowell

ABSTRACT: The purpose of this study was to gather data on the potential practicality of implementing an informal science learning campaign within a major East Coast metropolitan light rail mass transit system. In this study a Carbon Awareness and Attitudes Survey was created and administered in subway stations along two different lines. One hundred and fifty one subway riders completed the survey and provided information regarding the population's demographics and current awareness of and interest in learning about related scientific issues (i.e. global warming, climate change, carbon footprints). Results suggest that T-riders would be interested in learning about the science of environmental carbon if given the opportunity. Practical and logistic issues involved in presenting informal science education and conducting research in subways is discussed. This study can inform future research and informal education projects within the untapped medium of underground mass transit.

S6.6.7 The Importance of Visual Materials for Educating Latino Farmworkers About Pesticide Risks

Catherine E. LePrevost, North Carolina State University, celeprev@ncsu.edu Margaret R. Blanchard, North Carolina State University Julia F. Storm, North Carolina State University

Cesar R. Asuaje, University of Florida

Gregory Cope, North Carolina State University

ABSTRACT: Farmworkers work and live at sites of potential pesticide exposure, exposing them and their families to immediate and long-term health risks. Comprised primarily of low literacy Latino migrant and seasonal workers, this population lacks pesticide safety education that adequately addresses its particular educational needs. In this study, the effectiveness of new educational materials employing specific images and related messages was assessed in terms of how well crop-specific pesticide safety information was communicated. Twenty-eight migrant and seasonal farmworkers in two states participated in this qualitative study through focus group discussions and follow-up interviews. Analyses of transcription data suggest the importance of vivid and realistic images for communicating critical pesticide information to this low literacy audience. Additionally, findings indicate the effectiveness of a stoplight image in conveying the concept of variable toxicity. This study resonates with limited previous work in the field, and may provide insight to amendments to national farmworker training requirements.

S6.6.8 Utilizing Reflective Practice and Coaching Techniques in a Formal-Informal Education Partnership for Constructivist Science Teacher Preparation

Laura Saxman, CUNY, Lsaxman@gc.cuny.edu Barbara Schroder, CUNY

Preeti Gupta, The New York Hall of Science

ABSTRACT: The focus of this poster is a description of and specific data about reflective training techniques in a pre-service training program for science teachers that represents a partnership between a formal university program and an informal science institution. In this project, undergraduate students who are enrolled in the required courses for secondary science education at a local College work as docents or Explainers at an urban, interactive science museum. Training experiences at the museum are structured so that students have the opportunity to practice and refine their inquiry based teaching practice with coaching, and mentoring from museum and project staff. Electronic discussion formats also provide the opportunity for community reflective practice. The information in this poster will serve to highlight aspects of the training model that can be replicated.

S6.6.9 Atom Surprise: Science Theater under Investigation

Ayelet Baram-Tsabari, Technion, Israel, ayelet@technion.ac.il Ran Peleg, Technion, Israel

ABSTRACT: As interest in science drops, the science education community has to seek new ways of teaching and engaging children. One such strategy, which has so far received little research attention, is the use of theatre. This approach can be seen as part of the humanistic science education movement. This study, which is part of a larger project, focuses on the learning outcomes of a science play for elementary school children on the topic of matter, using a combination of quantitative and qualitative research tools. Children's knowledge on the subject of matter increased after viewing the play with younger children gaining more conceptual understanding compared to their older peers. The viewers were more likely to hold the misconception that molecules can be seen after watching the play, probably because a model of a molecule is presented during the show. Further evidence for learning from in-depth interviews will be given in the poster presentation. Results from this and similar studies could help science educators and creators of science plays utilize science drama more effectively and increase children's engagement and motivation to study science.

S6.6.10 Patterns of Youth and Family Interaction during Informal Science Activity: Implications for Learning Science In Formal and Informal Environments

Leah A. Bricker, Loyola University Chicago, lbricker@luc.edu

Philip Bell, University of Washington

ABSTRACT: People learn about science across the settings of their lives (e.g., home, school, museums, clubs) using a vast array of resources (e.g., other people, linguistic forms, media, various types of texts and tools). Using theoretical constructs from sociocultural historical images of learning and practice, we examine the interaction patterns of youth and families as they participate in science-related activities in a variety of settings. We utilize data from a cross setting, longitudinal ethnography of youth learning and expertise development related to science and technology. Data sources include video and audio-recordings of observations and interviews, as well as digital photographs, documents, and surveys. Findings indicate that youth and family interaction patterns during informal science activity are variations of more general youth and family interaction patterns that include linguistic practices, such as argumentation as a sense making tool, and orchestration of space and people in order to facilitate distributed cognition. Some of these interaction patterns travel across settings and some do not, which has implications for youth science learning in school. Implications for learning science in formal and informal environments are discussed.

S6.6.11 Public Engagement with Science in Informal Science Education: An Analysis of Five Case Studies in Science Theatre

Jane L. Lehr, California Polytechnic State University, jlehr@calpoly.edu Ellen McCallie, Carnegie Museum of Natural History Robin Meisner, MIT Museum Cora Olson, Virginia Polytechnic Institute & State University John Durant, MIT Museum

John H. Falk, Oregon State University Saul Halfon, Virginia Polytechnic Institute & State University Bruce Lewenstein, Cornell University Cynthia Needham, ICAN Productions Debra Wise, Underground Railway Theater

ABSTRACT: There is growing interest in strengthening and expanding Public Engagement with Science (PES) initiatives in the field of informal science education and its institutions. While conceptual support exists for the integration of PES in ISE and an emerging literature documents the impacts of PES initiatives at the institution-level, a recent CAISE inquiry group report argues that, "[a] fuller articulation of impacts and associated indicators" and "more empirical analyses of PES in ISE are needed, including theoretically based assessments of specific activities" (McCallie, et al, 2009). This paper responds directly to the call for empirical analysis. Focused on five discrete case studies in science theatre, this analysis applies, tests, and refines the strategy suggested in the report for distinguishing between different approaches to integrating PES in ISE via analysis of the role of the public, STEM-related experts, and content. Conclusions: Increased PES programming in ISE is not about rejecting scientific knowledge, but about placing scientific knowledge in the complex world in which we live. Second, while much science theatre is influenced in subject matter selection by the PES initiative, efforts to integrate other ideas associated with PES (including mutual learning and direct interactions between scientists and publics) are in their infancy.

S6.6.12 Using Cogenerative Dialogues in a Science Center

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

Correa H. Jennifer, New York Hall of Science

ABSTRACT: This study demonstrates how cogenerative dialogues are used as a methodology and method to support those involved in floor facilitation in science centers. Participants are undergraduate science majors who work as floor staff and their supervisors who together audiotape their interactions and discuss their praxis with the intention of developing understandings of self and others as learners and teachers.

Strand 7: Pre-service Science Teacher Education S6.7 Poster Session 10:30am – 11:45am, Conference Room 407

S6.7.1 Service Learning for Science Teacher Education: A Synthesis of Theory and Research

Carolyn S Wallace, Auburn University, csw0013@auburn.edu

ABSTRACT: Service-Learning for Science Teacher Education: A Synthesis of Theory and Research Also known as "authentic learning" (Ryan & Healy, 2009), service-learning engages students in providing a community based service, while at the same time developing academic, civic, or professional knowledge and affective dispositions. Service-learning has been used extensively in preservice teacher education because it provides an active pedagogy where candidates can build experiences with children. However, there has been little research on the benefits of service-learning in science teacher education, limited to only a few studies (Cone, 2009). The purpose of this paper is twofold: (a) to provide a theoretical framework for thinking about how service-learning might provide a rich and unique experience for science teacher education; and (b) to synthesize the literature from other fields to provide guideposts for further research in science teacher education. Suggestions for research in science teacher education are discussed.

S6.7.2 Aligning Preservice Teacher Knowledge about Models and Modeling with a Scientific Modeling Learning Progression Barbara Hug, University of Illinois Urbana-Champaign, bhug@illinois.edu

Tang Wee Teo, University of Illinois Urbana-Champaign

ABSTRACT: Scientific modeling is an essential part of science. However, scientific modeling is rarely used in elementary classroom to engage students in learning or doing science. One of the reasons is that teachers do not have a deep understanding of and about scientific modeling (MMK) or the necessary pedagogical knowledge (PCK) to integrate modeling into the classroom. In order to design effective professional development for teachers around modeling, it is important to understand where teachers are in their understanding of modeling. We are interested in examining what MMK and PCK preservice elementary teachers have in regards to their initial knowledge about scientific models and modeling across multiple research sites. By understanding this component, we can begin to design our preservice methods courses to impact both the MMK and PCK for scientific modeling of our preservice teachers. We are interested in linking the understanding that preservice teachers come to the methods classroom with to a proposed learning progression for scientific modeling. Our study's findings can be used to improve the design of elementary methods courses by emphasizing the areas the preservice teachers are unfamiliar with prior to instruction in a teacher education program.

S6.7.3 The Role of Coteaching in Valuing and Using the Disturbances of Learning to Teach Science

Catherine E. Milne, NYU, cem4@nyu.edu Kathryn Scantlebury, University of Delaware Jason Blonstein, NYU

Susan Gleason, Middletown High School Delaware

ABSTRACT: Drawing from the field of activity theory and our emic experience as coteachers, we examine the enactment of coteaching in university science education courses. One of the tools central to our study was the analysis of disturbances in the work and object of preparing science teachers. The presence of an extra instructor provided increased opportunities in the system for recognizing and valuing disturbances as indicators of underlying contradictions in elements of the activity system of the learning and teaching of science teachers. This analysis highlighted the role of coteachers in problem posing and problem solving through narrative for addressing observed disturbances. Our analysis suggests that coteaching offers expanded opportunities for the evolution of the activity system of preparing science teachers.

S6.7.4 Student-teachers Promoting Actions on Socioscientific Issues: Impetus from Their Science Inquiries

John L. Bencze, OISE, University of Toronto, larry.bencze@utoronto.ca

Gervase M. Bowen, Mount Saint Vincent University

Lyn Carter, Australian Catholic University, Melbourne, Australia

ABSTRACT: We are facing many challenges associated with fields of science and technology. Arguably of most concern is Climate Change, but there are many other issues, such as food quality, distribution and safety. Many of these problems may be related to individuals' tendencies towards repeating cycles of consumption of goods and services. Progress has been made in addressing such issues by, for example, encouraging students to consider complex socioscientific issues, take positions about them, and develop plans of action to address them. In the study reported here, though, we concluded — based on constant comparative analyses of qualitative data — that student-teachers' tendencies towards promotion of socio-political activism may be enhanced by findings from their self-directed science inquiries that indicated socioscientific problems.

S6.7.5 From PCK to TPCK: Developing A Transformative Model of Pre-Service Science Teachers

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

Kuan-Chung Chen, Chung-Yuan Christian University

ABSTRACT: This study examined the impact on a transformative model of integrating technology and peer coaching for developing pedagogical content knowledge of pre-service science teachers. A TPCK-COPR model and an online system were designed to restructure science teacher education courses. Participants of this study included a single instructor and a group of pre-service teachers (n=12). The study used self-assessment, peer assessment and expert assessment for assessing pre-service science teachers' competencies to teach with technology. The results showed that there were significant differences in "Total TPCK competency" between the two tasks. This study expanded four views, namely, the comprehensive, imitative, transformative and integrative views to explore the impact of TPCK. The model could help pre-service teachers develop technological pedagogical methods and strategies of integrating subject-matter knowledge into science lessons, and further enhanced their TPCK.

S6.7.6 Development of Science Pedagogical Content Knowledge: A Model Proposed for Elementary Teacher Education in Alberta

Saiqa Azam, University of Calgary, AB, Canada, sazam@ucalgary.ca

ABSTRACT: The elementary science instruction in Alberta predominantly follows a generalist model and many elementary science teachers lack science content, interest and confidence for teaching elementary science. Present teacher education programs in Alberta focus on developing generalist elementary teachers, and preparation for science teaching is not a strong aspect of these programs. Moreover professional development activities for elementary science teachers also have less focus on science instruction. This raises serious issues for the development of elementary teachers' science pedagogical content knowledge (PCK) for teaching elementary science. To address the above issue of development of science PCK of generalist elementary teachers, this paper proposes a hypothetical model for pre-service and in-service elementary teacher education based on critical review of relevant literature on PCK. This model of is anticipated to help develop accelerated acquisition of the science PCK of generalist elementary teachers in an authentic form suggested by research on PCK.

S6.7.7 Using Video Reflection to Foster Pre-Service Science Teacher Reflection and Identity Development: Nicole's Story Maria S Rivera Maulucci, Barnard College, Columbia University, mriveram@barnard.edu

ABSTRACT: One of the central challenges in science teacher education involves fostering the types of reflection that support development of pre-service teachers' science teacher identities, particularly for those pre-service teachers who aspire to teach for social justice. This study explores the value added by a web-based learning environment, VITAL (Video Interactions for Teaching and Learning), as a tool for promoting teacher reflection. Through an in-depth case study of one preservice teacher's reflections on a video of her mini-lesson, I propose that VITAL fosters specific, evaluative, and evidence-based reflections regarding Nicole's pedagogical methods, connections she was making to the methods seminar, and her future goals for becoming a teacher. This study adds to the research base on the use of video in science teacher education by describing the form and content of the pedagogical assignment, the nature, scope, and focus of the types of reflections the assignment affords, and new approaches to coding preservice teachers' video reflections.

S6.7.8 Writing In Science: Developing Positive Attitudes and Pedagogical Knowledge in a Teacher Education Course

Isha DeCoito, York University, idecoito@oise.utoronto.ca

Shelley Peterson, University of Toronto

ABSTRACT: Teachers who focus on writing primarily to demonstrate mastery of content knowledge and scientific format are attending only to a fraction of the discourse practices of science communities. With the goal of gaining a better understanding of how to support teacher candidates in fostering their future students' competencies in written communication in science, this research study took place in a science curriculum methods class where the instructor used a writers' workshop approach. This research study investigated the efficacy of the writers' workshop approach in supporting teacher candidates' development of (1) scientific writing skills, (2) positive attitudes toward the significance of writing as part of their students' scientific literacy, and (3) knowledge of effective instruction and assessment practices that address the expectations of the communication strand of the science curriculum. Findings indicate that teacher candidates demonstrated a strong scientific literacy and the quality of the information was not compromised by their attention to the needs of their eleventh-grade student audience, nor by the use of genres that have not traditionally been associated with scientific writing. Indeed, teacher candidates felt that their content learning was enhanced because they had to review and reshape their knowledge to communicate it in a new format.

S6.7.9 Factors Mediating the Quality of Teacher Workforce: Finnish and South Korean Cases

Miyoung Hong, Korea Institute for Curriculum and Evaluation, South Korea, myhong@kice.re.kr

Nam-Hwa Kang, Oregon State University

Jari Lavonen, University of Helsinki, Finland

ABSTRACT: The purpose of this study was to examine relationships among the structures of the labor market, science teacher education programs, and teacher perceptions in Finland and South Korea, whose students demonstrated high achievement in science. Teacher hiring processes, nature of teacher preparation programs and teacher perceptions and confidence about their work were examined. The findings demonstrated that the labor market structures mediated the nature of teacher education programs differently in the two countries and possibly influenced the teachers' perceptions of their role and self-confidence. Further research questions were suggested.

S6.7.10 What Makes A "Good" Argument? A Metacognitive Approach to Science Teacher Candidates' Ideas About Quality Criteria of Argument

Nicola Scheid, nicola.mittelsten.scheid@uni-oldenburg.de

ABSTRACT: Argument is a crucial strategy for sciences and science education. In particular, metacognitive knowledge (MCK) about argument allows for the strategic management of argument. This is why this study focuses on teacher candidates' MCK about quality criteria of argument. Recent research primarily focused on comments of students regarding given arguments. But within this study 50 Canadian teacher candidates were asked to freely list criteria of a "good" argument within an opened questionnaire. Qualitative Content Analysis leads to the following main six categories of quality criteria: Teacher candidates consider the quality of argument to be based on (1) the structure of argument, (2) backing, (3) the openness of argument, (4) its clarity and conciseness, (5) its internal consistency, and (6) the effect of the argument. This study contributes to NARST members and the science education community since argument represents a core issue of contemporary science education. In particular, the findings provide a basis for assessing, teaching and learning argument within science education.

S6.7.11 Confirmation of the Psychometric Properties of the Context-Modified Questionnaire of Attitude Toward Statistical Graphs (QASG) for Measuring Pre-service Teachers' Attitudes Toward Line Graphs in Science (QALGS)

Sebastian Szyjka, Central Michigan University, szyjk1s@cmich.edu

Frackson Mumba, Southern Illinois University Carbondale

Kevin Wise, Southern Illinois University Carbondale

ABSTRACT: This study sought to verify the psychometric properties of a context modified attitudinal instrument designed to measure pre-service elementary teachers' attitudes towards line graphs in science. Confirmatory Factor Analysis (CFA) was employed to test the statistical hypothesis that five main factor structures within the Questionnaire of Attitude Toward Statistical Graphs (QASG) would be maintained in the revised Questionnaire of Attitude Toward Line Graphs in Science (QALGS). Results for CFA indicated that the revised QALGS measure was sound in its psychometric properties when tested against the QASG and is suitable for use. The first four measurement models fit the data well as indicated by the appropriate descriptive and statistical indices. However, the fifth two-factor attitude model did not fit well with the data statistically (χ^2 [53, N = 94] = 100.34, p = .000) and fit well descriptively with two indices (GFI = .86, CFI = .85, RMSEA = .10). Reliability statistics for models 1-5 were .82, .81, .74, .70, and .81, respectively. Reliability statistics indicated that overall reliability for the 32 items in the QALGS was .90. The learning preferences construct had the lowest reliability (.67), while enjoyment (.89), confidence (.86) and usefulness (.77) constructs had moderate to high reliabilities.

S6.7.12 Establishing and Diagnosing Prospective Teachers' Diagnostic Competence

Claudia von Aufschnaiter, Justus Liebig University Giessen, cvauf@cvauf.de Gabi Duebbelde, Justus Liebig University Giessen

Janine Cappell, Justus Liebig University Giessen Marco Ennemoser, Justus Liebig University Giessen Juergen Mayer, Justus Liebig University Giessen Joachim Stiensmeier-Pelster, Justus Liebig University Giessen Rudolf Straesser, Justus Liebig University Giessen Anett Wolgast, Justus Liebig University Giessen

ABSTRACT: Modeling and researching professional competences of teachers constitutes an increasing area in science education research. Among the competences outlined to be relevant for pre- and in-service teachers, assessment is frequently mentioned. Teachers need to be able to identify students' (subject-matter) learning dispositions and their learning pathways in order to design instruction accordingly. Even though it seems to be clear that such diagnostic competence plays an important role in teachers' professional knowledge, research rarely explicitly focuses on this competence. In our project we have referred to the distinction between content knowledge, pedagogical content knowledge and pedagogical to establish a model that describes diagnostic competences in all three areas. In cooperation with math and science education as well as with educational psychology, a linked curriculum is developed to establish the modeled competences with prospective teachers. Prospective teachers' learning progress as well as changes in their motives, interests, and attitudes towards learner oriented instruction is diagnosed with established instruments.

Strand 8: In-service Science Teacher Education S6.8 Poster Session

10:30am - 11:45am, Conference Room 408

S6.8.1 School Culture: Understanding the Interaction between School Culture and Beginning Science Teachers' Induction Experiences

Yavuz Saka, Florida State University, yys3536@fsu.edu

Sherry A. Southerland, Florida State University

Barry W. Golden, Florida State University

ABSTRACT: By employing Saphier and King's (1985) school culture theoretical framework, the goal of this multicase qualitative study was to describe two reform-minded teachers' induction experiences and how school cultures and community members impacted on these novices' retention and implementation of science education reform. We place particular emphasis on the teachers' negotiation strategies used in response to contradictions embedded in the context of schooling. As a means to a better understanding of the changes that occur within the teacher, we specifically focus on how two novice teachers' interactions with the school administration and community members play out in shaping the actions involved in their teaching. Both teachers were tremendously influenced by their school cultures, in ways that were both positive and negative. The culture of the schools transformed these teachers. They were forced to rethink their strengths and weaknesses as teachers and as professionals, their expectations of self and peers and the attitudes, dispositions and beliefs they held as teachers.

S6.8.2 Entrepreneurial Leadership in STEM Teaching and learning (EnLiST) a Longitudinal Case Study

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

Fouad Abd-El-Khalick, University of Illinois

ABSTRACT: Organizational change in education includes systematic change such as: changes in policies and regulations that affect educational initiatives at a national level; state level changes related to mandates such as state standards in content areas; district level changes when a specific school district enacts change across all schools within the district; and school-wide change which occurs when a school decides to change a particular educational issue within the whole school setting such as the addition of a curriculum on bullying (Hall, 1992). Individual or small group change is concerned with efforts at long-lasting change for teachers in their own classroom. This study is situated at the intersection of organizational systemic change and individual teacher change. Entrepreneurial Leadership in STEM Teaching and learning (EnLiST) is a professional development initiative whose foundation has been mortared by educational change research, scholarship on distributed leadership, social network studies, and educational entrepreneurship literature. Its goal is to promote long-lasting systemic change by arming core groups of high school science teachers not only with advanced content and reform-based instructional practices, but with the skills and attitudes necessary to become teacher leaders that marshal support from upper elementary and middle school teachers, while partnering with administrators and district personnel. Collaboratively they develop innovations that are being implemented across traditional grade level and building boundaries. This paper outlines the conceptual framework of EnLiST and provides preliminary data for this 5 year, longitudinal study.

S6.8.3 Building an Online Community of Practice: A Pilot Study of the NASA Endeavor Fellows

Meghan E. Marrero, U.S Satellite Laboratory, Inc., mmarrero@us-satellite.net

Jessica F. Riccio, Teachers College, Columbia University

Glen S Schuster, U.S Satellite Laboratory, Inc.

ABSTRACT: The NASA Endeavor Science Teaching Certificate Project is a competitive fellowship program whereby 40 formal educators per year are chosen to pursue an online certificate in STEM education. One goal of the Project is for educators to develop an

online community of practice, a network of educators within the program with whom they can continue to collaborate and develop their pedagogical content knowledge for years to come. This case study examined interactions between participants within their online community, responses to questions about the online community and the ways in which the Endeavor Fellows used the community within the first six months of their Fellowship. Findings indicate that the Fellows began to use the online community as a place to share ideas and best practices as well as for camaraderie and support. These findings are promising in that best practices for teacher professional development reveal interaction and support between educators to be an important component of sustained professional development experiences. Although these educators were located in 16 states and taught in diverse settings, they were able to find common ground, suggesting that online professional development models can achieve a significant level of support and interaction between teachers.

S6.8.4 The Role of Teacher Belief Systems and Classroom Discourse in the Interpretation of Reform-Based Instruction

Lynn M. Sikma, University of Illinois Urbana-Champaign, sikma1@illinois.edu

ABSTRACT: Teachers existing belief systems affect their enactment of reform. This study involves teachers enrolled in an inquiry science methodology course at a major midwestern university. All teachers involved are practicing teachers who each have individual belief systems about teaching, learning, and what is important. This paper examines the acquisition of inquiry-based instruction in the contexts of the teachers' existing belief systems. Qualitative methods were used for data collection. Data sources included interviews (both formal and informal), field notes, and course assignments. Most teachers involved in the study did not grasp the concept of inquiry as purported by reform documents. This was due in part to the university professor's role in the classroom, and how the discourse was enacted.

S6.8.5 Developing Secondary Science Teachers' Knowledge of Adolescent Identity Development

M. C. Smith, Northern Illinois University, mcsmith@niu.edu

B. K. Kitts, Northern Illinois University

Penny Billman, University of Illinois College of Medicine

ABSTRACT: The presentation describes a professional development program for secondary science teachers that introduces the concept of identity action theory (Author, 2008). Identity action theory focuses on the importance of promoting adolescent students' identity development in the context of schools and subject matter instruction. Identity formation is a key psychosocial task of adolescence and we argue that when teachers direct attention to supporting students' identity strivings (practices that we call identity work), then appropriate subject matter motivation and academic achievement will follow. We present identity work as a promising alternative to teachers' efforts to "motivate" students to engage in science learning. Two cohorts of science teachers (N = 28) participated in either an on-going workshop (over 1 year) or an 8-week online summer course that introduced identity work into science instruction and they prepared an example science lesson plan that integrated identity development into their lesson. Our presentation focuses on the teachers' efforts at understanding identity work and their initial efforts to plan identity work activities for science teaching and learning. Implications for professional development and secondary science instruction will be described.

S6.8.6 What is Known about Mentoring in Support of Reform-Based Science Teaching

Thomas R. Koballa, University of Georgia, tkoballa@uga.edu

Leslie U. Bradbury, Appalachian State University

ABSTRACT: A comprehensive review of research related to science teacher mentoring was conducted by manually searching science education and general education journals and electronic databases. Forty-two texts, including journal articles, book chapters, books, and conference papers, that presented or reviewed empirical research over a period of three decades (1980-2009) related to science teacher mentoring were examined. The findings are based on empirical studies conducted in a variety of international contexts, including mentoring in conjunction with university-based teacher preparation and induction experiences, and in elementary and secondary schools. Overall, the research reviewed demonstrates the potential of mentoring to support the professional growth of novice science teachers. It also reveals that much is still unknown about mentoring in support of reform-based science teaching, but that there are many possible directions for future research to inform science educators' understandings of this important arena of teacher learning.

S6.8.7 Toward a Model of Effective Instructional Coaching in Science

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Eric Magi, Spokane School District

Cheryl Allendoerfer, FACET Innovations, LLC

Ruth Anderson, FACET Innovations, LLC

ABSTRACT: Instructional coaching is widely used in K-12 schools to help teachers improve their instruction. Research on professional development suggests that in-house, ongoing professional development can be very effective and efficient, and instructional coaching fits this description. However, models of coaching vary widely, and the effectiveness of these models has not been extensively studied. In addition, coaching is commonly used in the areas of literacy and mathematics, particularly at the elementary level, but less is known about how coaching works at the secondary level or in subject areas such as science. This study

focuses specifically on instructional coaching in science in a mid-sized urban school district, examining the implementation and impact of science coaching at four elementary schools, four middle schools, and four high schools. In this paper we describe what science coaching looks like in this district, and present findings regarding the effects of coaching on science teaching and learning. We also describe elements that appear to contribute to an effective instructional coaching model, which may be useful for school districts or professional development providers interested in improving science teaching and learning.

S6.8.8 Professional Development at the Cutting-Edge of Science: Teacher Experiences and Perspectives on Biotechnology Education

Jamie E. Mann, University of Florida, jmann@ufl.edu

Troy D. Sadler, University of Florida

ABSTRACT: This study is focused on teachers' experiences and perspectives associated with a professional development seminar focused on biotechnology. Teachers were observed and interviewed during a two-week professional development held at a major research university. The seminar focused on biotechnology and practices for incorporating biotechnology techniques into classroom instruction. Data from observational field notes were analyzed with an inductive approach consistent with naturalistic inquiry (Lincoln & Guba, 1985) and the Constant Comparative Method (Strauss & Corbin, 1998). Findings are categorized according to two main experiential parameters: 1) teachers' perceived limitations on their ability to implicate material covered in the PD upon returning to their classes and 2) the teachers' expected or desired outcomes from their participation in the PD. Teachers attend PD experiences for myriad reasons, with various expectations of how doing so will improve their teaching. Also, participants have many concerns about what may inhibit their attempts to incorporate PD material into their classes. The results of our study shed light on possible amendments to PD design and enactment to improve effectiveness and aid in the incorporation of emergent fields such as biotechnology, which are of great importance in industry and medicine, into secondary science instruction.

S6.8.9 Effectiveness of a Network-based Collaborative Professional Development Project on Teacher Professional Development: A case study

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Huey-Por Chang, National Changhua University of Education, Taiwan

Kuo-Hua Wang, National Changhua University of Education, Taiwan

Chien-Kuo Hsieh, National Changhua University of Education, Taiwan

ABSTRACT: The purpose of this study was to investigate effectiveness of a network-based collaborative professional development project on development of a novice science teacher. A case study was adopted in the study. We develop a collaboration professional development project which includes features of collaboration, authentic classroom teaching, and feedback and reflection through a network camera system (NCS). A professional development group consists of a novice chemistry teacher, a university professor, and the researcher. The main focus of the group is enhancing science teacher's inquiry teaching literacy. With support of the group, the novice teacher was asked to develop 3 units of inquiry teachings, including density, vibration and refraction. During the novice teacher taught these units in her class at a junior high school of a rural area, the professor observed the teacher's teaching through a network camera system from the university. After the instruction, the professor gave feedback to the teacher by using the system. Data was collected by participant observation, video tapings of teaching, online dialogue between professor and the teacher, interview, and documents. The findings indicate the teacher reflected that her perspectives on teaching and practice had changed through this strategy. It suggests the system can be used in teacher professional development.

S6.8.10 Using Structural Equation Modeling to explore the Relationships among Factors and Science Teachers' Professional Competences

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Ming-Jun Su, Shu-Te University, Taiwan

Jeng-Fun Hung, National Kaohsiung Normal University, Taiwan

ABSTRACT: This study aimed to illustrate the relationships among the affecting factors and secondary science teachers' professional competences using a structural equation modeling approach. The survey was conducted by using two questionnaires with the sample size of 126 secondary practicing science teachers. The first questionnaire FAPD, Factors Affecting Professional Development, used to recognize the level of each factor that the respondent has met. The second questionnaire GOPD, Goals of Professional Development, used to realize the level of competence that the respondent has possessed. The results showed that Personal Inner Factors including Attitude toward Teaching and Motivation are the most effective factors affecting teachers' competences except Probing Understanding. And only Instructional Practices as well as Personal Growth may promote Personal Inner Factors to improve teachers' performance. Environmental Support directly effects on teachers' competences except Probing Understanding, and even has a negative effect on Class Management. Above findings lead to a suggestion that the authority should encourage teachers to organize formal or informal learning community as an environmental support, and provide sufficient and quality learning activities for personal growth, rather than conduct instructional evaluations frequently.

S6.8.11 Changes in High School Chemistry Teacher Beliefs and Practice after a Professional Development Program

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Christine R. Lotter, University of South Carolina

Greg Rushton, Kennesaw State University

ABSTRACT: The National Science Education Standards describe inquiry teaching as engaging learners through scientifically oriented questions by giving priority to evidence so that they may develop, evaluate, communicate, and justify their own explanations (National Research Council (NRC, 1996). Science education literature also promotes teacher instruction using student-directed inquiry into scientific phenomena while allowing time for personal growth in thinking with peers in science investigations (Luft, 2001). Our study found that professional development and reflection changed six of our nine in- service chemistry teachers' beliefs and practice in their classroom. In designing our study, our proposition was that a professional development that modeled inquiry, allowed for reflection, and had enactment built-in would produce change in participant's beliefs and practice. Using multiple case study methodology, we collected in-depth data on participants' beliefs and practice including participant-observation in their classrooms (Creswell & Miller, 2000). Specifically, we answered the following questions: 1. How does the use of an inquiry approach with inservice chemistry teachers in a professional development result in their re-examining their pedagogical theories? 2. How does the reflection on the inquiry approach and practice teaching result in changes in these teachers' pedagogical theories? 3. How do the changes in these teachers' pedagogical theories translate into their classroom practice? Luft and Roehrig (2007) describe change in beliefs as movement of at least 3 categories from pre to post-interview on the Teacher Belief Instrument. Six of our teacher's TBI scores showed change in beliefs over the study. They described changing their instructional practice was due to their professional development experience. The Reformed Teaching Observation Protocol (RTOP) provided a criterion-referenced instrument to observe change in practice in pre-institute, institute, and post-institute videotapes. Six teachers' higher scores reflected a greater degree of reform and evidence for translating pedagogical theory into practice. They reported that having opportunity to practice, enact, and reflect on inquiry during professional development resulted in changing their pedagogical theories and practice.

S6.8.12 Engaging In-Service Teachers in Staff Development Through Model-Based Inquiry

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Christine R. Lotter, University of South Carolina

ABSTRACT: This poster describes our study of the effects of engaging in-service teachers in a model-based inquiry activity. Our research indicates that in-service teachers have a narrow understanding of the use of scientific models in both science and science teaching. Introducing in-service teachers to model-based inquiry as part of a two week summer institute can have positive effects on both teacher understanding of scientific models and teachers willingness to use model-based learning and model-based inquiry activities in the classroom.

Strand 9: Reflective Practice S6.9 Poster Session

10:30am – 11:45am, Conference Room 409

S6.9.1 Successes and Frustrations of High School Students during Their First Experience with Student-Driven, Problem-Based Physics Instruction

Jeffrey C. Nordine, Trinity University, jnordine@trinity.edu

ABSTRACT: Inquiry-oriented instruction shows potential for improving students' understanding of science content and the nature of science. Thus, science teacher educators promote inquiry-oriented curriculum and provide professional development to help teachers design their own inquiry-oriented curriculum. During the first implementation of my own student-driven, inquiry-oriented AP Physics unit, I found that my students – who had been successful in more traditional instructional settings – became sufficiently frustrated that many students dropped the course. Rather than revert to traditional methods, I resolved to conduct a systematic study of student learning during the next year's enactment of the unit and to investigate the sources of students' frustration. Preliminary results indicate that students' approach complex and ill-defined physics problems improved during instruction, but that their views of the nature of science remained largely unchanged. While students reported interest in the context of the inquiry (the Super Mario Bros. video game), students became frustrated by ambiguity, group members, a lack of time, and a perceived disconnect between their investigations and the textbook and AP-style problems on which they were assessed. Students reported feeling most successful when targeted direct-instruction lessons helped them to approach problems that had arisen during their student-driven inquiry.

86.9.2 Understanding High School Science Teachers' Perceptions of Inquiry Teaching

Issam H. Abi-El-Mona, abi-el-mona@rowan.edu

Sharon Blong

ABSTRACT: This study seeks to understand high school science teachers' perceptions of inquiry teaching in light of their own teaching practices. Guiding research questions were: (1) How do high school science teachers describe their own teaching practice? (2) What are the self identified "inquiry based" criteria embedded in their practice; (3) What criteria do they consider to be significant in determining the effective use of inquiry teaching within their own classroom and (4) How does such criteria compare with the
National Science Education Standards description of inquiry teaching in light of teacher identified curricular constraints? The study uses a phenomonological approach. Participants included 10 public high school science teachers (50% female) with a minimum of 1 year science teaching experience. Data collection occurred in three phases across a 4 month period. Phases involved classroom observations, field notes and semi structured interviews. Data analysis focused on triangulation of data sources. Preliminary results show that the majority of teachers see their teaching practices as adequate in fulfilling the required school science program. Teachers with more than three years of experience tended to debate the feasibility of inquiry teaching in light of the need to promote student content knowledge targeted towards state based assessments.

S6.9.3 How Does Being in a Journal Club Improve My Understanding of the Skills and Knowledge of Educational Research?

Karen A. Tallman, University of Massachusetts Amherst, kmtallman@comcast.net

Allan Feldman, University of South Florida

ABSTRACT: This paper reports on my action research study of the role of the journal club in the education of graduate students in science education. Journal clubs are not generally part of doctoral programs in education; however, they are traditionally found in doctoral programs in the science and medical disciplines. Their role is to help students learn how to read and present literature as well as promote the transfer of knowledge from expert to trainee. This study used an action research methodology. This action research study examined how being in a journal club improved my understanding, as a graduate student, of the skills and knowledge of educational research. I found that my understanding of how to analyze data increased. I found I gained a better understanding of the professional community that I am seeking to participate in. I also formed a bond with the other research assistants that created a community for discussion of educational literature that extended beyond the journal club. While this study is a small self-reflective examination of how one prepares to become an educational researcher, it suggests that journal clubs can be a fertile site for the growth of expertise in doing educational research.

S6.9.4 Beginning the Development of SAPP: Self-Analysis Professional Portfolio

Philip Clarkson, Australian Catholic University, Philip.Clarkson@acu.edu.au

Lyn Carter, Australian Catholic University

Anne Scott, Australian Catholic University

Andrea McDonough, Australian Catholic University

ABSTRACT: This paper proposes a new technique for digital video data collection by teachers to be utilised for their professional learning. The two key differences for this new approach is first to give teachers the decisions of what and when to collect data, and second for them to collect their own data by using hand held video cameras in their classrooms. Coupled with the data collection is an emphasis on the teachers following through a process that enables them to self critique their data and consider whether they have changed their practice. Although this technique was trialled in a mathematics teaching context, it will easily translate into science classroom contexts, and indeed other curriculum areas. We anticipate trialling SAPP in science classes in the first half of 2010. Pitfalls and successes in our first attempts at using this technique with a small group of teachers are documented.

S6.9.5 E-Portfolios as Portraits of Growth: Enacting Inquiry in an In-Service Chemistry Education Program

Rachel Ruggirello, Washington University in St. Louis, rachel.ruggirello@gmail.com

Wesley Pitts, Lehman College

ABSTRACT: This presentation focuses on the electronic portfolio as a portrait of teacher growth in an in-service chemistry education program, especially as teachers use inquiry to connect research and theory into their own practice. The e-portfolio supports teachers to document their growth, promotes reflective practice, provides the community with evidence of achievement and provides a more equitable means of demonstrating student learning. In our research, we theorize growth and evaluate this growth using the authenticity criteria: ontological, educative, catalytic, and tactical. Using a case study design we analyze student responses addressing specific rubric items of the e-portfolio. Through our analysis of teachers' reflective entries on their classrooms and on a variety of course assignments, including metalogues, action research projects, video and conversation analyses, and publications we find evidence that inquiry outcomes were strengthened through the duration of the program. We consider the benefits and potential difficulties of using the e-portfolio in teacher education programs. Finally, we provide evidence that when e-portfolios are well-designed they can enhance reflection by teachers and provide insights and educative examples of teacher growth, whereby they catalyze positive changes in their practice and dispositions as science educators.

Strand 10: Curriculum, Evaluation, and Assessment S6.10 Poster Session 10:30am – 11:45am, Conference Room 410

S6.10.1 Inquiry Based Performance Assessment Tasks Ann W. Wright, Canisius College Joe Engemann, Brock University Rodney Doran, State University of New York at Buffalo

Ethel Bournia-Petrou, Erie County Community College Joe Zawicki, Buffalo State College Gail Zichitella

ABSTRACT: Is the laboratory experience justified for learning science and, therefore, are performance assessments appropriate for evaluating students learning science? A conceptual framework will be presented that describes scientific inquiry experiences within school laboratory settings. The use of performance assessment within middle and high schools is intended to improve science instruction and encourage student engagement. In addition, results from research on the development of performance assessments will be presented. The assessments reflect the continuum in the dimension of inquiry (structured, guided, open). Millard, E. in (Free Library, 2007) emphasizes the extreme importance of the interdependence between learning in lecture and laboratory and how important high stakes testing can influence the interdependence. The complexity and the interconnectedness of national and state standards must be taken into account when reconsidering the role of laboratory experiences in school science, because some policies may constrain efforts to science laboratory experiences. The project will have a broader impact by adding to defining the role and value of science laboratory experiences (NAP, 2005). The presentation will model "Research into Practice: Practice Informing Research." The presentation will focus on applications and design of research in formal settings and the collaborations between researchers and classroom teachers and eventually the results can be used to inform educational policy.

S6.10.1 Comparative Analysis of the Presentation of the Nature of Science in U.S High School Biology and Korea High School General Science Textbooks

Young H. Lee, University of Houston, regina0930@yahoo.com

Eugene L. Chiappetta, University of Houston

Yeon-A Son, Dankook University

Seok Jun Hong, Dankook University

ABSTRACT: The aim of this study was to conduct a content analysis to compare the presentation of the four themes of the nature of science in the first chapter of four U.S. high school biology textbooks and five Korea high school general science textbooks with the modified four themes of the nature of science framework. The four-theme nature of science conceptual framework: (a) science as a body of knowledge; (b) science as a way of investigating; (c) science as a way of thinking; and (d) science, technology, and society. The current analyses of U.S. and Korean textbooks demonstrates with a good level of reliabilities ranging from .63 to .96 in U.S. and from .79 to 1.00 in Korea textbooks for Cohen's kappa that while only some U.S. high school biology textbooks reflect a reasonably balanced treatment of the four themes of the nature of science. Both authors of U.S. high school biology textbooks and Korean high school general science textbooks and Korean high school general science textbooks and Korean high school general science is by emphasizing investigation and the thinking processes of scientists -- not by presenting scientific knowledge.

S6.10.2 Assessing Scientific Reasoning in a High School Classroom: The Translation of a Research Instrument into an Instructional Tool

Edward R. Geaney, University of California, Santa Cruz, egeaney@ucsc.edu

Jerome M. Shaw, University of California, Santa Cruz

ABSTRACT: The purpose of this study was to translate a research instrument designed to measure scientific reasoning into an instructional tool. The lead author implemented the research instrument, entitled the "Malaria Epidemic Simulation," (MES), along with various activities, during a weeklong unit in a high school Advanced Placement (AP) Biology class, which he was teaching at the time of the study. Through a mixed-method methodology, consisting of field notes, the scored simulation, student work, and questionnaires, we explore the decisions made while implementing instruments such as the MES in high school settings, describe student patterns of performance on the simulation, and describe student patterns of attitudes toward the simulation and related tasks. While reporting the results, the lead author positions himself as both a researcher understanding the translation process and a teacher interpreting the data to inform classroom instruction. The findings indicate various levels of teacher "decisions" when implementing such instruments. Furthermore, students demonstrated the assessed areas of scientific reasoning with varying proficiencies and reported that they learned about the specific elements of scientific reasoning. Finally, students reported having a positive experience with the simulation and related tasks. Some of the translation constraints and student attitudes provide insight into future modifications.

S6.10.3 Exploring a Science Teacher's Assessment Beliefs and Practices through the Assessment Triangle Model

Edward R. Geaney, University of California, Santa Cruz, egeaney@ucsc.edu

ABSTRACT: The purpose of this study was to explore the assessment beliefs and practices of a high school science teacher. I drew on literature from science education, educational assessment, and teacher beliefs to develop a conceptual framework to inform my exploration. Furthermore, I drew on the assessment triangle model (Pellegrino, Chudowsky, & Glaser, 2001) to analyze the following three elements of assessment practices: how students learn (cognition), what evidence a student must show in order to demonstrate learning (observation), and teacher reasoning from the students' evidence (interpretation). Using the assessment triangle model, I coded multiple qualitative data sources – classroom observations, artifacts, a teacher questionnaire, teacher interviews, and a teacher reflective journal – centering on a Chemistry lab report. The framework allowed me to interpret the alignment between the assessment

triangle vertices. For instance, the teacher participant's beliefs about how student learn science (cognition) aligned with how she actually supported student learning in the classroom. However, the alignment among aspects of her assessment practices (i.e., observation and interpretation) differed depending on which particular learning belief I traced. This study contributes a framework that researchers can employ and further refine to explore a science teacher's assessment beliefs and practices.

S6.10.4 Meta-Content Informal Formative Assessment and its Influence on Middle School Students' Developing Science Knowledge

Joseph A. Brobst, University of Delaware, joebro@udel.edu

Eric M. Eslinger, University of Delaware

ABSTRACT: The utilization of informal formative assessment (IFA) strategies by two classroom teachers and a reading specialist were examined in the context of a software-based scientific inquiry intervention. Of particular interest were IFA interactions classified as "Meta-Content," meaning that teachers specifically prompted students to metacognitively self-assess their work and / or their developing science knowledge. Initial case analyses indicated a correlation between teacher use of meta-content IFA and student gains on a test of scientific inquiry skills. This study sought to extend upon those findings by determining the relationship that exists between teachers' engagement of students in Meta-Content IFA and subsequent student performance on multiple measures of science content knowledge. Results suggest the importance of considering teacher usage of informal formative assessment broadly and Meta-Content style assessment in particular in fostering student learning of new science concepts.

S6.10.5 Developing and Applying a Framework of Scientific Imagination and Measurement Scale for Scientific Imagination (MSI)

Jiyeong Mun, Ewha Womans Univerity, ksljyl@ewhain.net Kongju Mun, Ewha Womans Univerity

Sung-won Kim, Ewha Womans Univerity

ABSTRACT: Scientific imagination has a lot of educational values in science education. In this study, we defined scientific imagination as 'a thought process that creates new things based on scientific knowledge and past experiences.' In order to encourage science teachers to understand their students and teach them more effectively, we studied the characteristics of the scientific imagination, developed a framework of scientific imagination, and also developed the Measurement scale for Scientific Imagination (MSI) for elementary and junior students. These include three domains: Romance, Creativity and Productivity. The subjects were 190 Korean elementary school students (N=131) and junior school students (N=59). Data analysis indicated that the instruments developed in this study had proper validity and reliability measures ($\frac{4}{4}=0.886$). The results reveal that students were well associated in the aspect of creativity and productivity, but they were less associated in the aspect of romance relatively. Especially male students had lower romance while they had high creativity and productivity. Finally, there were positive correlations among romance, creativity and productivity.

S6.10.6 Stakeholder Discourse Dynamics in an Elementary School Science Reform Effort

Meena M. Balgopal, Colorado State University, Meena.Balgopal@colostate.edu

ABSTRACT: The call for and efforts to initiate reforms of science curricula in American schools continues, including in elementary schools. I developed a case study of an elementary school whose principal initiated a major reform effort to adopt a Science, Technology, Engineering, and Mathematics (STEM) focus. Many stakeholders (administrators, teachers, staff, parents, and university partners) interacted over a 10-month period in different formal and informal settings. Using a Symbolic Interaction framework I constructed a grounded theory about how discourse dynamics influenced these efforts. Using Emotion, Context, and Motivation as salient codes, I was able to categorize and explain the discourse in which stakeholders engaged. I discovered that 1) the stakeholders did not publicly acknowledge authoritative structures that existed between them; 2) stakeholders did not clearly express their motivation for participating in the reform effort; and 3) the stakeholders did not find a shared meaning of STEM or science literacy. Moreover, university partners were motivated to participate in the reform project to "improve" science education, whereas the teachers were motivated "enhance" science education. The discrepant views may seem subtle but if shared meaning is not found at the beginning of major reform projects, then the effort may be labored or fail.

S6.10.7 Investigating the Effectiveness of Design Method for Science Class Combined Two-Dimensional Teaching Method with One Page Portfolio Assessment: Grade Fourth Students Understanding of Phase Change

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Tetsuo Hori, University Yamanashi, Japan

ABSTRACT: This research investigates the effectiveness of the design method for science class combined Two-Dimensional Teaching Method (2DTM) with One Page Portfolio Assessment (OPPA). 2DTM is a teaching method, which analyzes and plans the element of science class from the two-dimensional viewpoints, Flow and Sequence. While OPPA is a one-page worksheet as assessment tool, which help students to record their learning history of every class and do self-assessment (a graphical organizer). Grade fourth students f class of phase change (solids, liquids and gases) was designed by the method and experimental class was conducted. Consequently, 70% of grade fourth students constructed scientific conception about phase change. This result revealed that the method was effective. Since this method is relatively easy to design, to employ the method as a professional development program

contents for pre-service and in-service teachers are expected. This design method could be used not only for elementary students f phase change, but also another domain of science from elementary to high school science.

S6.10.8 Development of an Instrument to Assess Science Teachers' Perceived Technological Pedagogical Content Knowledge James G. MaKinster, Hobart and William Smith Colleges, makinster@hws.edu

William J. Boone, University of Miami

Nancy M. Trautmann, Cornell Lab of Ornithology

ABSTRACT: This poster will describe the development and field testing of an instrument designed to measure teachers' perceived Technological Pedagogical Content Knowledge (TPACK – pronounced t-pack). The questionnaire includes 79 rating scale items organized into seven subcategories that represent theoretical constructs and empirical evidence of what constitutes good teaching in reference to pedagogy, content knowledge, use of technology, and the inter-relationships among these three knowledge domains. Principles of Rasch measurement guided the instrument development, with the goal of creating rating scales and items that yield scale scores for statistical analysis. Preliminary analyses indicate that calculated estimates provide a reasonable portrait of the data for the subscale presented here. Person measures suggested a need to add items to the scale that teachers are more likely to disagree with, but testing with a larger sample of teachers will determine whether this is indeed the case.

S6.10.9 Designing and Using Simulation-based Assessments in Balanced State Assessment Systems

Matt Silberglitt, WestEd, msilber@wested.org

Barbara C. Buckley, WestEd

Edys Quellmalz, WestEd

ABSTRACT: A number of efforts are currently underway to take advantage of technology to develop well-designed classroom assessments that can be used during instruction to monitor and improve progress and following instruction to document learning and remaining needs. These research-based classroom assessments can become credible components of a coherent, multilevel state science assessment system. This paper describes one effort to create and use simulation-based assessments in middle school science classrooms in three states. The simulation-based assessments are based on a theoretical framework that integrates model-based reasoning, evidence-centered design of assessments, and empirical studies in cognitive science. In addition, the assessments utilize screen enlargements for the visually impaired and text-to-speech. The technical quality of the assessments is ensured through external review by AAAS and state assessment officers, cognitive labs and classroom pilot tests. This paper will present the results of classroom pilots to be conducted during the 2009-2010 school year in approximately 100 classrooms in three states.

S6.10.10 Development of Attitudes toward Socioscientific Issues Scale

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ABSTRACT: This study aimed to develop and validate Attitudes toward Socioscientific Issues Scale (ATSIS) for undergraduate students. In the first step, data collected from 160 undergraduate students to provide reliability and validity of the new scale. Three dimensions emerged: interest and usefulness of socioscientific issues (SSI), liking of SSI, and anxiety toward SSI. In the second step, data collected from independent sample of 216 undergraduate students to confirm factorial structure of 30-item ATSIS. The Cronbach alpha coefficients ranged from 0.70 to 0.81. The ATSIS will serve as an important tool for science educators, curriculum developers, and policy makers to assess undergraduate students' attitudes toward SSI.

S6.10.11 A Case Study of a Virtual High School Biology Curriculum using the National Science Education Standards and the Revised Bloom's Taxonomy

Matthew E. Vick, University of Wisconsin-Whitewater, vickm@uww.edu

ABSTRACT: Virtual schools are a form of schooling that has become viable with the spread of the internet. The National Science Education Standards (NSES) put forward a vision of inquiry based teaching of science with the goal of achieving scientific literacy for all. Virtual education must use different means to teach science than in a traditional face-to-face classroom. This case study analyzes one virtual biology curriculum in terms of addressing the NSES and the levels of the revised Bloom's Taxonomy. The majority of assessment questions were at the remembering level of the taxonomy, but a large number of analyzing questions were also found. The curriculum did address almost all grade 9-12 life science standards, but there was also a large emphasis on comparative anatomy that better fit the grades 5-8 standards. This information can guide teacher educators the knowledge to prepare future teachers to create alternate assessments to reach the other standards.

S6.10.12 Studying Evaluative Process: Critical Thinking around Observing Science Professional Development Workshops

Kristin Bass, Rockman et al, kristin@rockman.com

Sarah Mushlin, Rockman et al

Molly Reisman, Rockman et al

ABSTRACT: "Studying Evaluative Process: Critical Thinking Around Observing Science Professional Development Workshops" Abstract Educational evaluations often boil down to results; usually, data is presented that either supports or negates claims regarding program impact. While results ultimately reveal what is and what isn't working in the field, the process through which program evaluators design their methods for data collection and analysis is often buried. Description of such processes appear only in the

introductory paragraphs to a paper or in a short opening statement to a presentation. In our paper, we argue that processes in program evaluation need more voice and that there is as much to be gained from sharing how critical thinking evolves into data collection instruments as there is in sharing the results of a program's impact. Knowledge-sharing around instrumentation and data collection builds expertise in the field of program evaluation and treats the process of documenting program and research design as a collective responsibility (Design-Based Research Collective, 2003; National Research Council, 2001). We articulate the steps we took to develop an observation protocol for observing science content professional development workshops for high school teachers. Understanding and discussing these processes illustrates the iterative process through which teaching practice informs instrument development and through which instrument design can inform teaching practice.

S6.10.13 EQUIP (Electronic Quality of Inquiry Protocol): A Valid Measure for Assessing Inquiry-Based Instruction

Jeff C. Marshall, Clemson University, marsha9@clemson.edu

ABSTRACT: This manuscript examines the two-year development cycle for the creation and validation of the Electronic Quality of Inquiry Protocol (EQUIP). This instrument was designed to measure the quality of inquiry-based instruction facilitated in science classrooms. The protocol evolved over several iterations and was supported by checks on validity and confirmatory factor analysis. The resulting protocol assesses 19 indicators aligned with four constructs: Instruction, Discourse, Assessment, and Curriculum. For teachers, the EQUIP provides a framework to make their instructional practice more intentional as they strive to increase the quantity and quality of inquiry instruction. For researchers, the EQUIP provides an instrument to analyze the quantity and quality of inquiry being implemented, which can be beneficial in evaluating professional development initiatives.

Strand 11: Cultural, Social, and Gender Issues

S6.11 Poster Session

10:30am - 11:45am, Conference Room 411

S6.11.1 Teaching Students with Learning Disabilities in the General Education Science Classroom: Examining Middle Grades Science Teachers Instructional Practices

Marlene Morales, Florida State University, drmarlenemorales@gmail.com Sherry A. Southerland, Florida State University

Penny J. Gilmer, Florida State University

ABSTRACT: Science teachers' instructional practices must align with the reform efforts to create an equitable and inclusive environment in which all students can learn science. Approximately, 50% of the 6.5 million students with disabilities enrolled in public schools receive special education services (U.S. Department of Education, n.d) within the general education classroom (US Department of Education, 2005). Students with disabilities are often the last to be considered when addressing issues of equity and science literacy (Lynch, 2000). The purpose of this study is to analyze the instructional practices utilized to address the needs of students with learning disabilities (SWLD) in the middle grades (6-8) general education classroom and expand the existing research on equitable science practices for all students.

S6.11.2 Influences on the Evolution of a STEM Teacher in an Under-Resourced School: The Case of Andrew

Athena R. Ganchorre, University of Arizona, athenag@u.arizona.edu

ABSTRACT: This study is part of a larger investigation of prospective STEM teachers' beliefs about students and families from low income or poor households. Prospective STEM teachers during their first years of preparatory work were followed into their first years of teaching in under-resourced school districts. This case study examines the life experiences of Andrew, a prospective STEM teacher. His early role advocating access to learning opportunities surrounding issues of literacy, and the ability to understand the complex lives and responsibilities shouldered by children from low income and Spanish speaking households strongly influenced Andrew's commitment to teach science in an under-resourced and bilingual school. Andrew sees his role as teacher, to advance the academic and personal success of low income, immigrant children and their families. The implications of this study may reveal instances to develop knowledge and understanding of prospective STEM teachers' lives and experiences that can be examined to aid, support and develop skills, knowledge and interest of potential teachers to best teach and serve students from diverse socio-cultural and linguistic backgrounds. Further, attracting prospective teachers from such communities with similar life experiences may be an effective means to increase quality teachers in under-resourced school districts.

S6.11.3 Growth in Elementary Teachers' Personal and Professional Beliefs about Diversity

Brian Fortney, University of Texas at Austin, Brian Fortney

Nancy Albrecht, University of Minnesota

Bhaskar Upadhyay, University of Minnesota

ABSTRACT: This is a quasi-experimental design study that tracked preservice teachers over a six month period, from methods classes to the end of student teaching experiences. The study shows that preservice elementary teachers' personal beliefs about diversity during science methods and after student teaching experiences don't change much but their professional beliefs about diversity do change to some extent. The growth curves plotted over a six months (3 waves of data collection) period show that the

rigidity in personal diversity beliefs and some flexibility in professional diversity beliefs. 56 preservice elementary teachers completed diversity beliefs survey (Pohan & Aguilar, 2001) that indicated that preservice teachers tend to keep their personal beliefs and professional beliefs separate even if they are contradictory at time.

S6.11.4 The Effects of School Type, Grade Level and Gender on High School Students' Metacognition

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Haki Pesman, Firat University

ABSTRACT: The present study aimed to investigate the effects of school type, grade level and gender on high school students' metacognition. Metacognitive Awareness Inventory was administered to 338 high school students from a public high school, an Anatolian high school, and an Anatolian teacher training high school. The results of the study indicated that there was a significant interaction between grade level and school type in their effects on high school students' metacognition. The interaction between grade level and school type had also practical importance. A significant difference between female and male students in metacognition did not found in the study.

S6.11.5 Investigating Parents' View about Involvement in Their Children's Education Through a Parental Science Learning Group

Yi-Ting Cheng, National Changhua University of Education, tonia0213@gmail.com

Huey-Por Chang, National Changhua University of Education

Wen-Yu Chang, National Changhua University of Education

Jun-Yi Chen, National Chiayi University

ABSTRACT: Recent years have seen increased attention being given to informal science education. Science learning should be omnipresent in the mundane lives of the students. Besides from the campus lives, family also plays an important role in the students' lives, whether mentally or physically. The aim of this article was to explore parents' attitudes to involvement in their children's' education, and in what ways they are so involved. The researchers set up two parental science learning groups, targeting the family member (usually a parent) most involved with the child's education in two Taiwan elementary schools. 32 volunteer parents took part in this study. Fortnightly group meetings of 2 hours' duration were arranged from October 2008 to June 2009. Data were collected primarily by means of taking field-notes, videotaping meetings, interviews, and questionnaires. The results revealed a number of factors affecting a parent's decision to participate in their child's learning. The types of participation that motivated parents' choice were discussed. The variables and processes at play in the parental participation decision were also presented. While this study has its limitations, it is hoped that it can serve as a basis for further study in engaging parents involving in their child's science learning.

S6.11.6 One Person Can Change a Village: The Differential Impact of Nutrition Education on Non-US Born Students and their Families

Penny M. Shumaker Jeffrey, North Carolina State University, penny_shumaker@ncsu.edu

Gail Jones, North Carolina State University

ABSTRACT: For students not born within the United States (US), it can be difficult to understand the complexity of our food culture and teaching nutrition to multicultural students adds rich challenges to educators. Dietary acculturation involves factors related to socioeconomics, religion and culture. Multiple reflections of 10 native born and 12 non-native born students enrolled in a community college nutrition course were analyzed for content related to the intersection of culture and nutrition and sociocultural contexts. Results showed that students not born within the US discussed culture a mean of 1.4 times per reflection as compared to a mean of 0.5 times per reflection for students who were born within the US. The reflections revealed that non-US born students reported sharing their new nutrition knowledge with family and other people back in their native country. The assimilation of new science knowledge into the cultural practices and beliefs of multicultural students is discussed.

S6.11.7 Empowering English learners in the Science Classroom

Adelina V. Alegria, Occidental College, alegria@oxy.edu

ABSTRACT: The principal aim of this exploratory case study is to describe the practices of biology high school teacher who has been able to create a classroom environment where her English learners not only thrive academically but contribute to the development of a learning community in her classroom, in the school, and in the surrounding community. This article showcases the teacher's knowledge, understanding, and practice of critical pedagogy. The researchers were able to identify four Critical Pedagogy Sessions. Each Session illustrated different activities or units of instruction and reflected one or two of the holistic-student components: a) identity/personal growth, b) academic/cognition, and c) critical understanding of society, power, inequality, and change.

S6.11.8 From Tri-Cultural Conflict to Tri-Cultural Connection: How Successful Urban Science Educators Become Culturally Connected

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ABSTRACT: Urban districts suffer from a severe shortage of qualified science teachers. Therefore, many new science teachers will need to take positions in urban schools without working with teachers of diverse students. With little or no exposure to urban

communities, prospective teachers will find it difficult to learn how to negotiate the cultural contexts of urban teaching. Consequently, it is essential for science educators to begin to examine the cultural contexts of urban science teaching to understand how to support the personal and professional well being of novice urban science educators. Through, in-depth phenomenological interviews the research documents the experiences, perceptions, and beliefs of successful veteran urban science teachers and how they navigated pathways to successful teaching careers. Results focus on how the cultural levels of teacher socialization (personal, institutional, and societal) shaped their induction into the teaching profession. In addition the analysis of the data suggests that teacher preparation programs need to be reconceptualized to include a specific focus on teacher identity development. This restructuring is key for novice urban teachers to either increase their cultural sensitivity, or align their own cultural belief systems in-order to develop the necessary skill set to become successful veteran science teachers in urban districts.

S6.11.9 A Portrait of Middle Grades Science Teachers' Beliefs about the Inclusion of Student with Learning Disabilities

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Sherry A. Southerland, Florida State University

Penny J. Gilmer, Florida State University

ABSTRACT: Today, general education science teachers have more students with disabilities in their classroom than in previous years due to current legislative policies, with an increase of children ages 3-21 enrolled in public schools receiving special education services (US Department of Education, 2006) and approximately half spending 80 % or more of their school day in general education classroom (US Department of Education, 2005). Taking into consideration the data on the composition of today's classroom, it becomes apparent that most science teachers may not have the beliefs and skills necessary to provide all students with equitable opportunities to learn science, particularly those with disabilities. Often student with disabilities are last to be considered when addressing issues of equity and science literacy (Lynch, 2000). Therefore, schools need science teachers that possess beliefs that are aligned with the reform efforts and are willing to create an equitable and inclusive environment in which all students can learn science. The purpose of this study is to examine the beliefs of middle grades science teachers regarding the inclusion of students with learning disabilities (SWLD) in the general education science classroom and its implication on preservice and inservice teacher education.

S6.11.10 Science as a Tool for Social and Economic Transformation: Exploring African American Students' Experiences in an Early College of Health Science Academy

Julie L. Haun-Frank, The University of North Carolina at Greensboro, jlhaunfr@uncg.edu

ABSTRACT: This paper investigates the science experiences of African American students who are members of an Early College of Health Sciences career academy. Drawing upon ethnographic data collected through participant observation and interviews, I discuss the ways in which students appropriated science in pursuit of their career goals. Students envisioned a career in health sciences as a way to contribute to society in ways that improved their lives and the lives of others. Findings suggest, however, that the career academy context constrained agency and development of identity for some students. Still, the data did reveal how the career academy context may provide small possibilities for the support/development of student agency.

S6.11.11 'Strangers in a Strange Land': Bridging the Gap between Preservice Early Childhood Teachers'

Valarie L. Akerson, Indiana University, vakerson@indiana.edu

Cary A. Buzzelli, Indiana University

Jennifer L. Eastwood

ABSTRACT: This study explored changes in preservice teachers' perceptions of the cultural values scientists hold after participating in interventions in science methods and foundations of early childhood education courses. The interventions were parallel assignments in each course and included a Cultural Heritage and Experiences Notebook to enable them to reflect on their own cultural experiences and influences, and a Culture of a Scientist Notebook that allowed them to reflect on scientists in the media, interview a practicing scientist, and the influence of culture on scientists. Data sources included the Schwartz Values Inventory used to measure preservice teachers' cultural values and those they believed scientists hold. Copies of student word allowed us to track the development of preservice teachers' perceptions of scientists. Analysis showed that post instruction preservice teachers perceived fewer differences in cultural values they held vs. those they believed scientists held. They still perceived scientists holding stimulation more highly than did they, and themselves valuing hedonism more than did scientists. It is evident from their Culture of a Scientists similar to themselves culturally they may teach more science.

Strand 12: Educational Technology

S6.12 Poster Session 10:30am – 11:45am, Conference Room 412

S6.12.1 Tracing the Development of Crystal Island: Uncharted Discovery: An Intelligent Game-based Learning Environment

James Minogue, North Carolina State University Bradford Mott, North Carolina State University

John Nietfeld, North Carolina State University Hiller Spires, North Carolina State University James Lester, North Carolina State University Marc Russo, North Carolina State University

ABSTRACT: This session will be to a deliberate demonstration of how the central features of design based research can be leveraged to build a comprehensive and usable description of the learning ecology of intelligent game-based environments. We will outline our view of the anticipated learning pathways and processes, describe the cultivation of our ongoing relationship with local practitioners, and explain how "the intelligence of the study" is being generated and communicated. Drawing primarily from the results of Year 1 efforts of a project funded by a four year National Science Foundation Grant, the presentation will share the results a focus group study with students, a focus group study with a Lead Teacher Cadre (LTC), an analysis of the targeted 5th grade science curriculum, and the design the Crystal Island setting and gameplay. Emphasis will be placed on the development and incorporation of in-game supportive cognitive tools including self-monitoring tools, virtual science notebooks, experimentation hints, presentation of just-in-time domain specific background information, and planning tools.

S6.12.2 The Effect of Computerized Peer Assessment on Scientific Writing Achievement of Secondary School Peer Assessors

Cees Terlouw, Saxion University, The Netherlands, c.terlouw@saxion.nl

Floris B. Bos, University of Twente, The Netherlands

Albert Pilot, University Utrecht, The Netherlands

ABSTRACT: To develop scientific writing requires regular practice of upper level secondary school, pre-university students in which feedback and an opportunity for reflection is given. Because time is lacking students rarely receive systematic or formal training in writing scientific texts in this way. An instructional design model, derived from a practice-oriented instructional learning theory, was applied to design an instructional arrangement in which the learning of the application of scientific writing standards and guidelines was learned for writing a scientific paper about chemical experiments. Computerized peer assessment was used to relieve the teacher's task concerning 'feed back' and 'reflection' in the process of practice. An experiment in a pretest-posttest control group design with 26 upper level secondary school pre-university students revealed that the application of computerized peer assessment for feedback and reflection in the experimental group resulted in a very significant increase of the scientific writing achievement score of the peer assessors. The learning gain for the experimental group was also very significantly higher than the control group. The application of computer assisted peer assessment is besides effective for student learning also efficient for the teacher, because it decreases the time load of science teachers.

S6.12.3 Developing Ecological Stewardship in Elementary School through Student Participation in Virtual Worlds

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

ABSTRACT: In recent years, researchers and classroom teachers have started to explore purposefully designed computer/video games in supporting student learning. This interest in video and computer games has arisen in part, because preliminary research on educational video and computer games indicates that leveraging this technology has the potential to improve student motivation, interest, and engagement in learning through the use of a familiar medium (Gee, 2005; Mayo, 2009; Squire, 2005; Shaffer, 2006). While most of this early research has focused on the impact of games on academic and social outcomes, relatively few studies have been conducted exploring the influence of games on civic engagement and ecological stewardship (Lenhart et al, 2008). This proposal will specifically look at how Quest Atlantis, a game designed for learning, can potentially be utilized to facilitate the development of ecological stewardship among its players/students, thereby contributing to a more informed, ecologically sound citizenry.

S6.12.4 SURGE: Integrating Tacit and Formal Understanding of Mechanics in a Digital Game

Douglas B. Clark, Vanderbilt University, doug.clark@vanderbilt.edu Brian C. Nelson, Arizona State University Cynthia M. DAngelo, Arizona State University Kent Slack, Arizona State University Mario M. Martinez-Garza, Vanderbilt University

Muhsin Menekse, Arizona State University

ABSTRACT: School science, with its focus on explicit formalized knowledge structures, seldom connects with students' tacit intuitive understandings. Commercial video games, however, are exceptionally successful at helping learners build accurate intuitive understandings of the concepts embedded in them due to the situated and enacted nature of good game design (Gee, 2003, 2004, 2007). In Thought and Language, Vygotsky (1986) discusses the potential for leveraging intuitive understandings from everyday experience ("spontaneous concepts") with "instructed" scientific concepts to build robust understandings. The question remains whether or not the intuitive spontaneous concepts developed in games can be successfully leveraged into robust instructed concepts in a manner that transfers to academic assessments and across domains recognized as central by the scientific disciplines themselves. This poster presents data from early studies with the SURGE video game, where students demonstrated significant (p = .037) across multiple items of posttest based on the Force Concept Inventory, suggesting that the sequence and structure of the models and representations designed in the SURGE game are effective in changing how students think about the formal instructed concepts, but care must be taken to ensure that the ideas that students take away from the game are the ones intended by the designers.

S6.12.5 A System for High-throughput Capture of Assessment Data from Pilot Tests

Francis Molina, AAAS - Project 2061, fmolina@aaas.org George E. DeBoer, AAAS - Project 2061 Cari F. Herrmann-Abell, AAAS - Project 2061 Brian Sweeney, AAAS - Project 2061

ABSTRACT: To help address the need for assessments that target specific learning goals, we are developing a collection of highquality middle- and high-school science and mathematics assessments. We have developed a suite of web applications that lets us pilot test the items we develop; analyze the items using criteria such as content alignment, confounding factors, and cost effectiveness; modify the items based on the results of the pilot tests; field test the items; and generate summaries. These activities will culminate in the development of a Web site that will allow educators to assemble items based on the learning goals for which they would like to assess their students' understanding. In this paper, we describe a "websourcing" strategy to achieve high-throughput capture of assessment data from pilot tests as a stage of our general workflow. We used Amazon Mechanical Turk, a marketplace for work that requires human intelligence, to achieve rapid transcription of pilot test data. This strategy proved to be highly efficient, both in terms of achieving fast turnaround times and lower costs. We expect to continue using this system in the future and hope that researchers involved in implementing wide-scale pilot testing of assessments would benefit from this approach.

S6.12.6 Evaluating the Potential Effects of Scaffolding Features on Student Learning of Science

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Namsoo Shin, University of Michigan

LeeAnn M. Sutherland, University of Michigan

ABSTRACT: Project-based inquiry science provides opportunities for students to explore and make sense of scientific phenomena; however, learning in authentic settings is highly complex. Many tasks common in project-based inquiry, such as synthesizing information and communicating understanding, involve barriers for students with learning disabilities. To support diverse students in completing such tasks, we applied Universal Design for Learning (UDL) principles to a web-based, digital version of one unit in the Investigating and Questioning our World through Science and Technology (IQWST) curriculum. In particular, we developed interactive, multimedia scaffolding features to support students as they read text and construct responses to sense-making questions in the reading materials. This proposal describes the research design and the results, including examples of students' perceived use (stated in feedback during interviews) and actual use (screen recording) of scaffolding features as they completed a task using the digital version of a 6th grade chemistry unit. We interviewed 13 African-American students enrolled in summer school regarding their perceptions of the potential of the scaffolding features to support their learning of science. This intensive qualitative study provided rich data for the development of design guidelines for electronic materials that maximize students' use of scaffolding features as they learn science.

S6.12.7 A Study of Achievement, Attitudes, and Motivation in a First-Year High School Chemistry Classroom Using an Audience Response System

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ABSTRACT: This study focuses on the effects an audience response system (clickers) had on achievement, attitude, and motivation in a first-year high school chemistry classroom when used in a social constructivist manor. The clickers were used over a period of nine and a half weeks. Pre-assessment data and assessment data collected during the study were analyzed for significant differences. The test group (two classes) was directed to discuss the displayed clicker results in small, seat groups before having a whole class discussion. The control group (one class) discussed the displayed results as a whole without getting to discuss the results in small groups first. This study did not realize a gain in achievement on tests and quizzes. Survey responses did not show an improvement in students' attitudes towards chemistry but did reveal that the students felt the clickers were an effective teaching tool. Survey and engagement data showed that clickers increased student engagement. Additional uses of clickers need to be studied as well as the role other pedagogies have on the effective use of clickers.

S6.12.8 Racing into the 21st Century: Usability Testing Results from a Serious Educational Game

Leonard A. Annetta, North Carolina State University, len_annetta@ncsu.edu

Marta Klesath, North Carolina State University

ABSTRACT: The benefits of video games include the ability to adapt to the pace of the user, provide immediate feedback, constructive learning environment, and to motivate the learner. 4H Fast track was designed to teach middle school students basic physics knowledge on Newton's Laws of Motion by using a truck racing game with various gear and tire settings. Total ninety-six 9th to 11th grades students were participated in the study. A pre-test/post-test method was used to test the learning potential of the game. User feedback was collected on seven elements of the game using Likert scale questions. The results show that there was no statistically significant differences (n=94, t=0.144, p=0.886) between the pre- and post-scores in answering the five physics questions. Several significant findings on the levels of student engagement when playing an educational game and how they learned from the experience will be reported.

S6.12.9 Embedding Assessment in Serious Educational Games: Impacting the Hawthorne Effect

Shawn Y. Holmes, North Carolina State University

ABSTRACT: This study investigated embedding assessment into a game platform. This assessment technique was employed to alleviate the Hawthorne Effect (the effect of participant responses because they know they are part of a study). Qualitative analyses were used to ascertain themes from open-ended responses to post game experience questions. Findings suggest interactive and immersive qualities of the simulation effected participant responses.

S6.12.10 Assessing Post Serious Educational Game Attitudes through Naturalistic Inquiry

Meng-Tzu Cheng, National Chaio Tung University

Elizabeth Folta, North Carolina State University

ABSTRACT: The purpose of this study was to examine the effectiveness of a racing game that was created for introducing the concept of force and friction to middle school students, especially focusing on investigating students' experiences and opinions of using this racing game. Naturalistic inquiry was employed and a total of 95 students graded 10-11 participated in the study. During their playing, students were invited to provide comments, suggestions, fixes, and recommendations regarding the racing game. Semi-structured interviews were conducted to ascertain post game qualitative follow-up.

Strand 13: History, Philosophy, and Sociology of Science

S6.13 Poster Session

10:30am - 11:45am, Conference Room 413

S6.13.1 The Influence of Argumentation on Students' Understandings of Nature of Science

Rola F. Khishfe, American University of Beirut, rkhishf@luc.edu

Saouma BouJaoude Shannon Palouci

Todd Medintz

ABSTRACT: The purpose of the study was to investigate the influence of argumentation instruction on the NOS understandings when dealing with a socioscientific issue. Participants were a total of 48 eighth grade students in a public school in the Midwest. Two eighth grade intact classes were randomly assigned to the (a) Treatment: NOS and argumentation instruction, and (b) Comparison: NOS with no argumentation instruction. The treatment lasted for eight weeks and involved a unit from SEPUP Issues Evidence and You (IEY) about the water usage and safety. Participants were pre- and post-tested using scenarios that target controversial socioscientific issues to assess their understandings about NOS and argumentation. One scenario was related to the treatment (familiar) and the second was not related to the treatment (unfamiliar). The percentage of participants with informed views about NOS and those with valid arguments were compared between and across the treatment groups. Results showed a general improvement in participants' views of NOS for both groups. However, the differences between the treatment and comparison groups for argumentation did not follow any pattern for the familiar and unfamiliar issues. The implications for the teaching and learning about NOS and argumentation are discussed

S6.13.2 Examining Professional Scientists' Epistemological Views of Science

Elizabeth H. Redman, University of California, Los Angeles, elizabeth.redman@gmail.com

William Sandoval, University of California, Los Angeles

ABSTRACT: While assessing and advancing students' understanding of the nature of science and scientific knowledge has been a priority in science education for years, little is known about professional scientists' views of scientific knowledge. Understanding more about professional scientists' epistemological views of science is important because it has implications for science education. This study explored professional scientists' epistemological views of science, investigating whether scientists' views were actually $\hat{a}\in \infty$ ophisticated $\hat{a}\in -$ and $\hat{a}\in \infty$ observe, $\hat{a}\in -$ as has often been assumed. Sixteen practicing scientists were interviewed to elicit their beliefs about the goals of science, the types of questions scientists hold epistemologically sophisticated views of science. The question of cohesion of views, however, was more complicated, with scientists generally not evidencing the sort of cohesion of ideas assumed by the interview. This study also utilized the responses collected from the participating scientists in order to expand the field's understanding of what epistemological beliefs held by those doing science look like.

S6.13.3 Facilitating Students' Conceptual Understanding of Stoichiometry

Mansoor Niaz, Universidad de Oriente, Venezuela

Luis Montes, Escuela Tecnica de Pesca, Venezuela

ABSTRACT: Facilitating Students' Conceptual Understanding of Stoichiometry Objectives of this study are: a) Develop a theoretical framework based on epistemology, history and philosophy of science (HPS); b) Facilitate high school (grade 10) students' understanding of stoichiometry. Study is based on two intact sections of high school students (10 grade, 15-16 year old). Control group instructor used the traditional strategy in which laws of definite and multiple proportions are defined as definitive, irrefutable

and applied in the classroom as algorithms. Experimental group instructor used a dialectic constructivist strategy based on the presentation of hypothetical experimental data leading to cognitive conflicts and a critical confrontation of different propositions. Both groups of students were tested on a 6 item test of stoichiometry (1-2 algorithmic and 3-6 conceptual items), after the topic had been taught. Experimental group performed better than the control group, not only on algorithmic items but also items requiring conceptual understanding. Differences in student performance on Items 1, 3, 4 and 5 were statistically significant. HPS perspective developed in this study leads to a critical evaluation of the laws of definite and multiple proportions and their role in chemistry education. Emphasizing these laws as irrefutable, inevitably leads to the use of algorithms and formulae in learning stoichiometry.

S6.13.4 Exploring Ideas of Representation by Epistemological Language and Scientific Meta-Language in Hybrid Adapted Primary Literature

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

ABSTRACT: Given the growing attention to scientific language and text, this poster explores the possible value that language may have for students from the perspective of what that language represents. The focus is epistemological language and metalanguage as semantic representations of the practices of science and the culture of science respectively. In parallel this poster explores an example of a form of text that explicitly integrates both type of language. The responses of a class of Grade 6 students is examined to illustrate ways in which students are engaging and not engaging with the representational meanings embedded through epistemological language.

S6.13.5 Searching for Representations of Nature of Science in Middle and High School Textbooks Adopted in a Large Urban Public School District in Western United States

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Cynthia L. Kern, University of Nevada Las Vegas

Thomas J. Bussey, University of Nevada Las Vegas

Kristoffer R. Carroll

ABSTRACT: This study aimed to examine representations of nature of science in middle and high school science textbooks adopted in a large urban public school district in Western United States. In general, the analyzed textbooks represented informed NOS views more than anticipated. The textbooks altogether contained almost equal number of explicit, implicit, and mixed NOS representations. Compared to partially informed and uninformed NOS representations, number of informed NOS representations was significantly higher. However, nature of science was not a central or major theme in any of these textbooks. None of the textbooks addressed all 10 NOS aspects in an informed way.

S6.13.6 Teaching the Conceptual History of Physics to Teachers

Charles Winrich, Boston University, cwinrich@bu.edu Peter Garik, Boston University Deb Nolan, School of Education, Boston University Arthur Eisenkraft, University of Massachusetts Boston Andrew Duffy, Boston University Manher Jariwala, Boston University Luciana Garabayo, Boston University Nicholas Gross, Boston University

ABSTRACT: The School of Education and the Department of Physics at an urban university offer interdisciplinary courses for high school physics teachers. The courses combine physics content, the conceptual history of physics (CHOP), and readings from the physics education research literature. In order to combine the CHOP with the physics content, epistemic game theory is used to design exercises. Each historical model of physics represents a constrained system that can be compared and contrasted with later models in the development of physics. We report on the impact of the CHOP on teachers' understanding of the nature of science, their use of it in their classrooms, and their use of it to understand their own students. The participating teachers generally have a good working knowledge of CHOP that informs their understanding of physics and the nature of science. The teachers report infrequently having time to explicitly teach CHOP in their classes. However, they value CHOP as a teaching tool. Examples of how the participating teachers found CHOP was useful include: providing a way of humanizing science content that was interesting to the students, providing a framework for teaching science content, and providing a way of understanding and addressing student misconceptions about physics.

S6.13.7 Presentation of Atomic Structure in Turkish General Chemistry Textbooks

Bayram Costu, Karadeniz Technical University, Turkey, bayramcostu@gmail.com

Mansoor Niaz, Universidad de Oriente, Venezuela

ABSTRACT: Presentation of Atomic Structure in Turkish General Chemistry Textbooks Objective of this study is to evaluate general chemistry textbooks published in Turkey based on eight criteria developed in previous research. Criteria used referred to the atomic models of Thomson, Rutherford and Bohr and 21 textbooks (published between,1964-2006) were analyzed. Results obtained showed that none of the textbooks explained satisfactorily: a) Thomson's experiments on cathode rays were conducted to clarify the

controversy with respect to the nature of cathode rays, that is charged particles or waves in the ether; b) Rivalry between Rutherford's hypothesis of single scattering based on a single encounter and Thomson's hypothesis of compound scattering led to a bitter dispute; c) Bohr had not even heard of the Balmer and Paschen formulae for hydrogen spectrum, when he wrote the first version of his article; d) Bohr's model was based on an inconsistent foundation in which he 'grafted' Planck's 'quantum of action' on to Maxwell's electrodynamics. Some textbooks explained satisfactorily: a) Rutherford's model of the atom had to compete with that of Thomson; b) Bohr's main objective was to explain the paradoxical stability of the Rutherford model. It is concluded that inclusion of historical reconstructions can provide students with a better appreciation of the dynamics of scientific progress.

S6.13.8 Secondary School Students' Conceptions of Theories and Evidence: The Development and Implementation of a Qualitative Instrument for Assessment

Andri Christodoulou, King's College, London, andri.christodoulou@kcl.ac.uk Jonathan F. Osborne, Stanford University Christina Howell-Richardson, King's College, London Katherine Richardson, Institute of Education Shirley Simon, Institute of Education

ABSTRACT: This paper aims to present the design and implementation of a qualitative instrument specifically created to evaluate secondary school students' conceptions of theories and evidence and students' ability to coordinate theories and evidence. Recent developments in science education stress the importance of students developing informed views on the nature of science. One of the aspects of the nature of scientific knowledge that students should develop an understanding of is the nature and role of scientific theories and evidence. Yet, secondary school students' conceptions of the nature and role of scientific theories are not in agreement with the accepted by the scientific community view of scientific theories as explanatory models of natural phenomena. A literature review of instruments used to assess nature of science conceptions was conducted to inform the design of the new instrument. An interview schedule, which includes both out-of-context and context-specific questions was created and piloted. The implementation of the new interview schedule elicited students' perceptions of scientific theories as abstract ideas, predictions and hypotheses tested to become facts. Students were found to hold a strong commitment to proof as the way to establish scientific facts, whose creation was considered as the overall objective of the scientific enterprise.

S6.13.9 The Impact of a U.S-Chinese Collaboration in Chemistry and Chemical Engineering: Scientists' Views of Collaboration and Science as a Global Enterprise

Anne S. Wrigley Collins, University of California, Santa Barbara, awrigley@education.ucsb.edu

ABSTRACT: In recent years, international collaborative efforts among scientists have grown in number and scope. I investigated ten graduate students' and two faculties' experiences in one such partnership to gain a qualitative understanding of their views of science and scientific practice as a result of participating in a US-China program in the fields of electron chemistry and catalysis. Faculty participants identified seven categories for opportunities afforded to graduate students who collaborate. Among those seven categories, graduate students referenced access to expertise, networking opportunities, and access to equipment as major considerations when choosing to collaborate in science and, in particular, study abroad as part of the program described here. Development of collaborative skills, funding opportunities, increased efficiency, and cultural experiences via research were also discussed. In terms of science as a global enterprise, graduate student participants articulated detailed observations about the "universal language" of and in science worldwide as well as the social structure among scientists in the US and China. Not only do findings inform future international collaborations motivating graduate student scientists, research offers insight into the ways in which ideas about the nature of science are taken up in schools and carried into scientific practice.

S6.13.10 Using Popper's 3-Worlds to Situate Metascientific (NOS) Knowledge

Jesse T. Bazzul, University of Toronto, jessebazzul@hotmail.com

John L. Bencze, University of Toronto

ABSTRACT: In light of an increased focus on NOS in school science curricula it follows that the contributions of those who produce NOS knowledge (MetaScientists) be given greater value by those who indeed need to facilitate the inculcation of such knowledge. Recent Studies have shown the benefits of involving the history, philosophy, and sociology of science in order to improve student understanding and motivation in science. However studies also show that many science teachers hold 'immature' views on the nature of science and experience difficulty in developing NOS pedagogy and teaching materials. Furthermore a teacher's understanding and ability to include NOS in her pedagogy requires metascientist knowledge as well as the scientific knowledge products of scientists. A modified version of Popper's three worlds of knowledge is developed here in order to help teachers begin/continue to conceptualize how the knowledge produced by metascientists about science interfaces with the way scientific knowledge is produced and accumulated. A distinction of the boundaries of scientific knowledge production and how metascientists inform that practice is also considered. The model is primarily intended to stimulate questions about the nature of scientific knowledge and its relation to metascientific knowledge.

S6.14 Strand 14: Environmental Education

Poster Session 10:30am – 11:45am, Conference Room 414

S6.14.1 Assessing Extended Outdoor Experiences using FiNE Model for Learning in Nature

Tali Tal, rtal@technion.ac.il

Orly Morag

ABSTRACT: We used the Field trip in Natural Environments (FiNE) Model that we developed in a previous study of daily field trip in natural environments to evaluate extended outdoor programs of fourth-sixth graders that were enacted by an environmental organization in nature parks located in the schools' region. The model's circles and components address the field-trip's planning, pedagogy, activity and outcomes. In addition to observations and in-depth interviews that we used in the study in which we developed the model, we developed student questionnaire that allowed collecting data from four programs and will allow employment in other settings as well. Our findings show ambiguity regarding goals, limited connection to the school curriculum and to the students' everyday life, alignment of activities to the environment and considerable amount of physical and learning activity. At the end of the program, the students' knowledge was fair and their beliefs and attitudes were strongly pro- environmental. The most enjoyable aspects of the program were being free in nature and being and doing things with friends. Overall, we argue that the FiNE Model adds a consistent instrument that allows assessing, measuring and comparing various aspects of the field trip to the outdoors.

S6.14.2 Building Elementary Teachers' Background Knowledge and Confidence Enriches Environmental Curriculum and Enhances Teaching and Learning

Penny J. Gilmer, Florida State University, gilmer@chem.fsu.edu Dawn Pack, Destin Elementary School

Cindy Phillips, Port St. Joe Elementary School

ABSTRACT: We conducted a follow-up on 89 K-12 teachers who were part of a scientific research experience in rural counties. We analyzed a) two of the elementary teachers' reflective writing during the two courses, and b) an on-line questionnaire to all participants on the vertical teaming that we utilized during the scientific research. We visited the two teachers in their schools with their students after one year of teaching following the scientific research. Our theoretical frameworks included cultural-historical activity theory and the theory of structure x agency, to guide our study and to use to analyze the reflective and observational data. The two elementary school teachers built self-confidence in learning to teach science through participating in two graduate courses, culminating in scientific research in rural facilities near their schools. With enhanced self-confidence, the elementary school teachers expanded their expertise in science beyond the research experiences. They had the power to act to develop and teach a new curriculum with an environmental focus on studying local natural bodies of water over the school year. Their students looked for patterns in their data over time, and tried to understand the reasons that turbidity, pH, and salt levels would change during the school year.

S6.14.3 Validating a Learning Environment Instrument for use in Diverse Settings

David B. Zandvliet, Simon Fraser University, dbz@sfu.ca

Carlos G. Ormond, Simon Fraser University

Rekha B. Koul, Curtin University of Technology

Souraya Mansour, Royal Roads University

ABSTRACT: This paper discusses the validation of a learning environment instrument, the Place-Based Learning And Constructivist Environment Survey (PLACES) for use in environmental education programs. Learning environment studies have acknowledged that learning takes place within the social realm and that social conditions contribute to both the quality of learning and experience. In order to access information about students' perceptions of place-based learning environments, a robust instrument for measuring student perceptions was developed and piloted in a variety of international contexts. The questionnaire was piloted in six countries (Australia, Canada, India, Lebanon, Mauritius and Taiwan). In all six of these countries, students noted a closer fit between their actual and preferred environments and often rated these settings more positively on all scales measured. This result also acknowledges the cultural sensitivity of the PLACES questionnaire. Validity and reliability data for the instrument from diverse settings is presented along with the possible implications of this data for future research in place-based environmental education settings, and potentially offers new models for participatory action research by environmental educators.

S6.14.4 Students Acting on Socioscientific Issues: Motivation from Their Science Inquiries

John L. Bencze, OISE, University of Toronto, larry.bencze@utoronto.ca

Margaret Bent, University of Toronto

Erin Sperling, University of Toronto

Steve J. Alsop, York University

ABSTRACT: We are facing many challenges associated with fields of science and technology. Arguably of most concern is Climate Change, but there are many other issues, such as food quality, distribution and safety. Many of these problems may be related to individuals' tendencies towards repeating cycles of consumption of for-profit goods and services. Progress has been made in addressing such issues by, for example, encouraging students to consider complex socioscientific issues, take positions about them,

and develop plans of action to address them. In the study reported here, though, we concluded — based on constant comparative analyses of qualitative data — that students' tendencies towards socio-political activism may be enhanced by findings from their self-directed science inquiries that indicate possible socioscientific problems.

S6.14.5 The Effect of Facilitator on Environmental Knowledge Construction of Learners in Field-Based Collaborative Inquiry

Cihan Cihangir, Giresun University, cgulin@metu.edu.tr Ozgul Yilmaz-Tuzun, Middle East Technical University

ABSTRACT: The purpose of the study was to find out the effect of facilitator on pre-service science teachers' (PSTs) environmental knowledge constructions. For investigation of environmental knowledge construction of PSTs, a course including five learning tasks designed according to field-based collaborative inquiry was prepared. A total of 20 PSTs participated in this study. To understand the environmental knowledge construction patterns of PSTs in-depth analyses were conducted on the PSTs' discourses during small group interaction by using an analytic tool developed by Kaartinen and Kumpulainen (2002). The results of the study revealed that PSTs' perceived environmental knowledge was derived from their daily life experiences so they asserted arguments mostly supported by everyday explanations which were found to be connected with using everyday knowledge. Due to this reason in the field, they could not integrate scientific knowledge gained through biology, physics, and chemistry courses to environmental issues and could not get right support from facilitator. Thus, lack of necessary conceptualization of environmental knowledge resulted in ill-structured scientific investigations. After science knowledge support provided by facilitators during in discussion, PSTs started to conceptualize environmental issue by integrating science knowledge.

S6.14.6 Outdoor Education Centres and Place-Based Education: Paradigms and Possibilities

Gabriel R. Ayyavoo, OISE/University of Toronto, Gabriel.ayyavoo@utoronto.ca

Erminia G. Pedretti, University of Toronto

ABSTRACT: This paper focuses on outdoor education within the context of the outdoor education centre (OEC) and the possibilities for enhancing environmental education, at both rural and urban centres. We use a place-based education as the main framework to guide our study. In particular, we examined OEC educator's philosophical orientations to OECs and their use of outdoor education centres. In this study, we surveyed over 300 teachers and OEC staff across Ontario, Canada. Interviews were conducted with 12 respondents who completed the survey and volunteered to be interviewed. Our findings suggest that OECs' purposes reflect predominantly the algorithmic, moral and ecological paradigms. Less common, is the view of an OEC as a place of transformative learning or agency, although participants noted that OECs can help to strengthen visitors' understanding of their environment and interactions with social issues. Keywords: Outdoor Education Centre, Environmental Education, Place-based Education, Algorithmic, Moral and Ecological paradigms.

S6.14.7 Teaching Identity in Environmental Education: The Pedagogic Roles Assumed by Environmental Educators And Their Impact On Teaching Practice

Patrick F. Dowd, University of California at Davis, pfdowd@ucdavis.edu

ABSTRACT: This paper considered the impact environmental educators' teaching identities had on their pedagogical practice. Identity theory links who people are with what they do. As such it is a valuable theoretical framework for understanding the complex relationship between an environmental educator's sense of self and her pedagogical practice. Data presented here are selected from a primarily qualitative study that explores the identity of 23 environmental educators from two continents. The research questions addressed how environmental educators' teaching identities, as formed through beliefs, knowledge, goals and significant experiences, influenced their pedagogical choices such as those within the interpretation and application of curriculum in the outdoor context. Data sources include: field notes, interviews and a questionnaire. What emerged was a picture of environmental educators making pedagogic decisions that were influenced by their teaching identities such as those expressed through the use of teleological and anthropomorphic reasoning in their teaching. The findings of this research can help in the development of more effective forms of teacher professional development through a better understanding of the aims and goals of environmental education as enacted in the field.

S6.14.8 The Development of a Place-Based Learning Environment

Carlos G. Ormond, cormond@sfu.ca David B. Zandvliet Susan Teed Laura Piersol

ABSTRACT: This paper describes and documents one elementary school's experiences in achieving their environmental literacy goals, through the development of a place-based learning environment over a period of four years. In September 2008 a two-year descriptive study began at a Canadian elementary school (CES) to support and encourage environmental education in addition to helping the school realize its broad environmental learning goals. This environmental education program is part of a larger science literacy education project funded by the Natural Science and Engineering Research Council of Canada (NSERC). Following a participatory observer research model, Year 1 of this project is recounted from the eyes, ears and experiences of the researchers involved. After the first year there is already visible and documented evidence for the development of a supportive and positive place-

based learning environment at a CES. Instead, the programs described in this paper provide us with insights for the development of environmental programming -- they enable us to track ourselves deeper into relation with the wonder of the local.

S6.14.9 Muddying the Waters: Promoting Environmental Education through Practice-Theory

Erminia G. Pedretti, OISE, University of Toronto, Erminia G. Pedretti

Katherine Bellomo, University of Toronto

ABSTRACT: This study, part of a larger project, focused on identifyingteachers' challenges in developing and implementing curriculum that supports environmental education. We present a case study of a Professional Learning Community(PLC), set in the context of elementary school teaching in a large districts chool board, implementing a new science and technology curriculum with anenvironmental education focus. We used Sauve's (2005) framework for environmental education to guide ourwork in our PLC and to analyze data. Participants felt supported and inspired in developing and implementing their curricula, yet most remained resistant to a more "political" or action/advocacy oriented agenda in their classrooms.

S6.14.10 A Climate Change Course for College Students

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Emi Ito, University of Minnesota

ABSTRACT: For the past 10 years, a climate change course for undergraduate students has been offered in a large Midwest university. This course has been focusing on improving college students' science information literacy of climate change using historical evidence of climate change and human interactions. This study evaluates the course's impact on college students' learning about scientific knowledge of climate change and human interaction based on students' responses on several questionnaires, interviews data collected through the academic year of 2009. Hierarchical Linear Modeling (HLM) and qualitative research method were used. Results show that even if individual students had a different level of background knowledge of climate change and human interactions before the course, their content knowledge had been improved through the course. The students agreed that the course positively affected their information literacy in science (climate change). However, they neither disagreed nor agreed that they learned science knowledge relevant to their everyday lives and current socioeconomic issues related to climate change. They also thought that their environmental behavior did not change much as a result of the course. This study shows that correlation between environmental knowledge and behavior is not fully compelling and probably does not offer lasting environmental stewardship.

S6.14.11 Seventh Graders' Concepts and Ways of Reasoning about the Impact of Global Warming on Tornadoes and Hurricanes

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Daniel P. Shepardson, Purdue University

ABSTRACT: This study investigated how students constructed an understanding of climate change based on their interpretation of scientific data and information. Particularly, this study explored how students' prior concepts and their ways of reasoning interplayed with each other to develop their understanding about climate change. We developed two vignettes presenting scientific debates about the impacts of global warming on tornadoes and hurricanes. Ten seventh grade students participated in the vignette-based tasks in which they verbalized their concepts and reasoning through a think-aloud protocol and individual interview. Patterns in the relationship between students' concepts and their ways of reasoning and its influence on students' conceptual development were identified. Implications to curriculum development and instructional design for climate change education are articulated.

Strand 15: Policy S6.15 Poster Session 10:30am – 11:45am, Conference Room 415

S6.15.1 Engaging STEM Faculty in K–20 Reforms—Implications for University Policies and Practices

Joseph McInerney, Westat, JosephMcInerney@westat.com

Xiaodong Zhang, Westat

ABSTRACT: The presentation looks at policies and strategies that can be used to promote partnerships involving university science, technology, engineering, and mathematics (STEM) faculty and K–12 teachers as well as the nature of such collaboration. The findings suggest while university tenure and promotion structures and faculty perceptions were considered major barriers for faculty involvement in Math and Science Partnership (MSP)-like endeavors, MSP projects employed a number of effective practices to support faculty involvement. Extrinsic incentives such as providing stipend and release time were universally used, whereas the need for intrinsic incentives–especially the intellectual benefits of such involvement to STEM faculty– were sometimes underestimated. Changing tenure and promotion policies is a slow process. We found small steps made toward either elevating the status of outreach/service directly or redefining MSP activities in terms of research or teaching.

S6.15.2 An Analysis of Science Achievement in Wisconsin's Urban Charter Schools

Matthew E. Vick, University of Wisconsin-Whitewater, vickm@uww.edu

ABSTRACT: The charter school movement focuses on the creation of public schools governed by a legally-binding agreement known as a charter. Charter schools are touted as allowing for innovation and creativity in exchange for increased accountability. The state of Wisconsin permits school districts to authorize charter schools statewide. In Milwaukee and Kenosha, other bodies are also permitted to authorize charter schools. This study analyzes the differences in student achievement in three types of schools in urban districts: district charter schools, non-district charter schools, and traditional district schools. Test results from the Wisconsin Knowledge and Concepts Exam are used to analyze school level performance on the science standards performance indices. MANCOVA testswere used to perform the analysis with the percentage of student eligible for free or reduced lunch and the percentage of students who were non-white as covariates. District charter schools showed higher achievement scores than traditional district schools at lower grades but not in higher grades. Non-district charter schools showed the opposite trend. These trends inform discussions around chartering authority and whether it should be primarily given to school districts.

S6.15.3 From the Trenches: Understanding the Impact of Policy on Science Education in Rural Schools in the Black Belt Region of Georgia from the Teachers' Perspective

Georgia W. Hodges, UGA, georgia.hodges@gmail.com

ABSTRACT: Staffing schools with qualified teachers receives vast attention from policymakers, researchers and the general public. Multiple reports, including the Glenn Commission on Mathematics and Science Teaching for the 21st century, reports from the National Research Council and the National Academy of Sciences illuminate the shortages specifically in mathematics and science education. Although turnover of science teachers approximates that of other subjects, such as English or social studies, science does not have an overabundance of new teachers to replace those lost, complicating the issue of science teacher retention. This study, situated in the Black Belt region of Georgia, addresses the issues of teacher retention, attrition and the impact of policy on each. Using qualitative methods, including life story interviews, participant observation, interviews, focus groups and document analysis of archival data, researchers illuminated multiple tensions that science teachers in the rural black belt region of Georgia face. Using grounded theory analysis, researchers have constructed a bottom-up, teacher centered perspective, which offers a different view of the daily life of the teacher to understand that often studied problem from a different perspective. This paper discusses the primary tensions as well as the cultural myths that impact teacher retention and attrition.

S6.15.4 Trends in Science Education Research Published in the Journal of Research in Science Teaching: A Longitudinal Policy Perspective

Michael R. Vitale, East Carolina University, vitalem@ecu.edu

Nancy R. Romance, Florida Atlantic University

Frank Crawley, East Carolina University

ABSTRACT: Explored is the relationship of empirical studies in science education to the stated purpose of NARST. Using the the 15 research strands for the NARST Annual Conference as a guide, an analytic framework was developed for determining the degree of relevance of science education research to the NARST purpose. Providing an operational perspective of the ontological structure of NARST, the resulting framework was then used to conduct an informal analysis of the scope of science education research by classifying a sample of empirical studies published in the Journal of Research in Science Teaching from 1965-2008. The results of the analysis (comparing 1965-1985 vs. 1995-2008) showed a decreasing trend in the percentage of studies addressing student achievement in science (61% to 37%), with the percentage of teacher-focused studies increased from 24% to 37% and advocacy studies from 3% to 14%. The findings are discussed in terms of policy implications for science education advocacy and strategies for using interdisciplinary approaches to magnify the focus of science education research on the instructional dynamics for engendering K-12 student science learning outcomes.

S6.15.5 Teachers' Response to Reform: Attitudes and Practice of Inquiry-Oriented Instruction

Jeffrey D. Thomas, Central Connecticut State University, thomasjed@ccsu.edu

Ann Rivet, Teachers College, Columbia University

ABSTRACT: A goal in education has been to improve scientific literacy. To meet this challenge, a State's Department of Education created inquiry-oriented labs for teachers to implement in their classrooms to influence the way science was taught. Yet, the lack of widespread and sustainable implementation of reform remains a problem. A possible explanation might be teacher attitudes toward reform. The purpose of this case study was to explore the attitudes of six teachers toward this reform and the impact these attitudes may have had on the implementation of inquiry-oriented instruction. Semi-structured interviews assessed teacher attitudes toward inquiry-oriented instruction and the way teachers expected they would enact the labs. Then, classroom observations determined whether the labs were implemented as the teachers had intended and as was expected by the State. Finally, semi-structured interviews verified whether teacher attitudes changed during the school year. Initially, it was thought that teacher attitudes would predict the way they would implement the labs. Although these attitudes were one predictor, understanding of the intent of the reform and inquiry-oriented instruction also were found to be possible influences. The results highlight the need for large-scale reforms to consider these factors in order for such a reform to be successful.

International Committee & Membership and Elections Committee Sponsored Session S7.1 Administrative Symposium: Various Strategies in Countries around the World

2:15pm – 3:45pm, Salon Ď

ABSTRACT: There is a considerable gap between what research in science education has to offer practice and what school practice is ready and able to adopt. It seems that so far research and practice both are somewhat closed systems. The international science education research community carries out research according to its own standards. What counts as good research may not be suited to actually improve practice and progress in research may even widen the gap. The practice side has proven somewhat resistant against adopting research findings. In order to improve practice actions are needed, on the one side, to make teachers familiar with research findings and to convince them that research actually has much to offer for their practice. On the other side the science education research community needs to rethink the actual emphasis and to consider whether it is suited to contribute to the improvement of practice. All over the world several attempts have been carried out to make practice familiar with research findings. Various means of actions have been established ranging from books including "what research has to say the science teacher" to interactive forms of cooperation between research and practice. Strategies used in four countries are presented. Individual presentations with corresponding authors are listed below.

S.7.1.1The Myths, the Reality, and the Promise of Linking Research and Practice

Julie Luft, National Science Teacher Association, Director of Research, USA

S.7.1.2 Bridging Research and Teaching Practice: One Step at a Time: A Domain Specific Approach from the UK Phil Scott, University of Leed, UK

S.7.1.3 Making Science Education Research Accessible and Useable in Practice: An Australian Example John Loughran, Monash University, Melbourne, Australia

S.7.1.4 Enhancing Dialogues between Theory and Practice--Learning to Teach Science and Mathematics in a Professional Learning Community

Chorn-Jee, National Science Council, Taipei, Taiwan

Strand 1: Science Learning, Understanding and Conceptual Change S7.2 SC-Paper Set: Knowledge Organization

2:15pm – 3:45pm, Conference Room 401

S7.2.1 Students' Rating of Problem Similarity as a Measure of Problem-Solving Expertise

Frances A. Mateycik, Pennsylvania State University - Altoona, fran_mateycik@yahoo.com

David H. Jonassen, University of Missouri - Columbia

N. Sanjay Rebello, Kansas State University

ABSTRACT: Recognizing the deep structure differences and similarities between problems has been shown to be an essential mark of expertise in problem solving. While novices focus on surface features of a problem, experts have been shown to focus on deep structure. We report on a year-long study with students participating in a treatment to facilitate expert like problem solving. To assess development of student problem solving expertise, students toward the beginning and the end of the treatment were asked to rate the similarities between problem pairs. We report on the results from the similarity ratings of thee students. We will present a comparison of the students before and after the treatment as well as compare the student similarity ratings with those of physics faculty members.

S7.2.2 Students' Conceptions – Coherent or Fragmented? And what Difference Does it Make?

David E. Brown, University of Illinois at Urbana-Champaign, debrown@illinois.edu

ABSTRACT: The coherence vs. pieces debate is often seen as a debate between those viewing students' conceptions as unitary misconceptions and those viewing students' naïve thought as completely incoherent and random. With these choices, it is not hard to see why a prevalent view today is of students' naïve ideas in science as unitary misconceptions, as many robust conceptual difficulties have been identified. However, these are straw-person perspectives that do not accurately represent the views of current coherence or pieces advocates. While there are still points of debate between coherence and pieces advocates, there is also much consensus. Drawing on these points of consensus leads to a powerful view of students' naïve thought as a dynamic conceptual system embedded in and embedding other dynamic systems. Taking this dynamic view leads to important practical implications. As a community we need to continue to debate areas of non-consensus. But we also need to move forward in areas of consensus, drawing on powerful theoretical frameworks for the advancement of both research and practice.

S7.2.3 Thinking Like a Scientist: Using Vee-Maps to Connect Scientific Process with Scientific Concepts

Christine M. Knaggs, University of Toledo, christine.knaggs@utoledo.edu

Rebecca M. Schneider, University of Toledo

ABSTRACT: It is considered important for students to participate in scientific practices to develop a deeper understanding of scientific ideas. Supporting students, however, in knowing and understanding the natural world in connection with generating and evaluating scientific evidence and explanations is not easy. Although tools such as vee-maps can scaffold students' efforts to design investigations, we know less about how these tools support students in connecting scientific ideas with the evidence they are generating or how these connections develop over time. In this study, we explored students' developing ability to reason scientifically by examining the relationship between students' understanding of scientific phenomena and their understanding of how to generate and evaluate evidence for their ideas. Three high school classes completed three investigations. One class used vee- mapping each time, one used vee-mapping once, and one not use vee-mapping. Students' maps and written reports were rated for understanding of relevant science procedural and conceptual ideas and their connection. Quantitative comparisons between groups and over time indicate a positive relationship between improved procedural and conceptual understanding. Findings also indicate that improved procedural understanding for student to connect evidence and explanation for science phenomena.

S7.2.4 Using Knowledge Space Theory to Analyze Concept Maps in an Undergraduate Immunology Course

Laura A. Cathcart, University of Maryland, cathcart@umd.edu Mike Stieff, University of Maryland Gili Marbach-Ad, University of Maryland Ann C. Smith, University of Maryland Kenneth A. Frauwirth, University of Maryland ABSTRACT: This study examines the use of knowledge space

ABSTRACT: This study examines the use of knowledge space theory as a novel method of analyzing concept maps. Concept mapping is a technique for expressing relationships between important ideas, using two-dimensional node-link diagrams to visually display understanding of the ideas and their relationships. We introduced concept mapping as a voluntary exercise in an upper-level undergraduate immunology course. The students were assigned ten concept maps (for which concept lists were provided) at intervals during the semester-long course. Students received extra credit for completion of at least five maps. After the student concept maps were submitted, the instructor provided the students with his "expert" concept map for each lecture topic. We utilized knowledge space theory (Folmagne & Doignon, 1988) to systematically analyze and compare the concept maps drawn by students to their instructor's "expert" concept maps. Using this novel analysis method, we were able to reveal students' level of understanding of course material, as well as alternative conceptions held by the students. We found knowledge space theory to be a productive method for systematically analyzing and comparing students' concept maps to expert's concept maps.

Strand 2: Science Learning: Contexts, Characteristics and Interactions S7.3 SC-Paper Set: Language, Identity, and Epistemology Development in Science Learning

2:15pm – 3:45pm, Conference Room 402

S7.3.1 Engaging Underrepresented Students in Science through Authentic Investigation

Xenia S Meyer, Cornell University, xenia.meyer@cornell.edu

Barbara A. Crawford, Cornell University

ABSTRACT: Despite educational reforms, urban schools serving students from underrepresented backgrounds seldom introduce students to the activities of science. Nonetheless, inquiry- based instructional approaches may provide greater science learning opportunities for these students, in particular, by involving them actual scientific practice. This study focuses on an urban middle school classroom serving English language learning (ELL) students from diverse backgrounds and investigates student engagement in science learning through the context of an authentic research project in collaboration with scientists. Classroom implementation of this project includes a curriculum that combines inquiry and explicit instruction in nature of science (NOS), as well as geology oriented content. Video data coding instructional episodes of student engagement in learning make the case for a continuum of student engagement associated with the degree of direct instruction or inquiry in this instructional setting. Students, in turn, demonstrated more informed views of science and more developed content-matter understandings on pre-post measures and in interviews.

S7.3.2 Exploring Science Teaching and Learning with English Language Learners in Urban Settings

Gillian U. Bayne, Lehman College of the City University of New York, gillian.bayne@lehman.cuny.edu

Romil Amin, Lehman College of the City University of New York

ABSTRACT: This multi-method study explores how ELL immigrant science students, who make up over 94% of the student population in a small public international high school that is located in a large urban city, navigate the complexities of new educational and social cultures. The use of critical ethnography and cogenerative dialogues were employed in a coordinated fashion as a means to study and understand challenges related to (a) the acquisition and utilization of the English language in science classrooms, (b) the teaching and learning of science as a cultural process, (c) cultural alignment and misalignment between teachers and students, and amongst students themselves, and (d) the involvement of teachers, students an other stakeholders in improving science experiences for ELL immigrant students.

S7.3.3 Young African American Children's Representations of Self, Science, and School: Making Sense of Difference

Maria Varelas, University of Illinois at Chicago, mvarelas@uic.edu

Justine M. Kane, University of Illinois at Chicago

Caitlin Wylie, University of Cambridge

ABSTRACT: We focused on young, low-income, African American children in 1st, 2nd, and 3rd grade classrooms where their teachers tried to enact for a year interactive, participatory, and dialogic pedagogy in the context of integrated science-literacy instruction. Using 22 students' journals (both text and pictures) that were a central part of teaching and learning science, and conversations around ideas expressed in their journals, we studied the children's ideological becoming relative to the practices of science and schooling, and interplay between their selves and others. We found that following behavioral codes seemed to be an important part of these children's school experience. However, these behavioral codes are in some ways antithetical to the active, inquisitive, questioning, flexible view of science and science learning that the teachers were trying to enact in these classrooms. Understanding how children made sense of, and coordinated, norms of schooling and science, and how they constructed (or not) a place for themselves in science classrooms where enabling pedagogy was attempted, helps us to appreciate the complex relationships that children form among their selves, school, and science, and to develop better ways of helping them see themselves doing science as a "legitimate," useful, and significant activity.

S7.3.4 Grounding Teaching in Naturalistic Descriptions of Teacher and Student Action in the Science Classroom

Karim M. Hamza, Stockholm University, karim.hamza@mnd.su.se

Per-Olof Wickman, Stockholm University

ABSTRACT: Descriptions of students' discursive practices for coping with science learning activities are increasing in number. Likewise, teachers' regular actions for supporting students' learning in science are well described. Here we describe some consequences of introducing students' own ways of coping with an activity for other students' reasoning as they engage in similar activities. We audio recorded conversations between a researcher and eight individual students around a real electrochemical cell. The researcher introduced elements from practical epistemologies described in previous studies. The interventions were consistent with earlier descriptions of teachers' epistemology analysis. Our findings show that actively re-orienting students towards aspects of practical epistemologies generated from students' own idiosyncratic reasoning may have various significant consequences for supporting other students' reasoning. For example, one aspect of previously described practical epistemologies is to make distinctions concerning the constituents of the real electrochemical cell. Such investigations sometimes had the consequence that the student productively included the distinctions made in her subsequent explanation. The results indicate new ways of converting naturalistic descriptions of teacher and student action into tools for supporting students' moment-by-moment learning in the science classroom.

Strand 3: Science Teaching--Primary School (Grades preK-6): Characteristics and Strategies S7.4 SC-Paper Set: Inquiry Learning and Inquiry Teaching: Stories from the Classroom 2:15pm – 3:45pm, Conference Room 403

S7.4.1 Hiring a Science Specialist to Improve Elementary Science Instruction is Just the Beginning: Supporting Schools to Maximize the Impact of Science Specialists

Wendy M. Frazier, George Mason University, wfrazier@gmu.edu

Donna R. Sterling, George Mason University

Amy Bordeaux, George Mason University

ABSTRACT: This study examined the effect of a professional development on elementary teachers' self- efficacy for science teaching, the quality of science instruction in participating teachers' classrooms, elementary teachers' content knowledge, the co-planning and co-teaching practices of science specialists and regular classroom teachers, and elementary student outcomes. Using a quasi-experimental design with matched comparison group measures, 28 elementary teachers in an urban school district were assigned to a treatment or control group. The Science Explorers Project provided treatment teachers with support for two summers and one academic year including science methods instruction in the summers conducted collaboratively by science education and science content faculty, in-class coaching support by a science education faculty member, and instruction during the academic year outside regular school hours emphasizing continued science methods instruction and action research strategies to improve science instruction. Data were collected through surveys, content tests, interviews, observations, and state science achievement tests. Data highlight the positive impact of the project on teachers' confidence for teaching science, the content knowledge of both teachers and students, and the quantity and quality of science instruction in the classroom while highlighting the importance of providing specific support to schools so that science specialists can be utilized effectively.

S7.4.2 Emerging Science in Teachers: Trials and Successes

Diana C. Rice, Florida State University, drice@fsu.edu Angela I. Canto, Florida State University Sibel Kaya, Florida State University

Carol Connor, Florida State University

ABSTRACT: This study aimed to examine the amounts and types of science instruction in second grade classrooms as well as second grade teachers' beliefs about and difficulties in teaching science. Science instruction in 16 second grade classrooms, in eight schools in southeastern United States was observed as part of a larger study focusing on individualizing student instruction. Classrooms were videotaped for one full instructional day and science instruction was coded using observation software. Results showed that time spent in science instruction in second grade was approximately 15 minutes. The majority of science instruction was delivered to the whole class and only 14% was conducted by small groups or individual students. Thirty percent of the instructional time was spent in non-instructional activities, such as organizing transitioning and off-task behavior. Six teachers were then interviewed using a semi-structured interview format to explore qualitative aspects of current science instructional practices. Our results suggest that early elementary science instruction needs improvement and teachers of need greater support and more professional development in this area.

S7.4.3 Early Science Teaching and Students' Achievement in Kindergarten and First-Grade

Refika Olgan, Middle East Technical University, rolgan@metu.edu.tr

ABSTRACT: By using the Early Childhood Longitudinal Study- Kindergarten class of 1998-99 (ECLS-K) kindergarten and firstgrade data files, this study attempted to understand the connection between science teaching practices in schools and kindergarten and first-grade students' science achievement. In addition, the study examined some of the factors that potentially influence children's learning in science. Statistical modeling techniques were used to examine the relative importance of selected variables, including gender, race/ethnicity, socioeconomic status, and various aspects of science teaching in the area of science based on direct and indirect assessment battery scores. This study found that science teaching and learning in kindergarten is limited. Moreover, inconsistent results were found about the effects of science teaching and learning practices on kindergarten and first-grade students' achievement in the area of science knowledge, based on student characteristics. Given the findings of this study, educators and policy makers should pay attention to the way teachers deliver science instruction in the early grades.

S7.4.4 Teachers Managing Students' Ideas, Questions, and Contributions in the Context of an Innovative Inquiry-Based Elementary Science Unit

Rachel S Phillips, University of Washington, rachelsp@u.washington.edu Christopher J. Harris, SRI International William R. Penuel, SRI International Britte Cheng, SRI International

ABSTRACT: Teachers are integral to creating and sustaining classroom conditions that support rich learning of science through inquiry. Teachers in science inquiry classrooms have a daunting task as the traditional notions of management have to be expanded for them to ensure that their students are actively engaging in scientific practices, grappling with important science ideas, and building conceptual understanding through meaningful discourse and activity. This study closely examined how teachers managed their elementary students' ideas, questions, and contributions during an innovative twelve-week inquiry-based, environmental biology unit. A goal of the study was to describe management interactions that impact inquiry instruction. Findings offer insight into how management and instruction are intertwined, and illustrate how teachers can work collaboratively with students to sustain and support student thinking and learning through thoughtful management interactions. This study supports the notion that the definition of management needs to be expanded to include more traditional, behavioral focused management as well as the management of student ideas, contributions and questions. Teachers who are able to balance all of these elements in their science inquiry classrooms, including maintaining a distributed authority system while attending to both the behavioral and cognitive aspects of learning have proven to be most successful.

Strand 4: Science Teaching--Middle and High School (Grades 5-12): Characteristics and Strategies S7.5 SC-Paper Set: Developing Science Teachers' Content Knowledge 2:15pm – 3:45pm, Conference Room 404

S7.5.1 A Shadow Curriculum: How Would the Biology Syllabus Look if it was Written by Students?

Ayelet Baram-Tsabari, Technion, Israel, ayelet@technion.ac.il

Galit Hagay, Technion, Israel

ABSTRACT: Students have been largely ignored in discussions about how best to teach science, resulting in a standard science curricula which is largely out of touch with their personal interests. A strategy for incorporating students' interest into the formal biology curriculum is suggested, and demonstrated in the context of the genetics, cardiovascular and reproductive systems syllabus in

Israel. Students' interests were identified using 563 self generated questions, which were analyzed and mapped into the national curriculum. Mapping the level of congruence between students' interests and the national curriculum, revealed that half of the questions asked by the students were not covered by the relevant sections in the syllabus. Genetics was the most popular subject according to self-reports and the number of questions asked by students. However, only a handful of dedicated teachers choose to teach advanced genetics in the Israeli school system, due to practical reasons. Within genetics, we demonstrated a mismatch between students' interests in human implications of biotechnology and the emphasis of the syllabus on agriculture implications. Translating students' interests into curricular terms resulted in a "shadow curriculum" that may inform teachers and curriculum developers and enable them to better address the disparity between students' interests and the national curriculum demands.

S7.5.2 New Tools for Investigating the Relationship between Teacher Content Knowledge and Student Learning

Sean Smith, Horizon Research, Inc., ssmith62@horizon-research.com

Melanie J. Taylor, Horizon Research, Inc.

ABSTRACT: Most would agree that teacher knowledge of disciplinary content directly and positively affects student learning, but the 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 that content. Recognizing a lack of measures, we created psychometrically rigorous assessments of teacher and student knowledge. This paper describes the development of these pairs of multiple choice assessments in three middle grades content areas: the flow of matter and energy in living systems, force and motion, and plate tectonics. We use the teacher assessments to illustrate the development cycle, which involves domain specification, expert review, cognitive interviews with teachers, and large-scale piloting and field-testing. We explain the types of teacher items included in the assessment, and describe reliability and validity information for all six measures. Using results from a pilot and two large-scale studies, we investigate whether teachers' knowledge of content is a significant predictor of student learning, as measured by our teacher and student assessments.

S7.5.3 "We are Taking their Brilliant Minds": Exploring the Use of Linguistic Devices to Mark Expertise in a Scientist-Teacher Collaboration

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

Robert E. Bechtel, University of Alberta

ABSTRACT: In 2008, a group of six science teachers spent the summer immersed in the research activities of one of three scientific research centres. The underlying assumption was that teachers and researchers would both bring expertise to the collaborative process and that this combined expertise would lead to the creation of high quality materials for schools. This study aimed to explore whether expertise was truly mutually recognized in the group and how that expertise was communicated and supported. We use a framework narrative positioning to explore the expertise status of the scientists and teachers and linguistic micro analysis to examine the devices that are used to communicate and support this status. Our findings suggest that both the teachers and the scientists recognize the scientists as the true experts. Subtle devices such as praise-criticism pairs are used to communicate and reinforce this status. In addition both the scientist and the teachers tend to undervalue and limit the expertise of the teachers and the teachers tend to remove themselves from being the central actors in their narratives. The results of this study bring up important questions for outreach and curriculum development initiatives that would seek to engage scientists and teachers in collaboration.

S7.5.4 Teacher Responses to Assessments of Understanding of Water in Socio-Ecological Systems: A Learning Progressions Approach

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Beth Covitt, University of Montana

Charles W. Anderson, Michigan State University

ABSTRACT: An understanding of how water and substances in water move through socio-ecological systems is critical for environmentally-literate citizens capable of participating in evidence- based decision-making about environmental issues. This study used a learning progressions framework to assess elementary through high school teachers' understandings about water. 61 teachers participating in a summer professional development program were assessed using items previously developed and validated to assess student understanding of the same domain. Teacher responses were coded using previously developed indicators of levels of achievement. Results show that most teachers provided responses that fit the upper levels of the learning progression. Compared to responses from students, more teachers than students were able to trace water along multiple pathways through socio-ecological systems. Furthermore, teachers provided richer descriptions of these pathways and were more likely to situate responses in real-world contexts. However, like students, teachers encountered difficulties applying constraints on processes, especially when tracing water through hidden parts of systems such as unconfined aquifers. Furthermore, like students, teachers had difficulty reasoning about substances in water at the atomic-molecular scale and identifying the chemical nature of substances in water. These results have implications for the design of professional development and the refinement of the learning progressions framework.

Strand 4: Science Teaching--Middle and High School (Grades 5-12): Characteristics and Strategies S7.6 SC-Paper Set: Argumentation and Socioscientific Issues

2:15pm – 3:45pm, Conference Room 406

S7.6.1 Examining Images of Scientific Inquiry through the Lens of Teacher Classroom Argumentation

Ron Gray, Oregon State University, ron.gray@science.oregonstate.edu

Nam-Hwa Kang, Oregon State University

ABSTRACT: The purpose of this study was to examine the qualitative differences between the arguments secondary science teachers make in the classroom for science topics that rely on different methods of inquiry. Four highly-experienced secondary science teachers participated in the study. Each participating teacher was videotaped during two instructional units: one covering an experimental science topic and another covering an historical science topic. These observations were transcribed and coded to identify argument patterns. Toulmin's (1958) argumentation scheme was used to examine the argument patterns. Analysis shows a distinct difference between arguments developed for instruction of experimental vs. historical science. These differences map with the current understanding of the differences inherent in these two types of science. The results of this study inform research into classroom argumentation and images of scientific inquiry.

S7.6.2 Socio-Scientific Issues – A Way to Improve Students' Interest and Learning?

Britt Lindahl, Kristianstad University, Šweden, britt.lindahl@hkr.se Margareta Ekborg, Malmö University, Sweden Mikael Winberg, Umeå University, Sweden Christina Ottander, Umeå University, Sweden Maria Rosberg, Kristianstad University, Sweden Eva Nyström, Umeå University, Sweden Malin Ideland, Malmö University, Sweden Claes Malmberg, Malmö University, Sweden

Agneta Rehn, Malmö University, Sweden

ABSTRACT: According to many documents there is a strong need to renew science education. One way could be to work with socio scientific issues (SSI). This paper reports about both students and teachers' experiences and learning when working with socio-scientific issues in science education at senior level (age 13-16). The approach is multidimensional as factors that influence cognition as well as motivation and the forming of attitudes are complex. Results suggest SSI work forms are more important than personal factors for explaining outcomes. Relevant issues, autonomy and functioning group work seem to be important aspects of successful SSI work together with structure provided by the teacher, and information that challenges previous knowledge. In general, SSI seems to be most efficient for students, who believe they learn from presenting and discussing their knowledge, focus on 'the large picture', acknowledges own responsibility for learning, finds school science personally relevant and are self-efficacious. It seems that the outcomes from SSI work are much in the hands of the teacher. Thus, working with SSI could be considered as an appropriate activity for all students. However, educators should continue to look for ways to promote development of students' attitudes and epistemological beliefs.

S7.6.3 Writing Differently about a Socioscientific Issue: Developing Students' Scientific Literacy through the Writing of Hybridised Scientific Narratives

Louisa Tomas, James Cook University, Australia, louisa.tomas@jcu.edu.au

Stephen M. Ritchie, Queensland University of Technology, Australia

ABSTRACT: The development of scientific literacy continues to remain an important educational priority, particularly in the face of international assessments of student science achievement, and growing evidence of students' waning interest in school science. This triangulation mixed methods study investigated the development of 9th grade students' scientific literacy through their participation in an online science-writing project on the socioscientific issue of biosecurity. Children from eight, in-tact science classes wrote a series of short stories that integrate scientific information with narrative storylines. We call these hybridised scientific narratives, BioStories. The students' BioStories were quantitatively analysed using a series of specifically-designed scoring matrices that produce numerical scores that reflect students' developing fundamental and derived senses of scientific literacy. In addition, the students also completed an on-line Likert-style questionnaire, the BioQuiz, which examined selected aspects of their affect toward science and science learning. The results suggest that the students' participation in the project enhanced their awareness and conceptual understanding of issues relating to biosecurity, while writing differently about a socioscientific issue developed a more positive affect toward science and science and science learning, particularly in terms of the students' interest and enjoyment. Implications for research and teaching are also discussed.

S7.6.4 How Middle School Students and High School Students Evaluate the Arguments Found within Articles Written For the Popular Press: A Comparison Study

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Victor Sampson, Florida State University

Melanie Hester, Florida State University Kiesha Williams, Florida State University

ABSTRACT: In today's age, scientific innovation and discovery is constant. As such, scientific and technological issues are becoming more prevalent in popular media (Kolstø et al., 2006; Philips& Norris, 1999). Through various types of media (e.g., newspapers, magazines, and websites), authors convey what is known about a topic and aim to transform or alter the way other people, think about the topic. A major aim of science education in the United States is for all students to develop scientific literacy by the time they finish high school. This study examines how middle and high school students (n=50) evaluate science-related claims found in popular media and thus, apply science literacy skills. Further, the authors investigated which characteristics of arguments in support of science-related claims middle school and high school student find persuasive in popular media and the criteria they use to determine persuasiveness.

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

S7.7 SC-Paper Set: Students' Views and Beliefs in Undergraduate Biology and Biotechnology

2:15pm – 3:45pm, Conference Room 405

S7.7.1 Exploring Student Generated Questions using Media and Self-selected Science Information in an Undergraduate Nonscience Major's Biology Course

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ABSTRACT: This study explores the type of questions formulated by eighteen undergraduate students in a non-science major's biology course using an independent journaling process and self- selected popular science articles from various media sources. Students' questions were categorized as nature of science (NOS), knowledge construction, or knowledge gap questions. Question types were evaluated alongside media source (print, internet, audio/visual) and article type (applied, combination) to determine effects on questions generated. Students' questioning practices revealed that most students formulated knowledge construction questions followed by knowledge gap questions regardless of media source. Article type was significant with NOS questions least frequently generated and primarily constructed by students who completed higher level mathematics coursework. The limited number of NOS questions formulated provides some evidence that students do not have well constructed NOS views. The implications of this discovery can be used to affect change in the teaching practices of science and may impact science literacy efforts in undergraduate science education. A teaching emphasis in the classroom that supports the development of NOS understanding, along side content knowledge, will equip students with the necessary cognitive framework to negotiate the various science texts they will encounter in the media and support science literacy initiatives.

S7.7.2 "Genetically Modified Foods are the Only Foods that have DNA": Epistemological Beliefs and Conceptual Understanding in a Non-Majors Biotechnology Course

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Marcelle A. Siegel, University of Missouri - Columbia

Sharyn K. Freyermuth, University of Missouri - Columbia

Bruce A. McClure, University of Missouri - Columbia

ABSTRACT: Epistemic beliefs are a contributing factor to students' ability to reason, evaluate information, and make informed decisions. With recent advances in biotechnology there is an emerging need to investigate college students' understanding and epistemic beliefs in this area. In this study, we have performed an in-depth case study analysis of three undergraduate, non- science major college students. We focused our study on students who initially performed well above average and below average on the first in-class exam. Utilizing multiple data sources – interviews, class exams, and a biotechnology concept inventory, we examined students' understanding and epistemologies. We developed individual profiles and conducted a cross case analysis. The results showed that a student with more sophisticated epistemology had greater conceptual gains at the end of the course than a student with less sophisticated epistemology, even though the latter performed higher initially. Our results suggest the need to foster epistemological growth in order to spur real conceptual growth.

S7.7.3 Pre-Service Elementary Education Students' Scientific Content Knowledge of Biotechnology and Its Implications for Teaching and Learning

Brandy A. Skjold, Western Michigan University, brandy.pleasants@wmich.edu Renee' Schwartz, Western Michigan University Carrie McKean, Western Michigan University

ABSTRACT: There has recently been increased interest in the United States to re-evaluate policies concerning scientific research in areas such as stem cells and cloning. Therefore, biotechnology related issues are more often incorporated into science courses, in part,

as a decision-making tool for students. Research in teaching and learning about biotechnology issues has also been increasing. Studies focus on addressing the moral and religious implications of these topics, as well as determining how and why students make decisions about them. This research seeks to further elucidate the role of students' conceptual understanding of biology topics, such as genes and cells, on their understanding of stem cells and cloning. Pre-service elementary/middle school education students enrolled in a introductory biology course were given pre and post assessment surveys asking about their understanding of a variety of biology topics, including biotechnology issues. Several students also participated in interviews. The findings suggest that student conceptions of all topics are vague and under-developed. Of interest is an increased, but often inappropriate, use of "scientific" vocabulary, which was not seen in pre-assessments. This research suggests that part of students' difficulties in dealing with biotechnology related issues is their emphasis on learning terminology without seeking conceptual understanding.

S7.7.4 Undergraduate and Teaching Assistant Nature of Science Understanding in an Explicit / Reflective Biology Laboratory

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Nazan U. Bautista, Miami University

Melanie A. Link-Perez, SUNY College at Oneonta

ABSTRACT: An explicit / reflective (ER) approach has been advocated to foster student understanding of NOS, but investigation of this technique in undergraduate science laboratories has been limited. We report on a project that implemented four laboratory treatments (inquiry, inquiry + ER, expository, and expository + ER) and assessed NOS understanding of students and the TAs who taught the labs. Both qualitative and quantitative measures of NOS indicated that students in the course gained NOS understanding over the semester, but this gain was uniform across treatments. Teaching assistants had NOS understandings similar to their students, and also gained NOS understanding over the semester according to one instrument, but not the other. The level of NOS knowledge and/or NOS gains of the TAs and their students did not appear to be related. This project suggests that undergraduate students can gain NOS understanding through the undergraduate years, given the similarity of undergraduate and graduate student responses. This suggests that the implementation of an ER approach in college laboratories may require extensive professional development of teaching assistants.

Strand 6: Science Learning in Informal Contexts & Strand 14: Environmental Education Co-Sponsored S7.8 Symposium: Beyond Citizen Science: Science Learning and Public Participation in Environmental Research 2:15pm – 3:45pm, Conference Room 414

Discussants:

Carol Brandt, Virginia Polytechnic Institute and State University, cbbrandt@vt.edu

Jennifer Shirk, Cornell Lab of Ornithology Ithaca, NY

Rebecca Jordan, Rutgers

Heidi L. Ballard, University of California at Davis Davis

Terry M. Tomasek, Elon University

ABSTRACT: Wishing to go beyond the catch-all of "citizen science," the Center for the Advancement of Informal Science Education (CAISE) recently published a report entitled, Public Participation in Scientific Research: Defining the Field and Assessing Its Potential for Informal Science Education (Bonney et al., 2009). In this symposium, we use the PPSR models offered by the CAISE report to look more closely at how the public is positioned within these participatory projects and the types of science learning that occurs in these settings. Our focus is not only the environmental research that is being conducted, but also, the social ecology of the learning context (Barab & Roth, 2006). We are interested in questions of epistemology and scientific inquiry as well as the cognitive, emotional, and social demands of learning. And finally, we want to understand the ways that the public – children and adults – have a voice in the scientific process that connects with their sense of place in what is an increasingly glocal economy.

Strand 7: Pre-service Science Teacher Education

S7.9 SC-Paper Set: Pre-Service Teachers' Knowledge of Content and Students

2:15pm – 3:45pm, Conference Room 407

S7.9.1 Depicting a Comprehensive Picture of Science Teacher's PCK: A Theoretical Model

Saiqa Azam, University of Calgary, AB, Canada, sazam@ucalgary.ca

HsingChi von Bergmann, University of Calgary, Canada

ABSTRACT: constitutes PCK of science teachers, and to propose a model to comprehensively depict science teachers' PCK. More specifically, our inquiry is founded by the following two questions: (1) What are the sources of science teachers' PCK, and how do these sources contribute to the development of PCK? (2) What processes are involved in the development of science teachers' PCK, and how can they be described and represented? In this study, through a systematic methods of reviewing both research papers and conceptual ones, we propose a theoretical model for understanding of science teachers' PCK. This model is believed to be comprehensive and can address the two common issues in research and study of PCK construct.

S7.9.2 Finding Connections between Pre-service Elementary Teachers' Understandings of Science and Mathematics Teaching and Learning

Julie M. Kittleson, University of Georgia, jkittl@uga.edu Rachel E. Wilson, University of Georgia Amber Jarrard, University of Georgia

ABSTRACT: This study considers pre-service elementary teachers' conceptions of science and mathematics teaching and learning and how ideas about one can bootstrap ideas about the other. Given that elementary teachers are prepared to teach all content areas, yet not all areas (e.g., science) receive equal emphasis during teacher preparation, it is important to find ways to make useful connections between content areas. Science and math were selected because they share goals such as problem solving, using evidence to develop explanations, etc. This qualitative study involved pre-service elementary teachers enrolled in a science methods course. Participants were interviewed twice during the semester; additional data sources included coursework and artifacts generated in class. Analysis reveals pre-service teachers' ideas about math and science teaching and learning and how these ideas do and do not support one another. For example, one participant's ideas about math instruction, particularly the importance of assessing students' prior understandings, helping students make connections between ideas, and using manipulatives to engage with concepts, are applicable to science instruction. These ideas, however, were not invoked in the context of science instruction. Finding from this study suggest ways in which ideas about math and science instruction can be used to reinforce one another.

S7.9.3 Teaching Science as Argument: Prospective Elementary Teachers' Knowledge

Reizelie Barreto, Towson University, rbarreto@towson.edu

Carla Zembal-Saul, The Pennsylvania State University

ABSTRACT: For the past two decades there has been increasing emphasis on argumentation in school science. Participating in argumentation is fundamental to children's science learning experiences. However, it increases challenges for prospective elementary teachers since their understanding of and experiences with science are overwhelmingly inconsistent with teaching science as argument. This study investigated the ways in which preservice elementary teachers appropriate components of "teaching science as argument" during their student teaching experience. It followed a multi-participant case study approach and analyses were informed by grounded theory. Cross-case analysis allowed for the development of five key assertions: (1) The presence of opportunities for interacting with phenomena and collecting first hand data helped participants increase their emphasis on evidence-based explanations. (2) Participants viewed science talks as an essential mechanism for engaging students in the construction of evidence-based explanations and as being fundamental to meaning-making. (3) Participants demonstrated attention to scientific subject matter during instruction rather than merely focusing on activities and/or inquiry processes. (4) Scaffolded protocols positively influenced participants' attention to having students construct evidence-based explanations during science planning and teaching. (5) Teachers' beliefs about children's science capabilities influence their attention to and adoption of practices associated with teaching science as argument.

S7.9.4 Integrating ICT into the Science Curriculum: Teacher Knowledge (TPACK) and Strategies to Support K-8 Science Skills and Concepts

Candace B. Figg, Brock University, cfigg@brocku.ca Kamini Jaipal, Brock University

ABSTRACT: Competent teachers foster meaningful learning when they demonstrate the ability to connect subject matter content and pedagogical processes in ways that promote effective student learning in that content area. Using the TPACK model proposed by Koehler & Mishra (2006), this paper outlines specific Technological Pedagogical Knowledge (TPK) characteristics for supporting preservice teachers' effective integration of technology into classroom practice and provides specific examples of Technological Pedagogical and Content Knowledge (TPACK) in the elementary Science classroom. The characteristics emerged from a cross-case analysis of data sources from a qualitative study of four pre-service teachers who planned and taught technology-enhanced lessons during a 7-week practice-teaching block at two K-8 schools. Data sources included pre and post focus group interviews, individual interviews, planning and support sessions, lesson plans, and observations of pre-service teachers' classroom practice. Findings indicated that TPK characteristics were significant to the success of initial technologically-enhanced lesson implementations.

Strand 8: In-service Science Teacher Education S7.10 SC-Paper Set: Teacher-Scientist Collaborations 2:15pm – 3:45pm, Conference Room 408

S7.10.1 How Research Experiences for Teachers (RET'S) Effect Science Teachers' Knowledge, Beliefs and Practices

Barry W. Golden, Florida State University, bgolden@fsu.edu Patrick Enderle, Florida State University Yavuz Saka, Florida State University Sibel Uysal, Florida State University

ABSTRACT: Given that the science education reform documents (AAS, 1989, NRC, 1996) call for models of science teaching that differ, sometimes radically, from the version actually experienced by many current teachers, professional development opportunities become a crucial aspect of reform efforts. This research sought to examine two different professional development opportunities (Research Experiences for Teachers, or RET's) in terms of changes in the science teachers' beliefs, understandings, and practice that result from their experiences. The two RET programs were based on very different models, with one having a more intense research immersion, whereas the other had a more marked emphasis on development of inquiry-based pedagogy. Mixed methods were employed, including statistical analysis of several survey instruments administered pre and post program (including the Pedagogical Discontentment Survey, Reform-Based Teacher Observation Protocol, or RTOP) and also qualitative analysis of interview data pre and post program. Results indicate that the choice of RET program significantly predicts changes in pedagogical discontentment scores. Cases from the interview data provide qualitative support to this hypothesis.

S7.10.2 A Study of Teacher-Scientist Collaboration Settings

Kalani J. Eggington, The University of Queensland, Australia, keggington@yahoo.com

ABSTRACT: Teacher-scientist collaborations help science teachers acquire pedagogical tools that can enhance their teaching of contemporary science. This study contributes to our understanding of teacher-scientist collaborations by primarily focusing on the setting in which the collaboration takes place $\hat{a} \in$ a factor which has been largely unexamined in the literature. An activity theory framework is used to investigate the extent and ways the setting of the collaboration between teachers and scientists influences teachers' appropriation, or adoption, of pedagogical tools for teaching contemporary science. Nine different collaboration models were investigated involving teachers and scientists who had worked together. A qualitative research design was implemented by interviewing all participants as well as by observing several classroom and collaborative sessions. Data analysis confirms that the setting of the collaboration has a strong influence over teachers' appropriation of pedagogical tools. Teachers gained a greater understanding of the nature of science if their collaborative experience took place at the scientists' workplace as opposed to a traditional school setting. These teachers also gained more exposure to contemporary activities and resources that could be implemented in their classroom. Knowledge of effective setting components will assist those involved with designing professional learning programs for science teachers.

S7.10.3 The Impact of Scientist Mentors on Science Teachers' Perceptions of Scientists and Understanding of Science

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Patrick Enderle, Florida State University

Pat Dixon, Florida State University

Barry W. Golden, Florida State University

Jose Sanchez, Florida State University

ABSTRACT: This study focuses on the mentor relationship between science teachers and their scientist mentor in a Research Experiences for Teachers (RET) program at a national laboratory facility. Using mixed methods, the authors surveyed and interviewed the eleven participating teachers before and after the program. The authors also observed the teachers with their mentors weekly. Based on the pre-program data, very few of the teachers could articulate their expectations for their relationship with their scientist because they were not sure how scientists worked. The observations showed that there are a variety of mentoring relationships, ranging from little to no interaction with one's scientist to daily meetings. The post data indicates that half of our sample saw their scientist as a mentor who had an impact on their science teaching. We will continue to follow these teachers throughout the school year to determine the longitudinal effects of the mentor relationships that help link the science community with the science teacher community. This study can also highlight best practices for other RET programs.

S7.10.4 Development of Teachers as Scientists in a Research Experiences for Teachers Program

Lisa C. Benson, Clemson University, lbenson@clemson.edu

Emily G. Medders, Southern Wesleyan University

Cheryl P. Cass, Clemson University

ABSTRACT: This qualitative study of a NSF Research Experiences for Teachers Program, a six week summer program in which secondary science and math teachers are immersed in research environments, examined teachers' development as scientists from the theoretical frameworks of cognitive development (based on Bloom's revised taxonomy) and adult learning theory. Hierarchies developed from these theoretical frameworks allowed tracking of changes over time for the attributes of interest. We also examined the roles that mentors played in the process and the level of independence achieved in scientific practice by the teachers. Participants included 10 teachers with varying levels of education and experience. Data included weekly journal entries written during the program and exit interviews conducted at the conclusion of the program. Data were coded with respect to the two hierarchies, and then evidence pertaining to mentors and independent practice were extracted and examined. Increases in functionality as researchers, level of cognition of scientific topics, and/or level of independence were observed for all teachers who completed the program. Differences were observed in levels achieved and rates of development within each construct, due to teachers' individual characteristics and relationships with mentors. Mentors had a clear influence on the development of teachers' independent scientific practice.

Strand 8: In-service Science Teacher Education

S7.11 Related Paper Set: The Effect of Professional Development on Teachers' Knowledge, Skills, and Classroom Implementation and Their Students' Ability to Write Scientific Explanations

2:15pm – 3:45pm, Salon C

S7.11.1 The Effect of Context and Activities on Teachers' Scientific Explanations

Dale R. Baker, Arizona State University, dale.baker@asu.edu

Nievita Bueno Watts, Arizona State University

Gita Perkins, Arizona State University

Tapati Sen, Arizona State University

Elizabeth B. Lewis, University of Nebraska-Lincoln

Michael G. Lang, Maricopa Community College District Offices

ABSTRACT: Abstract: The Effect of Context and Activities on Teachers' Scientific Explanations This study reports on the efforts of the Communication in Science Inquiry Project professional development to help teachers write scientific explanations. The research examined the effect of five contexts and seven activities on the quality of 85 middle school and high school science and English teachers' scientific explanations. During the professional development, teachers engaged in exploring mystery boxes, and inquiry activities on the topics of plants, cells, rivers, and a physics activity called poppers. Teachers also engaged in English-based inquiry activities (Is Homer a hero?, What is poetry?). The five contexts were 1) structured versus unstructured inquiry, 2) background information provided, 3) scaffolding versus no scaffolding for writing explanations, 4) writing explanations as an individual or a group, and 5) writing with and without feedback. After the activities teachers wrote explanations in the form of claims, evidence and reasoning. Four hundred and seventy-three explanations were coded using a 0-4 point rubric. There was no effect for any of the activities except for feedback. When feedback was provided the quality of the explanations improved. There was no effect for any of the activities except for mystery boxes. High school science teachers outperformed high school English teachers.

S7.11.2 Growth in High School English Teachers' Understanding of the Science Concept of Energy

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Dale R. Baker, Arizona State University

Nievita Bueno Watts, Arizona State University

Michael G. Lang, Maricopa Community Colleges District Offices

ABSTRACT: The purpose of this study is to examine how the understanding of the concept of energy by high school English teachers changes over a 3-day institute. The sample included 7 high school English teachers who participated in the Communication in English and Science Inquiry Project (CESIP). We asked teachers to define energy and energy in language using an open-ended response survey in July 2009. With their participation in the 3-day professional development activities, there was a shift towards a more scientific view of energy as the ability to cause change. This shift occurred from their daily language use of energy as a "thing." Their discussion on real life experiences such as the roller coaster led to an understanding of the differences between potential and kinetic energy. Their understanding of entropy as a disorder came about from the bank account activity. It is recommended that points of intersection be found to build a bridge between English teachers' daily language use and scientific language.

S7.11.3 Improving High School Teachers' Content Knowledge of Energy in Systems Through Research-based Professional Development

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Dale R. Baker, Arizona State University

Steven Semken, Arizona State University

Michael G. Lang, Maricopa Community Colleges District Offices

ABSTRACT: As the quest for renewable, affordable energy becomes more prominent as a global priority, it becomes clear that a scientifically literate population must possess the knowledge necessary to evaluate various energy sources with regard to the environment, as well as the economy. As a society we are counting on high school science teachers to develop global citizens who are informed about the development and use of various forms of energy to power our society into the future. We are expecting our high school teachers to achieve this goal, but do they have the content knowledge necessary to broach the interdisciplinary topic of energy in systems? The Communication in English and Science Inquiry Project (CESIP) professional development project investigated this topic using a two-tier pre- and post- Energy assessment linked to both national and state science standards. We found that teachers had difficulty with topics of energy density, energy efficiency, and renewable vs. non-renewable resources. A paired-samples t -test showed that, after a week of instruction on energy in systems, teachers scores increased significantly from pre (M = 65.18, SD = 13.62), to post assessments (M = 91.45, SD = 10.88), t (10) = 5.78, p < .001.

S7.11.4 The Effect of Implementing the CISIP Model on Students' Scientific Explanations

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Gita Perkins, Arizona State University Dale R. Baker, Arizona State University Michael G. Lang, Maricopa Community Colleges District Offices Rachelle Beard, Arizona State University Sibel Uysal, Florida State University Elizabeth B. Lewis, University of Nebraska-Lincoln

ABSTRACT: It is important that the students develop communication skills in science with special emphasis on writing scientific explanations in terms of claims, evidence and reasoning. Teachers need to guide students in achieving this goal. In this research study we examined the correlations among the quality of teacher arguments, the quality of their students' arguments, and the fidelity of implementation of CESIP model as observed during classroom visits. We found that teachers are themselves weak in writing good reasoning for their scientific arguments and they have not been successful in engaging the students in writing strong scientific arguments that is rich in reasoning. The contributions of the research are discussed.

S7.11.5 Modeling Teacher Professional Development and Classroom Implementation of Instructional Strategies For Building Scientific Classroom Discourse Communities

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Dale R. Baker, Arizona State University

Brandon Helding, Arizona State University

Michael G. Lang, Maricopa Community Colleges District Offices

ABSTRACT: Three-hundred-and-twenty-three classroom observations of secondary science and language arts teachers were made over two academic years while teachers engaged in professional development (PD) in how to construct scientific classroom discourse communities. These observations were used, along with teacher demographic information, to build a hierarchical linear model to explore statistical relationships. The length of time that the teachers received PD was chosen as the exclusive predictor of teacher change while a schools' percentage of students who qualified for free and reduced lunch (SES) was chosen as the exclusive predictor of the intercept (i.e., teacher starting point). Over the course of two years, the teachers who had participated for longer periods of time used more of the PD, that is, they had higher rates of change than newly participating teachers. The model indicated, with statistical significance, that SES predicted teachers' baseline levels of use of the PD. However, with respect to teachers change over time, only the amount of PD that a teacher received or their treatment group membership predicted use with statistical significance. Ergo, while teachers' students' SES was important in determining where teachers began, the treatment itself accounted for how teachers change over time.

Strand 9: Reflective Practice S7.12 Related Paper Set: Pedagogical Content Knowledge for Teaching the Nature of Science

2:15pm – 3:45pm, Conference Room 409

S7.12.1 Developing PCK for NOS through Self-Study

Deborah L. Hanuscin, University of Missouri, hanuscind@missouri.edu

ABSTRACT: Understanding the nature of science (NOS) is critical to being able to teach NOS; however, research illustrates that even when teachers have understandings of NOS consistent with reforms, they generally do not explicitly teach these ideas, or may do so through didactic approaches. Helping teachers develop pedagogical content knowledge (PCK) for NOS is critical. Teachers must have a wide array of strategies for organizing and representing ideas about NOS in ways that are accessible to their students. What exactly constitutes PCK for NOS? Through a self-study, we sought to answer this question. Under the guidance of a science educator, 8 graduate students (future science educators) undertook a collaborative effort to develop their PCK for NOS. Each had been previously enrolled in a course on NOS, and thus had developed sufficient subject matter knowledge; however, none had any experiences teaching NOS. Over the course of the semester, the group was able to observe and participate in NOS instruction in the faculty member's undergraduate elementary science methods course. Using the Content Representation (CoRe) and Pedagogical and Professional Repertoires (PaP-eRs) developed by Loughran, Mulhall, and Berry (2006), we documented and portrayed our PCK for NOS, and how it developed through our self-study.

S7.12.2 Developing PCK for NOS: Making Instruction Explicit

Deepika Menon, University of Missouri, dm2qc@mizzou.edu

Stephen B. Witzig, University of Missouri

Tina M. Roberts, University of Missouri

ABSTRACT: The New Society activity (Cavallo, 2008) is useful to introduce various aspects of nature of science (NOS) explicitly through teaching. The activity involves role playing in which volunteer scientists make an attempt to identify the rules of a new found society. We used the New Society activity as a way to explore and develop our pedagogical content knowledge (PCK) for NOS. We conducted a self-study utilizing the Content Representation (CoRe) and Pedagogical and Professional-experience Repertoire (PaP-eR) (Loughran, Berry, & Mulhall, 2006). We entered into this self-study with NOS-specific subject matter knowledge having studied NOS

extensively in the previous semester. Our paper focuses on how we implemented the New Society activity, what lessons we learned from implementing it and our suggestions to improve our effectiveness in utilizing the activity to teach NOS. We learned how the activity could serve as an important instructional tool for teachers in helping students understand various aspects of NOS. Through the development of our PaP-eR, we developed our knowledge of context, instructional strategies, assessment of student ideas/understanding and extended our subject matter knowledge throughout the process. Through self-study, we developed PCK for explicitly addressing NOS in our teaching.

S7.12.3 Anticipating Student Questions: A Self-Study Approach to Develop PCK for teaching Theory and Law

Emily M. Walter, University of Missouri, emily.walter@mail.mizzou.edu

Andrew West, University of Missouri

ABSTRACT: Magnusson et al. (1999) conceptualized that the act of teaching represents a combination of one's knowledge of learners, assessment, curriculum, and instructional strategies. All of these are influenced by one's orientations to teaching. The transformation of these components for teaching particular topics constitute one's pedagogical content knowledge (PCK), and although they are interrelated, the development of PCK can be influenced by developing understandings of individual components. We utilized the Pedagogical and Professional Repertoire (PaP-eR) (Loughran et al., 2006) tool to conduct a self-study of our own PCK for teaching about the nature of theory and law. The purpose of this PaP-eR is to help teachers anticipate questions that students might ask related to teaching ideas related to theory and law in science, particularly in relation to teaching about evolution. The thought is that if teachers are able to anticipate student ideas ahead of time, they can address the ideas in more powerful and purposeful ways when they arise. This allows teachers to make conscious decisions regarding the ways they respond to student ideas. In short, an awareness of student misconceptions of a particular topic promotes the development of PCK.

S7.12.4 Developing PCK for NOS: A Self-Study of the Use of Concept Mapping to Assess NOS

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

Nattida Promyod, University of Missouri

Ya-Wen Cheng, University of Missouri

ABSTRACT: The importance of explicit teaching and assessment of students' understanding of the nature of science (NOS) has been documented in research as an effective tool to improve beliefs about science. However, for teachers to teach NOS effectively, they need knowledge of different types of activities to assess students understanding of NOS. We believe concept mapping can be an effective, accessible, and creative method to assess students' understanding of NOS. To experiment this belief, we implemented concept map construction in an elementary science methods course for preservice teachers using two different methods: a group of participants constructed concept maps given some of the aspects of nature of science, and another group of participants constructed concept maps creating their own words about what science is. Both approaches provided different results: Group one concentrated on the connections between the NOS aspects provided and produced very little extra words, while group two concentrated on creating many aspects of what science is and provided fewer connections among words. The activity helped us and the pre service teacher participants reflect in the effectiveness of each of the methods in terms of the purpose of the activity and the implementation at different stages of instruction.

S7.12.5 Developing PCK for NOS: Strategies for Probing Students' Ideas about Subjectivity in Science

Jennifer Lacy, University of Missouri, jelr4c@mizzou.edu

Deborah L. Hanuscin, University of Missouri

ABSTRACT: Students often have little understanding of how personal bias affects how scientists and students of science observe nature. The process of uncovering their ideas about the nature of science is important when planning activities designed to develop more scientifically literate students. Through self-study, I explored my own pedagogical content knowledge (PCK) for assessing students' ideas about subjectivity. This Pedagogical and Professional- experience Repertoire (PaP-eR) (Loughran, Berry, & Mulhall, 2006) is designed to illustrate how the development and implementation of probes can build teachers' pedagogical content knowledge of the nature of science. Two probes were designed and administered to 27 preservice teachers from an elementary science methods course to uncover their ideas about the role of subjectivity in the field of science for the purpose of developing lesson plans to guide them to more appropriate understandings. This PaP-eR takes the form of an interview, with the author reflecting on questions concerning probes developed for assessing students' understanding of the subjectivity, and how she might incorporate those ideas explicitly in class activities.

Strand 10: Curriculum, Evaluation, and Assessment

S7.13 SC-Paper Set: Assessing Teachers' Knowledge, Beliefs and Practices

2:15pm – 3:45pm, Conference Room 410

S7.13.1 Statewide Assessment Data in Pre-service and In-service Teacher Preparation

Joe Zawicki, State University College at Buffalo, zawickjl@buffalostate.edu

Laura Dustin, Honeoye Central School District

David Henry, State University College at Buffalo

Timothy Johnson, Western New York Regional Information Center (WNYRIC)

ABSTRACT: While there has been an dramatic growth in the level of statewide and regional testing since the implementation of No Child Left Behind Legislation, the compilation, distribution and effective use of the resultant data has been problematic (NCLB, Darling-Hammond). This study focused on twenty pre-service and in-service participants in a graduate course preparing new physics teachers. The novice teachers (course participants) were asked to review items from a recent statewide assessment; the participants predicted the most difficult items on the assessment. An analysis of 4,595 exam papers, written by P-12 learners, allowed a comparison between novice predictions and the actual item difficulties. A preliminary analysis shows that the range of actual item difficulties predicted by the novice teachers (mean = 0.68) paralleled the distribution of item difficulties on the overall test (mean - 0.69). In predicting student success, novice teachers may be responding to their own (personal) perception of the item's difficulty or surprise at finding particular items on such assessments. The data provided little evidence of novice teacher recognition of significant factors affecting item difficulty. The importance of 1) exposing novice teachers such rich analyses, and 2) fostering discussions related to program improvement are of paramount importance in professional development.

S7.13.2 Assessing Teacher Science Content Knowledge: Measurement Sensitivity to a Physics Course Intervention

Thomas R. Tretter, University of Louisville, tom.tretter@louisville.edu

ABSTRACT: Science teachers' content knowledge is an important influence on student learning, and is a potentially important variable in research designs. This paper summarized the subscale structural characteristics built into a widely-used measure of teacher science knowledge (Diagnostic Teacher Assessments in Mathematics and Science - DTAMS) and reported on its efficacy in measuring the teacher content knowledge impact of a semester-long Physics for Teachers course. The assessment subscale structures (breadth of knowledge subscale and depth of knowledge subscale) permitted a reasonably fine-grained analysis of course impact in a pre-post design for a sample of 43 teachers. Results indicated statistically significant growth in overall test score (with partial eta-squared = 694), along with statistically significant growth in most (7 of 8) of the subscale scores. However, effect sizes suggested growth was not uniform across subscales and could be accounted for primarily by growth in: (a) deep conceptual understanding and (b) enhanced pedagogy knowledge. Across breadth dimension subscales, knowledge growth was concentrated in the unifying theme of energy and in applications of science principles to society. These results reinforced conclusions that the measurement instrument was sensitive to the intended emphases of this course. The inclusion of effect sizes enhanced the interpretability of DTAMS results.

S7.13.3 Investigating the Influence of Teachers' Orientations toward Curiculum Materials on Enactment

Meredith Houle, San Diego State University, mhoule@mail.sdsu.edu

Michelle Nolasco, San Diego State University

Katherine L. McNeill, Boston College

ABSTRACT: The development of educative curriculum materials has been suggested as one means to support teacher learning (Davis & Krajcik, 2005). However, in order to develop effective educative materials we need to understand how and when science teachers use curriculum, how their use is shaped by their beliefs, knowledge and orientations and how their curricular use influences their classroom practice. This study examines the influence of teachers' orientations toward curriculum on their enactment of a high school urban ecology curriculum. We found teachers' orientations towards the curriculum materials influenced the degree to which they relied upon curricular versus personal resources and may lead to misinterpretations of the intentions of the lesson.

S7.13.4 Investigating Teacher Impact on Student Inquiry Science Learning Using a Hierarchical Linear ModelInvestigating Teacher Impact on Student Inquiry Science Learning Using a Hierarchical Linear Model

Ou Lydia Liu, Educational Testing Service, lliu@ets.org

Hee-Sun Lee, Tufts University

Marcia Linn, UC Berkeley

ABSTRACT: Teachers play a central role in inquiry science classrooms. This study investigated how various teacher characteristics (e.g., experience, beliefs, workshop attendance, teacher collaboration) affected student inquiry understanding in high school physics, chemistry, and biology, and middle school physical science, life science and earth science courses. Using a two-level hierarchical linear model, we analyzed data from 4,513 students and 40 teachers in five states. Results revealed that students of teachers who believed in the importance of inquiry teaching strategies were more successful than students of teachers who believed in traditional teaching methods (p = .05). Teachers?workshop attendance also had a positive impact on their students?science performance (p = .05). Having a partner teacher teaching the same unit (p = .03) was another beneficial factor for improving student science achievement. These results underscore the importance of professional development and collegial support in the success of inquiry science.

S7.13.5 Exploring Patterns in Student Reports of Classroom Instruction

Gavin Fulmer, National Science Foundation, gfulmer@nsf.gov

Ling L. Liang, La Salle University

ABSTRACT: Are there latent constructs of teachers' classroom instruction? Can professional development affect these latent measures of instruction? This paper seeks to answer these questions using student survey data on their teachers' classroom practices

using factor analysis and Rasch modeling. It draws on data from a larger, quasi-experimental study on model- centered science instruction. Results indicate that three factors were present in the data, explaining a total of 41% of the variance in the data. Additionally, items from these factors showed good fit with the Rasch measurement model. The results were used to create three subscales from the items: Modeling and Reflecting (MR), Communicating and Relating (CR), and Self-Guided Inquiry (SGI). The unidimensionality of the subscales indicate that they may measure some underlying characteristic or process (Bond & Fox, 2001), a more stringent requirement than the simple covariance relations identified in factor analysis. Furthermore, upon analysis, the treatment group had much higher scores than the comparison group on all subscales, with effect sizes ranging from 0.55 (SGI) to 1.25 (MR). This paper reveals that student report data can be used to construct instruments for classroom practices and that these practices may be analyzed using these empirically-validated IAS subscales.

Strand 11: Cultural, Social, and Gender Issues

S7.14 SC-Paper Set: Dialogues, Discourses, And Children: Cogenerating Science in the Everyday World 2:15pm – 3:45pm, Conference Room 411

S7.14.1 "Dressing Rooms", "Jelly Donuts", and "Straws": An Exploration into How Urban, Kindergarten Girls Integrate Scientific and Everyday Discourse

Cassie F. Quigley, Indiana University, cquigs@indiana.edu Gayle A. Buck, Indiana University

ABSTRACT: Presently there is a global initiative of maintaining worldviews, languages, and environments of which science education can be a part (McKinley, 2007). Using the framework of congruence and third space theory informed by worldview theorists, the purpose of this paper is to understand the how and the extent to which scientific discourse is incorporated into their funds of knowledge in urban kindergarten girls at an all girls science academy. Over the span of 6 weeks, the authors observed, videotaped, photographed and interviewed girls in a kindergarten classroom (n= 28) at an all girls elementary school in an urban area. The primary data sources include field notes of participant observations and Photo-talk (Serriere, 2007) interviews with the girls. During the Photo-talks, the girls described the incorporation of scientific discourses in their language and the authors were able to use gain understanding into their language acquisition, which could point to Third Space construction in their classroom and ultimately promote scientific discourse in classrooms. In this way, these conversations are one tool that researchers can use to describe Third Space construction from the students' point of view.

S7.14.2 Young People's (Grade 4/5) Aspirations and Interest in Science

Louise Archer, King's College London, Iouise.archer@kcl.ac.uk Jennifer DeWitt, King's College London Justin Dillon, King's College London Jonathan F. Osborne, Stanford University Billy Wong, King's College London

ABSTRACT: The concern about students' engagement with school science and the numbers pursuing the further study of science is an international phenomenon and a matter of considerable concern amongst policy makers. Research has demonstrated that the majority of young children have positive attitudes to science at age 10 but that by age 14, their attitude and interest in the study of science has been largely formed. The ASPIRES project – a funded 5 year longitudinal study seeks to determine how students' interest in science and scientific careers evolves. As part of the initial study, 6 focus groups were undertaken with young students, age 10, to explore their attitudes towards science and interest in science, the findings of which are presented here. This preliminary work was conducted by drawing on a theoretical framework of identity which views the students' responses through a lens that sees identity as an embodied and a performed construction, that is both produced by individuals and shaped by their specific structural locations. This work offers new insights into the manner in which students construct representations of science and scientists and valuable lessons for those engaged in curriculum development and policy.

S7.14.3 Children's Learning about Water through Discourse-in-Interaction

Charles Max, University of Luxembourg, charles.max@uni.lu

Christina A. Siry, University of Luxembourg

Gudrun Ziegler, University of Luxembourg

ABSTRACT: This proposed presentation presents research that investigates the interconnectedness of scientific inquiring in multilingual settings, focusing on student-to-student interactions around the teaching of water as an element. Specifically, the deployment and development of discourse competencies in interaction grounds processes occurring within small inquiry groups of children from preschool, first and second grades. The rationale behind this research is to explore the social, cultural and historical nature of science learning, through linking learners' knowledge building in terms of scientific reasoning with discourse-in-interaction. To that end, this work documents the multimodal nature of 4- to 8-year-old children's spontaneous ways of arguing, reasoning, imagining, representing and knowing about the properties of water, while collaboratively investigating this element with everyday equipment. The

project has generated tangible outcomes about the multimodal, and discursive ways of young children's enacting of knowledge and reasoning about elementary science topics. A specific emphasis in the findings is on processes of enrichment or of fundamental reorganization of the children's spontaneous frameworks through enacting-in-interaction.

S7.14.4 Connecting Urban Students to Science: The Importance of Building Social Capital and Enacting Reality Pedagogy

Sheila I. Borges, Teachers College, Columbia University, sib2110@columbia.edu

Alissa Berg, Teachers College, Columbia University

Tanzina Taher, Teachers College, Columbia University

Christopher Emdin, Teachers College, Columbia University

ABSTRACT: Using a sociocultural theoretical framework as a base, this paper discusses a yearlong study of three novice teachers' in their attempts to develop stronger relations with their students in hopes of improving the teaching and learning in their science classrooms. The site for this study was an Urban Public high school where 97% of the students qualified for free/reduced lunch and the student population was primarily African American and Latino/a. The first of the three teachers was Taylor. She is a white female from a small town outside of the urban school who was 27 years old and beginning her second year of teaching. Russo, the second teacher, is an Italian-American male who was 26 and embarking on his third year of teaching. The third teacher was Rivera, a 29-year-old female in her third year of teaching who identified herself as white and Latina. One university researcher was paired with each teacher. They made weekly visits to their partner teachers' classroom, observed lessons, and facilitated dialogues with students and their teacher. To inform the research, data was collected in the form of video recordings of classroom lessons and student-teacher dialogues, tape-recorded interviews, field notes, student artifacts, and lesson plans.

Strand 12: Educational Technology

S7.15. SC-Paper Set: Examining Classroom Contexts and On-Line Learning Environments

2:15pm – 3:45pm, Conference Room 412

S7.15.1 Technology Mediated Teacher Student Interactions and Classroom Discourse

 $Sibel \ Uysal-Bahbah, \ Florida \ State \ University, \ sibel.uysal@gmail.com$

Colleen Megowan-Romanowicz, Arizona State University

David A. Birchfield, Arizona State University

Mina C. Johnson-Glenberg, Arizona State University

ABSTRACT: Technology is part of our life and the integration of technology is essential in our school system. SMALLab, the Situated Multimedia Arts Learning Laboratory, is a semi-immersive mixed reality learning environment that affords face-to-face interaction by co-located participants within a 3-dimensional space informed by visual and sonic media that respond to participants' movements and gestures within the space. This paper explores two of the reasons that SMALLab provides a better science teaching and learning environment. Our research shows that SMALLab increases positive teacher-students interactions and increases students' oral discourse in comparison with regular lecture and laboratory instructional environments

S7.15.2 Project PEER: Supporting Teachers and Students in a Virtual Community of Learners

Rodelyn P. Stoeber, St. Boniface College

Brian Lewthwaite, University of Manitoba

ABSTRACT: Many challenges face teachers teaching science in the rural context. Project PEER, "Petites écoles en réseau:" or the Creation of a Small School Network seeks to understand and alleviate the risk factors impacting on science delivery of these teachers through the use of Internet technological tools with the objective of promoting teacher sharing and collaboration. A model for science delivery was developed and tested in a pilot project in order to determine how technology can be integrated into a professional development strategy that takes into account the needs of teachers within the rural, minority language context. An interpretive case study approach involving four teachers was conducted in which data was collected though semi-structured individual interviews with teachers and consultants at the divisional and provincial level; teacher questionnaires; transcriptions of online and face to face discussions between the participants and electronic Internet documents. The initial findings indicate that both teachers and students benefited from their involvement in the model of science delivery despite certain technical and logistical problems. An anticipated outcome of this ongoing project is the increased resilience of teachers through the sustained support of the professional development strategies incorporating Internet technologies.

S7.15.3 The Development and Structure of Student Communities in the Secondary Blended Learning Science Classroom Jonathan B. Crymes, The University of Georgia, joncrymes@gmail.com

ABSTRACT: Researchers have determined that students enrolled in blended classes typically have a greater engagement with the class, a greater understanding of the material, enjoy the class more, prefer its structure over traditional classes, and generally do it in less time. However, few of these studies have focused on the primary or secondary levels of education and there is little rigorous or relevant guidance in creating, implementing, sustaining, and improving these blended classes. This study investigated how students create and interact in online communities in four Advanced Placement Physics blended classes. Students were initially confused and

resistant to an online component, but soon realized they had a powerful tool. They actively and quickly engaged in building an online community for homework and class work support, socialization, problem solving, and even regulating behavior within the community. Enjoyment of the class was attributed to its online component, including making new friends, helping students understand the material, and giving community support. The students feel a sense of connectedness to their class, peers, and class work even while away from the classroom. Learning becomes a more collaborative endeavor and students commonly create and manage online communities for support, socialization, and increased learning.

S7.15.4 Examining Argument Structures Developed by Students Engaging in Online Discussion on Inquiry Investigations

Aeran Choi, Kent State University, achoil@kent.edu

Brian Hand, University of Iowa

Lori Norton-Meier, University of Louisville

ABSTRACT: The purpose of this study was to investigate the online discussion produced by 5th grade students who were engaged in in-class inquiry scientific investigations. Each group of students from five different classes taught by two teachers presented their group question, claim, and evidence; negotiated the meaning of their inquiry-based investigation with other participant students in written form in online discussion. Seven-hundred thirty-nine notes were produced by one-hundred seven students in the online discussion of a first semester 'Plant Investigation' where each group of students generated one or two their own testable questions on how environmental factors affect plant growth. Six hundred seventy- one notes were produced in the online discussion of a second semester 'Human Health Investigation' where each group of students was provided with one patient's symptoms and requested to do research so as to collect data to diagnose each patient's health problem. Data analysis indicated that students in both online discussions focused on negotiating the evidence regarding reliability, validity, and sufficiency, in order to make sure that the provided evidence supported their claims. In addition, the students challenged and queried about test procedure in the Plant Investigation online discussion online discussion.

Strand 12: Educational Technology

S7.16 Administrative Symposium: Investigating Virtual Learning Environments in STEM Education

2:15pm – 3:45pm, Conference Room 501

Presenters:

Robb Lindgrenn, Stanford University, robblind@stanford.edu

Melissa Gresalfi, Indiana University

Chris Dede, Harvard University Keisha Varma, University of Minnesota

ABSTRACT: This symposium presents a progression of research on virtual learning environments in science education. Dr. Robb Lindgren studies how the ability of virtual environments to offer novel physical perspectives can facilitate learning. In his presentation, he will discuss the potential for using these environments for conveying "expert perspectives" that give learners the opportunity to experience doing actions in an expert way. Dr. Melissa Gresfali will introduce designs that can enhance students' consequential engagement with content to support procedural and conceptual understanding of key ideas in science. She will discuss the potential of virtual environments for supporting /dispositions/ towards meaningful disciplinary engagement. Dr. Chris Dede will summarize results from four funded projects studying immersive learning and assessment in STEM fields for middle school students. The interactive media involved include both multi-user virtual environments and augmented reality. He will discuss findings, lessons learned, and heuristics for the design of effective immersive learning experiences. The discussant, Dr. Yasmin Kafai, will use a constructivist lens to synthesize the presentations and discuss how the presented work fits into the larger research agenda around gaming, simulations, and virtual worlds. The audience will then have time to interact with the presenters and the discussant.

Strand 13: History, Philosophy, and Sociology of Science

S7.17 SC-Paper Set: Frameworks and Factors Associated with Science Epistemologies

2:15pm – 3:45pm, Conference Room 413

S7.17.1 A Study of Student Beliefs about the Epistemology of Science and their Relationship with Students Personal Epistemologies

Jonathan F. Osborne, Stanford University, osbornej@stanford.edu Christodolou Andri, King's College London Howell-Richardson Christina, King's College London Katherine Richardson, University of London Shirley Simon, University of London ABSTRACT: A recent trend in the teaching of science has been to place greater stress on teaching about the nature of science. One of the goals of this emphasis has been to improve students' knowledge and understanding of the epistemology of science. More recently

another body of research has begun to explore and measure students' personal epistemologies. Therefore, the research presented in this paper sought to explore the extent to which students' epistemic beliefs and their personal epistemologies were related using a sample of 480, Grade 6 and Grade 8, UK students. Students' beliefs about the nature of science were measured using both a questionnaire and interview-based study with instruments adapted from previous research. Their personal epistemic beliefs were assessed using an instrument developed by Deanna Kuhn et al. and from the interviews. Quantitative data were analyzed using SPSS and the qualitative data from the interviews coded and analyzed for their principle themes using NVivo and then compared. The findings fill a gap in the literature offering some insights into the relationship between these two constructs suggesting that students' personal epistemologies are more sophisticated than their understanding of the epistemology of science. The implications for the teaching of science are explored

S7.17.2 Nature of Science in Science Education: Toward a Coherent Framework for Synergistic Research and Development Fouad Abd-El-Khalick, fouad@illinois.edu

ABSTRACT: Making headway with the crucial domain of teaching and learning about nature of science (NOS) in precollege science education necessitates synergistic, long-term research and development efforts. While these efforts should be pluralistic rather than single-minded, they nonetheless need to draw on a coherent broad framework. Such a framework has been, and continues to be, wanting because of a lack of clarity about the nature of the construct of NOS (I am not referring here to the usually invoked philosophical, historical, or sociological discords about what is NOS). In particular, discourse, research, and development related to NOS have been guided by two broad, mostly confounded perspectives, which I label here as the "lived" and "reflective" perspectives. The result has been bifurcated research and development efforts that, at best, lack synergy and, at worst, seriously hamper progress within the field. This position paper explicates the assumptions underlying the two perspectives, and examines their implications for research and development efforts related to teaching and learning about, as well as assessing conceptions of, NOS. Next, the paper outlines a framework that could foster synergy within the field and help advance both research and development efforts related to NOS in science education.

S7.17.3 The Unique Nature of Biology, the Changing Nature of Biological Research and Questions Raised for Biology Education

Matthew J. Kloser, Stanford University, mkloser@stanford.edu

ABSTRACT: Contemporary research has failed to articulate the differences between both the nature of and teaching of biology and the physical sciences. National standards and textbooks include elements on the nature of science, but fail to articulate the distinct differences in the questions, methods, and types of evidence accepted in these different disciplines. Traditional nature of science discussions often portray all sciences in light of an essentialist, reductionist, and deterministic framework applicable to physics and chemistry, but contrary to the nature of biology. Furthermore, biology, as the study of life, assumes unique ethical dilemmas that physical science research only confronts through the application of technology. While biological sciences in the 21st century are shifting toward more quantitative questions and methods that previously defined physical science research, articulating biology's continuing autonomy may have important implications for the teaching and learning of biology. This paper examines the essential differences between biology and the physical sciences and raises significant questions about how the historic and current nature of biology can impact biology curriculum and instruction to improve student conceptual understanding.

S7.17.4 Effect of Student Level Variables on Elementary Students' Nature of Science Views

Esme Hacieminoglu, Selcuk University, ehacieminoglu@gmail.com

Hamide Ertepinar, Middle East Technical University

Ozgul Yilmaz-Tuzun, Middle East Technical University

ABSTRACT: The purpose of this study was to investigate which of the student level variables help to explain the difference in understanding the nature of science (NOS) views. The sample included 3,062 students enrolled in sixth, seventh, and eighth grade elementary schools located in Cankaya, Turkey. Data was collected during the spring of 2008. The Nature of Science Instrument, Learning Approach Questionnaire and Achievement Motivation Questionnaire were applied to the students. Hierarchical linear modeling (HLM) was selected as a modeling technique to investigate how the student level factors influence the students NOS views. Random coefficient model was conducted to determine student level variables that explain the differences in the students' NOS views. Results revealed that grade level, science achievement, highest educational level of parents and learning and motivational factors are also related at least two dimensions of NOS. It can be concluded that all of these variables are related with each other either directly or indirectly and affected students' NOS views related to different dimension. For example parents' education level was another important factor in students' NOS understanding. Results showed that when education level of parents' increased, their children' NOS understanding also increased.

Strand 15: Policy

S7.18 Administrative Symposium: STEM Education Engagement and Advocacy: An Examination at Different Organizational Levels

2:15pm – 3:45pm, Conference Room 415

Discussants:

Charlene M. Czerniak, The University of Toledo, Charlene.Czerniak@utoledo.edu

Kadir Demir, Georgia State University

Camillle Sutton-Brown, Georgia State University

Carla C. Johnson, University of Cincinnati

Norman G. Lederman, Illinois Institute of Technology

Judith S Lederman, Illinois Institute of Technology

Mary Cummane, Perspectives/IIT Mathematics and Science Academy

Chad D. Ellett, CDE Research Associates, Inc.

Lisa Martin-Hansen, Georgia State University

ABSTRACT: Despite the increased efforts at the federal and state levels, STEM education has not progressed at the desired rate, and it is still in need of much improvement if students are to compete in our knowledge-based society. In many ways, local and national policy can act as barriers to effective science learning environments, as teachers oftentimes focus on drill and practice to prepare students for paper and pencil high stakes assessments. Community engagement, leadership, and advocacy are instrumental in implementing and sustaining educational reform, and a lack of inter-organizational support may undermine even the best-designed programs. This symposium presents 4 papers that center on stakeholder involvement and the role that community, business, and other partners can play in the change process. In this symposium, participants will discuss issues surrounding the need for stakeholder advocacy at the neighborhood, community, district, university, and state levels. Additionally, issues of corporate involvement in STEM education in the greater community, and how state policies affect the various components of STEM education will be shared.

Strand 1: Science Learning, Understanding and Conceptual Change S8.1 SC-Paper Set: Scientific and Technological Understanding 4:00pm – 5:30pm, Conference Room 401

S8.1.1 The Role of Metaconceptual Awareness in the Change and the Durability of Conceptual Understandings

Mesut Sackes, The Ohio State University, msackes@gmail.com

Kathy Cabe Trundle, The Ohio State University

ABSTRACT: This longitudinal study examined the role of metaconceptual awareness in the change and the durability of preservice teachers' conceptual understandings of the cause of lunar phases. Sixteen preservice early childhood teachers who participated in an earlier study were the participants of this follow-up study. Two data gathering techniques were used. Semi-structured interviews were conducted to reveal the participants' conceptual understanding of lunar phases (pre, post, and delayed-post) and level of metaconceptual awareness (delayed-post only). Based on the change and stability in participants' conceptual understandings from pre to post and from post to delayed-post interviews, participants' conceptual understandings were assigned into three groups that described the profile of their long-term conceptual understandings: "decay or stability", "continuous growth", and "growth and stability" Results indicated that participants in "continuous growth" and "growth and stability" groups had significantly higher metaconceptual awareness scores than participants in the "decay or stability" group. The results of the Partial Least Square Path Analysis showed that the direct effects of metaconceptual awareness on conceptual change and the durability of conceptual change were statistically significant. The results provided evidence that metaconceptual awareness plays a significant role in the change and the durability of conceptual understandings.

S8.1.2 Recognizing and Applying the Explanatory Power of Pivotal Scientific Theories in the Science Classroom

Kevin D. Cunningham, University of Wisconsin - Madison, kdcunningham@wisc.edu

ABSTRACT: Theories are among the most valuable conceptual tools in science. What makes these fundamental ideas indispensable is their explanatory power—their unique ability to account for, unify, and systematize many seemingly disparate aspects of the natural world. Most science courses consider relevant theories, but if they are not routinely applied, students may be less likely or unable to use theoretical perspectives when constructing or evaluating descriptions, explanations, and predictions. In order to explore this potential relationship, this study examined the extent to which students in a classroom where the kinetic molecular theory (KMT) was regularly employed came to see this framework as fruitful. Specifically, do students grow to recognize the explanatory power of the KMT? Additionally, is there any correlation between the personal status afforded the KMT and a student's tendency to apply it as an explanatory mechanism? While students considered the KMT to be important, they generally failed to acknowledge its explanatory power, and those who expressed a lower regard for the KMT were less likely to apply its concepts and principles. Analysis of data

gathered through student-generated models, surveys, and individual interviews suggest factors shaping students' applications and perceptions of the KMT and why they might do so.

S8.1.3 Children's Learning about Materials Science through Engineering-Design-Based Instruction

Kristen B. Wendell, Tufts University, kristen.bethke@tufts.edu

Hee-Sun Lee, Tufts University Department of Education

ABSTRACT: This paper examines how children's materials science performance changes over the course of science instruction based on an engineering design task. We studied nine third-grade children who participated in engineering design-based science instruction with the goal of constructing a stable, quiet, thermally comfortable model house. Their materials science learning was assessed by science workbooks and pre-post interviews. Used throughout the instructional sequence, the workbooks were embedded assessments that included reflection questions and data tables. The interviews consisted of two materials selection design tasks: selecting materials for a sturdy stepstool and for a warm pet habitat. There was a significant increase in interview performance from pre- to post-instruction, with an effect size of 1.3. These gains were significantly positively correlated with performance on the workbook tasks. The children who took greatest advantage of opportunities to record observations and reasoning in their science workbooks showed the greatest improvement on the interviews. These findings suggest that constructing written and pictorial representations may facilitate children's learning of materials science. This has implications for the development of any design-based science curriculum for children. Such curricula should provide ample opportunity for children to keep records as they plan, build, and test their design artifacts.

S8.1.4 Research on Undergraduate Students' Understanding of Nanoscience and the Development of a Nanoscience Concept Inventory

Alan K. Szeto, Purdue University, alan.szeto@calumet.purdue.edu

George M. Bodner, Purdue University

ABSTRACT: Five years ago, a multi-year project to study strategies to incorporate nanoscience in the existing science curriculum in Grades 7-16 in the United States began with the identification, description, and clarification of the "big ideas" in nanoscience. Since then, our cumulative experience in attempting to teach nanoscience under the project as well as our early research into undergraduate students' understanding of nanoscience had led us to develop a hypothesis. Our hypothesis was 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. The outcomes of the study reported here suggest that future work in investigating students' understanding of size-dependent properties of matter would seem to be fruitful endeavors. As far as our development of the Nanoscience Concept Inventory is concerned, placing heavier emphasis in generating and revising conceptual questions that focus on the topic of size-dependent properties seems to be very appropriate.

Strand 2: Science Learning: Contexts, Characteristics and Interactions S8.2 Symposium: Perspectives on Authenticity in Secondary Science Education 4:00pm – 5:30pm, Salon D

4.00pm – 5.50pm, Saio

Presenters: Anat Yarden, Weizmann Institute of Science, Rehovot, Israel, anat.yarden@weizmann.ac.il Maria-Pilar Jimenez-Aleixandre, University of Santiago de Compostela, Spain Clark A. Chinn, Rutgers University Michiel van Eijck, Eindhoven University of Technology, The Netherlands Hadas Gelbart, Weizmann Institute of Science, Israel Luis Fernández-L'pez, University of Santiago de Compostela, Spain Beatriz Bravo, University of Santiago de Compostela, Spain Beatriz Bravo, University of Santiago de Compostela, Spain Ravit Duncan, Rutgers William J. Pluta, Rutgers

ABSTRACT: In this symposium we suggest to present and discuss different perspectives on authenticity in secondary science education. We will initially challenge the various means of the term authenticity. Subsequently, we will present results collected in three different contexts in which the use of authentic scientific practices was examined in terms of teachers' practices and students' outcomes. We will end with a theoretical perspective claiming that authentic forms of science education appropriate the dynamics of science, which is required in any curricular reform for scientific literacy. We will show that the authenticity of practices depends on their purpose, design and scaffolding provided by the teacher. Indeed, teacher practices that can be associated with student performance include: making criteria for good models and good arguments explicit to students, focus class talk on why and how evidence supported or contradicted different models, and using various means to establish strong epistemic norms for group work. In the context of learning genetics, we will show how a teacher apprenticed her students to use their general inquiry thinking skills and prior genetics knowledge in a way that enabled the students to recognize the research practices as well as the heuristic strategy of genetics.
Strand 2: Science Learning: Contexts, Characteristics and Interactions

S8.3 SC-Paper Set: Contexts and Factors Influencing Students' Science Attitudes and Interests 4:00pm – 5:30pm, Conference Room 402

S8.3.1 Post-16 Participation in Physics: A Survey to Explore the Factors that Influence It

Fani Stylianidou, University of London, F.Stylianidou@ioe.ac.uk

Tamjid Mujtaba, University of London

Michael Reiss, University of London

Bijan Riazi-Farzad, University of London

ABSTRACT: This paper presents the preliminary findings of a study that explores the factors that shape student engagement with physics and choices for further study after the age of 16. Our analysis draws on questionnaires completed by 1905 students aged 14/15 years from 63 secondary schools in England and utilizes multi-level modeling methods to ascertain which school and student level indicators have independent influences in explaining students' stated intention to participate in physics post-16. We find that student self concept in physics and extrinsic motivation are key psychological factors. Other important factors are student ethnicity and gender and their understanding of core physics concepts, namely electricity and forces. We also have found that school policy plays an important role in reducing gender biases and in general, for all pupil groups, increasing the intention to participate in physics. Schools with a higher proportion of classes taught by physics specialists helped reduce some of the gender bias and ensure a more advantageous learning environment for females. We also conducted a comparative multi-level analysis on science attainment at age 11 which indicates that there seems to be different forces in play that explain difference between motivation to study physics post-16 and actual attainment.

S8.3.2 Learning With Black-Box-Experiments

Gunnar Friege, Leibniz University, Germany

ABSTRACT: Experiments of the black-box-type can be understood as problem solving experiments and has been investigated by us in three studies. Students often fail to solve a black-box-experiment even if they have the knowledge and even if they are advanced solvers of theoretical problems. Experimental problem solving is not studied as often and deep as theoretical problem solving. In study 1 we were aiming at finding the central solution steps and the main difficulties or barriers in solving this type of experiments with the intention to use these results in physics instructions. What determines the success in solving experiments of the black-box-type? Often black-box-experiments are compared to a riddle and it is sometimes asserted that intelligence is the most important factor for solving these experiments. The different opinion to that emphasizes the influence of domain-specific knowledge for the solution process. We investigated this research question in a small exploratory study 2. The motivation of students are assumed to be dependant on the difficulty of the tasks. The highest motivation is often said to occur with moderate difficulty whereas easy and difficult tasks are not very motivating. The cognitive demand, motivation and the difficulty of several black-box-experiments estimated by the pupils has been investigated in study on young pupils in regular school teaching.

S8.3.3 An Investigation of Children's Interested and not Interested Science Topics in Textbooks

Fu-Pei Hsieh, Kuang-Hua Primary School, Kaohsiung, Taiwan, sfp.sfp@msa.hinet.net

Sung-Tao Lee, Naval Academy

ABSTRACT: The purpose of this study was to investigate the science topics that children felt interested and not interested in Textbooks for compiling science texts to improve their learning. Four hundred and eighty-eight fifth and sixth graders were invited to finish Interested Science Topics (IST) questionnaire which was composed of three subscales of (1) the science contents in textbooks (Textbooks), (2) science-related ads (Ads) and (3) science news (News). The findings in this study were based on the data collected in Textbooks subscale. The analyses were conducted by t-test and descriptive statistics, including percentage and bar chart. The results indicated that more than 50% of the students felt interested in the five most interested topics shown in ISTs, with only a few exceptions. However, the number of interested students dropped to about 30% when it comes to the five least interested topics in ISTs. Moreover, the results of t-test also revealed that there were significant mean differences with different effect sizes in science achievement between different genders, graders and areas. Finally, some implications for future research and science teaching were discussed.

S8.3.4 Contextualization across Curricular Interpretations: A Case-Study of a Project-Based Learning Environment Kathryn F. Drago, University of Michigan, kdrago@umich.edu

ABSTRACT: Science education reform documents recommend contextualization to support integrated student learning. However, contextualization is not well-characterized or researched in the education literature. In this study, I created a framework for contextualization by applying theory from diverse literature to the analysis of contextualization in the classroom. Then using this framework, I analyzed contextualization in a case study of an inquiry-oriented, project-based middle school science curriculum. Coordinating analysis of written teacher materials (formal curriculum), classroom video (enacted curriculum), and student interviews (attained curriculum) allowed me to make complex assertions about contextualization across curricular interpretations. Findings suggested that the formal and enacted curriculum supported students building normative science ideas through illustrative learning tasks. However, students often held non-normative conceptualized understanding likely due to modification of features that make

conceptions visible for revision in the enacted curriculum. This work also suggested other categories of contextualization that require more research into how they interact with learning. Through the analysis of contextualization in practice, I developed a greater understanding of how this tool might support learning. Teachers and curriculum designers can then apply this more nuanced understanding of contextualization from research to back to practice to improve student outcomes in the classroom.

Strand 3: Science Teaching--Primary School (Grades preK-6): Characteristics and Strategies S8.4 SC-Paper Set: Hearing From the Teachers: Their Thoughts on Inquiry Teaching 4:00pm – 5:30pm, Conference Room 403

S8.4.1 Examining the Beliefs and Practices of Two Effective Primary Science Teachers

Angela C. Fitzgerald, Edith Cowan University, Perth, Australia, afitzge1@student.ecu.edu.au

ABSTRACT: Teachers are key players in the reinvigoration of science education. However, there is much focus on highlighting the shortcomings associated with teaching and learning in science. If the status and quality of science education in schools is to improve, there needs to be efforts made to better understand what is required. With key stakeholders identifying science education as an area requiring improvement, the time is right for investing research energy into uncovering what effective science teachers are actually doing in the classroom. Two primary school teachers, nominated as effective teachers of science, participated in Phase 1 of this doctoral study. Data was collected through classroom observations of science lessons and teacher interviews about their beliefs regarding science teaching and learning. This paper summarises the preliminary findings for Deanne and Lisa. Several themes were identified as characterising the beliefs and practices of the two teachers. It was found that the beliefs of the teachers influenced how they teach science in their classrooms and why they teach science in the ways they do. The themes were reflective of the different contexts that the teachers were working within and were essentially linked to the development of student interest towards and understanding of science.

S8.4.2 Teachers' Voices on Integrating Metacognition into Science Education

Nir Orion, Weizmann Institute of Science, adi.ben-david@mail.huji.ac.il

Adi Ben-david, Weizmann Institute of Science

ABSTRACT: This study is an attempt to gain a new insight, on behalf of science teachers, regarding the integration of metacognition into science education. Participants were 44 elementary school science teachers attending an INST program. Data collection was carried out by triangulation of several data sources: recordings of all verbal discussions that took place during the program, collecting teachers' written assignments and semi-structured interviews. Our findings provide a qualitative analysis of the 44 teachers' voices as a group, as well as a detailed case-study narrative analysis of 3 teachers' stories. The findings show that the teachers' intuitive knowledge was very poor and unsatisfactory and their voices were skeptic and against it. Following the INST program (a) Teachers expressed amazement how such an important and relevant issue was almost invisible to them. (b) Teachers identified the affective character of Metacognitive Experiences as the most significant metacognitive component that acts as a mediator between teaching and learning. (c) The non-existence of learning materials addressing metacognition and the absence of supportive in-classroom guidance were identified as the major obstacles for its implementation. (d) Teachers expressed a willing to continue their professional development for expanding their abilities to integrate metacognition as inseparable component of science classroom.

S8.4.3 Exploring Primary Teachers' Conceptions of Science Teaching: Implementing Inquiry Science Lessons

Uzma Khan, Syracuse University, umkhan@syr.edu

Sharon Dotger, Syracuse University

Vicki McQuitty, Davis College

ABSTRACT: The purpose of this study was to explore what influences primary teachers decision making when teaching science through participation in a lesson study group. This paper describes how teachers conceptualize science teaching and implement their practice. It provides insight on what motivates them to implement the science lessons they use and highlights their decision making process. An integrated cognitive framework (Spillane, Reiser, Reimer, 2002) was used along with lesson study as a professional development strategy. A constant comparative methodology was used. This study highlights a case that helps us to see how teachers enact a lesson that differs widely from their traditional practice. Their natural sense-making processes can lead to the types of challenges observed in our study. Our framework suggests that learning new ideas requires restructuring of existing schemas. Our research has surfaced the complexity of enacting new instructional approaches beyond an act of encoding.

Strand 4: Science Teaching--Middle and High School (Grades 5-12): Characteristics and Strategies S8.5 Related Paper Set: Teaching in Whole Class Discussion Mode: Teaching Strategies, Interactive Simulations, and Science Learning

4:00pm – 5:30pm, Conference Room 404

S8.5.1 Case Study of Teaching Strategies Used Before, During and After a Simulation to Scaffold the Development of a Visualizable Microscopic

Norman Price, University of Massachusetts-Amherst, nprice@educ.umass.edu

Abi Leibovitch, University of Massachusetts-Amherst

ABSTRACT: We examined video and transcript evidence of two teachers leading middle-school classes through one lesson in Lee's (1993) Matter and Molecules curriculum. This lesson addressed what happens on a molecular level when we smell something. The teachers both used a simulation designed to mimic particle motion in order to give students a visual depiction of what occurs on a microscopic level. They also utilized an overlay technique, drawing both the cookies and the noses of individual students, to bridge the conceptual understanding between the microscopic explanation of molecular motion and the students' everyday experience of smelling cookies (macroscopic). This strategy was used as part of a strategic sequence: 1) present a macro phenomenon; 2) probe the initial student models of this phenomenon at the micro level; 3) use an overlay simulation to promote modification of student micro models; 4) use the new student model to prompt student ideas for modifying the simulation; 5) assess student micro models with a drawing prompt about a new phenomenon. Our analysis focuses on examining the lesson strategies and teacher moves used to generate student model modification and encourage class discussion around the simulation with the higher order goal of achieving meaningful conceptual change.

S8.5.2 Supporting Students' Construction of Mental Models for Electric Circuits: An Investigation of Teacher Moves Used in Whole Class Discussions

E. Grant Williams, School District 18, Fredericton, New Brunswick, Canada, Grant.Williams@gnb.ca

ABSTRACT: In this paper, we present a synopsis of teaching moves or strategies used during whole class discussions by high school physics educators in their attempts to supports students' construction of explanatory mental models for concepts in circuit electricity. Using a combination of hands-on partnered cooperative learning activities followed by whole class discussions, these teachers appeared to be able to foster significantly greater pre-to- post treatment gains in students' abilities to solve conceptual electric circuit problems than students who were instructed through more traditional didactic means. The whole-class discussion-based teaching strategies that we believe supported the students' active engagement in reasoning and mental model construction are portrayed in a chart format that: a) lists the specific teacher moves, b) provides examples of the moves from transcription of classroom conversation, c) organizes the moves into larger categories, and d) classifies these categories according to their contributions to the cycle of Observation, Generation, Evaluation and Modification that we have observed occurring during model construction process in a wide variety of science topics and grade levels. It is our intention that this study will contribute to the growing body of research on the effective uses of whole-class discussion-based instructional strategies in supporting students' understandings of abstract concepts in science.

S8.5.3 Small Group vS Whole Class Use of Interactive Computer Simulations: Comparative Case Studies of Matched High School Physics Classes

A. Lynn Stephens, University of Massachusetts-Amherst, lstephens@educ.umass.edu

John J. Clement, University of Massachusetts-Amherst

Ileana Vasu, University of Massachusetts-Amherst

ABSTRACT: Although it is generally felt that online simulations are better used in small groups working hands-on at computers, many teachers do not have ready access to the number of computer stations required. We ask whether teachers can engage students in effective, active learning when the students are not able to explore a simulation/animation on their own. Several teachers taught a number of high school physics topics to their classes in either of two conditions: a) small groups working hands-on at computers with simulations, and b) whole classes observing simulations projected from a single computer onto a screen before the class. We examine sets of matched classes to compare pre-post gains and teaching strategies used. The three teachers of the classes analyzed here anticipated that the small class format would work better, and students did appear at first glance to be more engaged in small groups. However, results showed that the whole class format produced similar—and in one comparison, significantly stronger—gains, as measured by pre-post tests. We use the pre-post results and videotape evidence to look at issues that might have affected student learning in the two kinds of situations.

S8.5.4 Computer Simulations to Teach Kinematics in Large and Small Group Settings: Achievement, Gender and Attitudes Ileana Vasu, University of Massachusetts-Amherst, Ivasu@educ.umass.edu

Renee C. Sweeney, Westfield High School, Massachusetts

ABSTRACT: This exploratory study examines in what ways a computer simulation used in two different formats impacted student understanding of uniform accelerated motion in an Honors Physics high-school lesson sequence. We examine student performance

and the effects of gender on performance in Small and Large Group teaching formats, based on current theory that achievement in the science classroom with technology is gender dependant. Attitude surveys showed an overall gender difference and suggested a possible interaction between gender and teaching format, but pre-post tests did not bear this out, showing no significant difference in gains between the two formats and no interaction between gender and format. There was a trend, however, toward gender differences across formats, though not significant at the $\alpha = .05$ level. The male students studied had a better attitude toward technology and scored slightly (though not significantly) higher than female students on each concept tested. Interestingly, female students, although they indicated they preferred to work in smaller groups, had slightly higher gains in the larger format. Attitude surveys indicated that students believed they need time to get used to technology and preferred that simulations be combined with classroom discussions.

Strand 5: College Science Teaching and Learning (Grades 13-20) S8.6 SC-Paper Set: Inquiry-based Laboratory Experiences for Undergraduates

4:00pm – 5:30pm, Conference Room 405

S8.6.1 A Cross-Case Study on Implementing Inquiry-Based Laboratories at the University Level

Stephen B. Witzig, University of Missouri, sbwitzig@mizzou.edu Ningfeng Zhao, East Tennessee State University

Ningieng Zhao, East Tennessee State Univers

Sandra K. Abell, University of Missouri

Frank J. Schmidt, University of Missouri

ABSTRACT: The U.S. National Science Education Standards provide guidelines for teaching science through inquiry. The difficulty in achieving this vision of the standards at the university level lies in how instructors interpret/implement inquiry. In an NSF-funded professional development project, faculty developed new inquiry- based laboratory materials using the "mini-journal" approach. The mini-journal is designed as an alternative to cookbook laboratory curricula and represents the way that scientists conduct and report science. This study took place at four different institution types, spanning disciplines and course levels. The research design used a qualitative approach including laboratory observations, semi-structured interviews with the instructors/students, course surveys, and analysis of course documents. The findings of this cross-case analysis describe the teaching and learning strategies that were implemented, and the views of instructors/students. This research provides a concrete example of how instructors incorporated inquiry-based curricula in science courses at the university level in various contexts. Although there were differences at each setting, we found: 1) inquiry-based curriculum could be incorporated in college classrooms, regardless of institutional context, 2) mini-journals were effective in engaging students, and 3) despite more work involved with mini-journals, students reported improved learning and a gain of understanding of the scientific enterprise.

S8.6.2 Use of Self-Explanations in Chemistry Laboratory Reports: Supporting Student Procedural Understanding and Transitioning Laboratory Curricula

Andrea G. Van Duzor, Chicago State University, agay@csu.edu

ABSTRACT: This qualitative, action-research, case study investigates how use of a writing method that emphasizes student self-explanations of procedures and outcomes, specifically the Decision/ Explanation/ Observation/ Inference method, supports student understanding of chemistry laboratory procedures. The context for this study was a year-long, organic chemistry laboratory course transitioning from verification to inquiry-based experiments. Explanation prompts were provided for initial experiments to scaffold student use of the writing method. Results indicate that explanation protocols encouraged students to understand the procedures and that students used the method recursively enriching their initial understandings in the laboratory. However, findings suggest that prompts should be used judiciously because they can subvert the student-centered intent of the method. The paper concludes with a discussion of the utility of this method for transitioning from a verification to an inquiry-based laboratory environment with results intimating that the method encourages a focus on student thinking but provides more structured support for technique than more complex, problem-based experiments. Implications of this study speak to means and methods of incrementally introducing student-centered, inquiry-based reforms into traditional organic chemistry laboratory courses.

S8.6.3 Argument Driven Inquiry: An Instructional Model for Use in Undergraduate Chemistry Labs

Joi P. Walker, Tallahassee Community College, walkerj@tcc.fl.edu

Jonathon Grooms, Florida State University

Brittany Anderson, Florida State University

Carol O. Zimmerman, Tallahassee Community College

Victor Sampson, Florida State University

ABSTRACT: This paper presents a new instructional model for undergraduate college chemistry called Argument-Driven Inquiry (ADI). ADI is designed to provide students with an opportunity to develop methods to generate data, to carry out investigations, use data to answer research questions, write, and be more reflective as they work. In addition, the ADI instructional model integrates opportunities for students to engage in scientific argumentation and peer review. ADI was piloted in select sections of General Chemistry I labs during the 2008-2009 academic year. During these three semesters the remaining lab sections were taught using a traditional method and used for a comparative study. Data indicate that students in the ADI labs perform as well as students in the in

traditional lab sections on assessments of conceptual understanding even though they complete fewer labs. Alternative assessments demonstrated that students in the ADI laboratory sections were better able to use evidence and reasoning to support a conclusion, and had a more positive attitude towards science.

Strand 6: Science Learning in Informal Contexts S8.7 Symposium: Intersections of Science Education Research and Practice and Issues of Access, Equity, and Culture

4:00pm – 5:30pm, Conference Room 406
Discussants:
Sandra T. Martell, University of Wisconsin-Milwaukee, smartell@uwm.edu
Leslie R. Herrenkohl, University of Washington
Doris Ash, University of California Santa Cruz
John H. Falk, Oregon State University
Jean Creighton, UWM Planetarium
Thao Mai, University of California Santa Cruz
Elizabeth R. Drame, University of Wisconsin-Milwaukee
Dale McCreedy, The Franklin Institute

ABSTRACT: In this special symposium, structured as a panel followed by an interactive discussion, learning sciences and informal science education authors bring together researcher and practitioner perspectives to address issues of access, equity, and culture. The symposium connects findings from research studies in relation to six themes, which feature overarching perspectives and questions. The studies focus on 1) resources diverse learners bring to informal learning experiences and how practitioners look at learners in different ways; 2) urban teachers and informal learning environments as resources that can inform pedagogy and understanding of the nature of science; 3) underrepresented and underserved audiences and knowledge acquisition in a planetarium; 4) situated identity-based leisure needs and the reframing of approaches to understanding science center-based visitorship and meaning making; and 5) nondominant groups and issues of engagement, identity, self-efficacy, and border crossing. The authors will first present empirical studies and then come together to talk with NARST audience members about the findings in relation to the themes of Understanding and Promoting Seamless Learning; Negotiating Local Meaning & Embracing Hybridity; Supporting Professional Development for Informal Educators and Learning Scientists; Cultivating a Community; Developing Generative Theories; and Promoting Generative Practice.

Strand 7: Pre-service Science Teacher Education S8.8 Related Paper Set: Transforming Science Teacher Education in Two Contexts (HBI and PWI): The Project Nexus Study (Years 1 – 4) 4:00pm – 5:30pm, Conference Room 407

S8.8.1 The Beliefs and Reported Science Teaching Practices of Newly Graduated Elementary and Middle School Education Majors

J. Randy McGinnis, University of Maryland, jmcginni@umd.edu Gili Marbach-Ad, University of Maryland Scott J. Dantley, Coppin State University Rebecca Pease, University of Maryland Amy H. Dai, University of Maryland ABSTRACT: Project Nexus was designed to develop and test a science teacher professional development model that prepares,

ABSTRACT: Project Nexus was designed to develop and test a science teacher professional development model that prepares, supports, and sustains upper elementary and middle level specialist science teachers. Participants (interns and beginning science teachers) benefited from a baccalaureate program that featured connecting transformative undergraduate science content courses with reform-aligned science method courses, supported internship experiences with adolescent students in informal education contexts, field placements in urban professional development schools, and ongoing innovative educational experiences that target the needs of minority and urban students. Our model was implemented at a Historically Black Institution (HBI) (63% African-American; 32% White), and a Predominately White Institution [PWI] Research University, Very High (81% White; 5% African-American). We collected and analyzed baseline data of the previous year's graduates of the two institutions' undergraduate elementary/middle school teacher preparation programs. The areas of interest included the new graduates' beliefs of science and science teaching and of their ethnicity/race in career decisions (to become teachers and how to teach). In our presentation, we will discuss the construction of a survey that measures "New Teachers' Beliefs and Practices of Science" and of our sample's responses compared with a sample of national teachers' responses.

S8.8.2 Promoting Science for All by Way of Student Interest in Transformative Undergraduate Science Non-majors Courses in Historically Black Institution and Primarily White Institution

Gili Marbach-Ad, University of Maryland, gilim@umd.edu J. Randy McGinnis, University of Maryland Scott J. Dantley, Coppin State University Spencer Benson, University of Maryland Amy H. Dai, University of Maryland Rebecca Pease, University of Maryland

ABSTRACT: During Year Two of Project Nexus, we investigated curricular and pedagogical innovations in undergraduate science courses for non-majors in two types of universities: Historically Black Institution (HBI) and Primarily White Institution (PWI). The aims were twofold: to improve students' understanding of science and attitudes towards science (by connecting their prior experience and interest to the science content) and to attract students (especially African Americans) to consider a degree in teacher education. Therefore, we redesigned two courses: The PWI Microbes and Society course and the HBI Technology and Human Affairs course. Both courses were developed with the same fundamental principles of teaching for all and connection to student interest. The final projects were designed so as to allow the students with the opportunity to choose their topic of interest, research this topic and prepare a group power-point presentation to share with the class. We assessed the consequences of the innovation by examining two perspectives: the students and the instructors. Data collection included: researchers' observations, the instructors' perspective and students' feedback. A major insight was that how the instructors perceived their roles within their contexts (PWI or HBI) influenced the way they designed, implemented, and assessed their learners.

S8.8.3 An Investigation of the Influence of an Informal Science Education Afterschool Internship in a Formal Science Education Teacher Preparation Program

Phyllis Katz, University of Maryland, pkatz15@gmail.com Emily Hestness, University of Maryland Kelly Riedinger, University of Maryland J. Randy McGinnis, University of Maryland Amy H. Dai, University of Maryland Rebecca Pease, University of Maryland

ABSTRACT: The Year Three study of Project Nexus highlighted the use of drawings as a way to gain insight into the influence of an informal science education component of an elementary teacher preparation program. The study took place within the context of an NSF-funded teacher preparation project that included an informal science education internship in prospective teachers' professional development. The central research question of the study was: To what level of success and for what reasons do field-based placements in afterschool informal science education programs that serve adolescent students affect the recruitment (and preparation) of college students, particularly those who are members of underrepresented groups, to be science specialist upper elementary/middle level teachers? We asked the interns (N=28) to draw two perspectives, "Draw Yourself Teaching Science" and "Draw Your Students Learning Science." These two prompts allowed us to analyze the pre- and post-test similarities and differences between two perspectives: the viewpoints of the teachers and their perceived viewpoints of their students. Our findings suggested that bridging formal and informal science education in teacher preparation by use of an afterschool internship impacts prospective teachers' attitudes, and perspectives on the use of manipulatives, inquiry, and student collaboration.

S8.8.4 Transforming Elementary Science Teacher Education by Bridging Formal and Informal Science Education in an Innovative Science Methods Course

Kelly Riedinger, University of Maryland, krieding@umd.edu Gili Marbach-Ad, University of Maryland J. Randy McGinnis, University of Maryland Emily Hestness, University of Maryland Rebecca Pease, University of Maryland Phyllis Katz, University of Maryland

ABSTRACT: During Year Four of Project Nexus, we investigated curricular and pedagogical innovations in an undergraduate science methods course for elementary education majors at a major research university in the mid-Atlantic. The goals of the innovative elementary science methods course included: to improve students' attitudes toward and views of science and science teaching; to model transformative science teaching methods; to encourage including elements of informal science education in teaching. We included aspects of informal science education and socioscientific issues. The course included informal science educator guest speakers, a live animal demonstration, a virtual field trip, and a global climate change curricular module. We compared data from a treatment course and a control course taught by the same instructor. Data collection included: researchers' observations, instructors' reflections, and students' feedback. Student feedback involved interviews, responses to drawing prompts, responses to reliable and valid instruments. We used complementary methods to analyze the data collected. A key finding of the study was that while benefits were found in both types of courses, the difference in results underscores the need to identify the primary purpose for innovation as a vital component of consideration.

Strand 8: In-service Science Teacher Education S8.9 SC-Paper Set: Urban Science and Reform

4:00pm – 5:30pm, Conference Room 408

S8.9.1 An Earth Science Professional Development for Urban Teachers

Younkyeong Nam, University of Minnesota, namxx020@umn.edu

John Oughton, Universiddy of Minnesota

ABSTRACT: Since 2004, a professional development program, called 'Earth System Science for K-12 Teachers (ESST)' was been offered in two large Midwest cities to support urban science teachers' understanding of earth and environmental science content knowledge relevant to the urban geological environment and to improve their skills of culturally responsive science teaching. Employing a formative evaluation study (Fitzpatrick, 2004), this study not only evaluates teacher participants' perceptions about the program but also probe impact of the program on urban teachers learning and practice about urban student and urban geological environment to suggest a positive way to improve the program. Mixed methods including quantitative analysis of survey and qualitative analysis of interviews, journals, and lesson plans were used. Through the program, the teachers gained knowledge of earth science teachings were not culturally responsive. Based on the teachers' perceptions about the overall program, we found that the program needs further improvements. However, it was apparent that urban teachers needed more systemic and sustainable supports from their schools to improve their culturally responsive science teaching using urban geologic sites.

S8.9.2 Challenges and Solutions of a Collaborative Science Professional Development in Urban Centers

Irene U. Osisioma, California State University Domiguez Hills, iosisioma@csudh.edu

Hedy Moscovici, California State University Domiguez Hills

ABSTRACT: This study explores the perception of participants and facilitators of a collaborative professional development on their development of deeper conceptual understanding, skills in using inquiry strategies, PD methodology, and their comfort level in implementing the density and buoyancy immersion unit in their classrooms. Data sources were pre and post institute surveys with participants and facilitators, PD videos as well as video of classroom implementation. Result show that while facilitators experienced growth in their comfort level in the PD methodology, participants developed knowledge and understanding of D& B content, as well as the skills and comfort level of implementing the unit in their classrooms. Implication for science education is discussed.

S8.9.3 Under The Fog of Science Education Reform: A Spotlight on Administrators

Rachel Ruggirello, Washington University, Rachel.Ruggirello@gmail.com

Sonya N. Martin, Drexel University

ABSTRACT: Research in the field of educational leadership suggests principals may be the most significant factor in determining whether school reform measures will be successful (Spillane, 2006; Fullan, 2002; Lewthwaite, 2004). One study demonstrated that an administrator's own experience with and value of mathematics, science and research-based teaching models informed their capacity to support reform (Nelson & Sassi, 2000a). These findings suggest that research on the role of administration in supporting science and mathematics education in schools is a real keystone to the issue of reform. This presentation foregrounds the knowledge, attitudes and perceptions of school administrators involved in a professional development program at a private university in a larger urban center. Utilizing a two-phase research design, this study examines the relationship between administrators and science teachers to uncover how administrators' understandings and beliefs inform their practices as building leaders and thus impact teaching practices. Additionally, this research highlights the activities of the program that have had a significant impact on administrator actions and underscores the implications of this program's impact on K-12 school science reform. Finally, this presentation outlines the ways in which our research transformed administrator practice and impacted the implementation of reform science teaching in their schools.

S8.9.4 Teaching Science in the City: Bridging Formal and Informal Science Learning Contexts with Preservice and Inservice Teachers

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

Jennie S Brotman, Barnard College, Columbia University

ABSTRACT: The purpose of this paper is to describe an innovative approach to inservice and preservice science teacher development that bridges formal and informal science learning contexts, the Science in the City seminar. The study focuses on the teachers' presentations of evidence of student learning from trips they made to the museum. The findings will show linkages between teacher education, teacher practices, and student learning through: a) novel use of the museum as a place to learn science connected to mandated science curricula, and b) clear, reciprocal connections between students' learning in the museum and in the science classroom. While drawing upon the tenets of design and evaluation research, this study seeks to build a set of theories and practices that may guide the recruitment and retention of science majors into teaching, the preparation of elementary and middle-level teachers in science education, and the design of science professional development experiences for in- service teachers, particularly for urban schools.

Strand 8: In-service Science Teacher Education S8.10 Symposium: Understanding the Complex Nature of Professional Development Characteristics that Impact Large-Scale Science and Technology Projects

4:00pm – 5:30pm, Salon C **Discussants:** Susan A Yoon, University of Pennsylvania, yoonsa@gse.upenn.edu Lei Liu, University of Pennsylvania Sao-Ee Goh, University of Pennsylvania Betty Chandy, University of Pennsylvania Jorge Santiago-Aviles, University of Pennsylvania James McGonigle, University of Pennsylvania Kira Baker-Doyle, Penn State Michael Schrlau, Temple University Robert Johnson, Temple University Dorothea Lasky, University of Pennsylvania

ABSTRACT: With the increased emphasis on technology integration in K–12 classrooms, educational researchers have signaled the need for more and better professional development opportunities (Cuban, Kirkpatrick, & Peck, 2001; Fishman & Pinkard, 2001). Professional development characteristics believed to be effective include social interaction and knowledge sharing (Garet et al., 2001; Goldman, 2005), collaborative inquiry and active learning to construct understanding (Goldman, 2005; Swan et al., 2002), and efforts to modify programs to adapt to situated contexts (Hughes & Ooms, 2004; Swan et al., 2002). However, these characteristics in technology implementation programs, as Dede and Honan (2005) summarize, are in need of continual investigation to answer the question what works when and how (Means & Penuel, 2005). In this structured poster symposium session, we introduce multiple research methods for examining the impact of professional development activities on teacher practices and student learning. The six studies focus on what the various research methodologies reveal about: i) teacher collaborative interactions; ii) pedagogical choices and adaptations that promote student learning; iii) influences of teacher beliefs and knowledge; iv) influences of teacher experiences and practices; v) teacher social networking behavior toward community building; and vi) scientist instructional practices to improve high school teacher knowledge.

Strand 10: Curriculum, Evaluation, and Assessment

S8.11 SC-Paper Set: Implementation of Reform-Based Science Curriculum and Assessment 4:00pm – 5:30pm, Conference Room 410

S8.11.1 Outdoor Learning Experiences Embedded in a Curricular Unit about The Local Environment: The Students' Perspective

Molly L. Yunker, University of Michigan, yunker@umich.edu

ABSTRACT: This study describes the changes in attitudes, content knowledge, and perspectives of 111 6th grade students who used a science curriculum that integrated and embedded outdoor learning experiences with classroom and laboratory activities. The curriculum focused on the interactions of components of Earth's four spheres, and was grounded in a study of the local setting in which it was enacted. Quantitative analyses were used to compare the mean scores of Likert scale questionnaires about students' attitudes towards field trips and the use of outdoor learning experiences during science class, and to compare pre and posttest content knowledge. Findings suggest that aspects of the enactment resulted in positive views and attitudes towards field trips for the social aspects. Students, on average, had higher scores on the content knowledge assessment after the curriculum enactment, and the amount of gain from pre to posttest differed based on the teacher's assignment of her students' to different levels of science ability. These findings will be supported by qualitative analyses of interviews with 12 students of differing science abilities from before and after the curricular enactment.

S8.11.2 Comparing Student Achievement across Time in Contexts Using a Coherent Inquiry Curriculum Versus Those Using Traditional Curricula

Joseph S Krajcik, University of Michigan, Krajcik@umich.edu

LeeAnn M. Sutherland, University of Michigan

Sean Smith, Horizon Research, Inc.

Brian J. Reiser, Northwestern University

David Fortus, Department of Science Teaching Weizmann Institute of Science

ABSTRACT: Research-based, well-designed science curricula are important in improving student learning. However, little research evidence exists to support the use of inquiry-oriented curriculum in promoting student learning. In this paper, we explore how the achievement of middle school students who experience a coherent, project-based inquiry curriculum compares with that of students

who participate in traditional science instruction. The Investigating and Questioning our World through Science and Technology project (IQWST), a 12-unit middle-school science curriculum, is aligned with national standards and project-based inquiry approaches, incorporates research-based practices that promote science literacy, and supports rigorous learning of science content and scientific practices across time. This paper presents the results of a national field test design for the first and second years of a 3-year study, in which a cohort of students who experience the IQWST curriculum is tracked across time and measured against a comparison group who experienced traditional curriculum. Both groups were administered a distal, benchmark-aligned assessment. Results indicate that all students show gains in understanding even though it was the first time teachers enacted IQWST. The paper shares information about how a curriculum designed to build conceptual understanding across time supports learners in developing coherent understanding of key science ideas.

S8.11.3 Addressing Challenges of Construct Validity through the Design of a Scalable Cognitively-Based Science Performance Assessment Task

Audrey S Whitaker, Columbia University, arw2131@columbia.edu

Ann Rivet, Columbia University

ABSTRACT: Assessment is an integral part of teaching and learning, yet research shows that most large-scale assessments in science are inadequate for measuring students' development of skills or thinking beyond a superficial level, without compromising rigor or validity. We present a design for addressing these issues through the use of cognitively-based performance assessment. Our approach combines the conceptual aspect of the BEAR assessment system (2005) with the philosophical approach to science performance assessments in order to more effectively measure the types of knowledge, practices, and skills that are integral to effective learning in science. Our design principles are intended to address many of the practical challenges that have prevented the widespread adoption of performance assessment, while preserving their capabilities to provide rich, detailed observations of student learning. In this initial work, we explore an instantiation of this design in the content area of geology.

S8.11.4 Student Involvement in Assessment -- A Vehicle for Disciplinary Learning

Janet E. Coffey, University of Maryland, College Park, jecoffey@umd.edu

Sandra Honda

ABSTRACT: The past two decades has generated a substantial amount of attention and research that helps us better understanding the multiplicity of forms and purposes assessment takes in classrooms. While assessment research has long-standing roots in summative purposes, gaining ground and visibility are recognition of the importance that assessment practices can have on student learning when used formatively. While research speaks to the value of involving students in assessment, much of the research work in formative assessment has focused on the teacher's role in assessment, and has not closely examined students' role in classroom assessment activity and the consequences that has for student learning. Drawing on intensive classroom observations, this paper focuses on student involvement in assessment activity and its consequences for science learning. The paper argues that involving students meaningfully in assessment can become a vehicle for deep science learning. Afterall, assessing ideas and reasoning sits as a fundamental element of scientific practice. As student learn to assess ideas in science, they are engaging in scientific practice and learning how to learn science.

Strand 11: Cultural, Social, and Gender Issues

S8.12 SC-Paper Set: Sense of Place and Social Justice in Science Education 4:00pm – 5:30pm, Conference Room 411

S8.12.1 Science Education, Radical Social Justice, and Scientific Heteroglossia: An Ethnographic Examination of the Street Medic Movement

Matthew Weinstein, University of Washington-Tacoma, mattheww@u.washington.edu

ABSTRACT: This paper examines the relationship of science and social justice by examining the medical and scientific practices of the street medic movement, a network of lay medical practitioners organized to facilitate protesters in areas where the conventional medical systems have been excluded. Such areas include demonstrations that have been declared civil disturbances including the recent G8 and World Trade Organization meeting protests. The paper reviews the history of the network starting in the 1960s civil rights struggles through their revival in recent demonstrations. The paper, drawing on ethnographic material, describes their training, education work, and field practices. The paper analyzes how these practices, discourse, and vision of medicine and science articulate with the largely anarchist—meaning decentralized, anti-hierarchical, socialist—politics of their communities. The paper also analyzes the street medic's use of clinical trials to find effective treatments for tear gas and pepper spray. The paper uses these experiments to theorize how the goal of social justice embraced by the street medics necessarily involves "scientific heteroglossia," the ability to speak across and to multiple scientific and medical traditions. Finally, the paper contrasts this with the monoglossia of science literacy and social justice embodied in Standards based conceptions of science education.

S8.12.2 How Sense of Place Matters: Lessons Learned from the Implementation of an Interdisciplinary Place-Based Curriculum

Tara B. O'Neill, University of Hawaii - Manoa, toneill@hawaii.edu

Angela Calabrese Barton, Michigan State University

Verneda Johnson, Issac Newton Middle School for Math and Science

ABSTRACT: The purpose of this paper is to offer an analysis of the tensions emergent in the implementation of a place-based air quality curriculum for middle-school students in Harlem, NY. In particular, we examine how the narratives of place embedded in the curriculum positioned the youth and teachers in particular ways with regard to each other, science and the community. We also explore how the tensions resulted in struggles over the goals of learning and participation, student authority/voice in science class, and the meaning and value of environmental justice. The research questions that guided this investigation are: How did teachers and students define and enact a sense of place during the air quality unit? How did their differences in a sense of place position the students and teachers with respect to each other, science, and their community? Drawing upon participatory action research data generated during the year-long efforts to design and enact an interdisciplinary environmental justice curriculum, we report on the emergent tensions in our place-based curriculum and the resulting impact on student participation and personal investment.

S8.12.3 "Our Elders are our Scientists": Western Scientific and Aboriginal Use of Language in oral Presentations Robert E. Bechtel, rbechtel@ualberta.ca

ABSTRACT: This research utilizes discourse analysis on public hearing transcripts for the purpose of understanding the similarities and differences in language and discourse used by both community members (e.g., hunters, Elders, Indigenous peoples) and by the others who come to the community to share their knowledge or give advice on scientific issues. Although the intention of the public hearing was to reach agreement through the sharing of knowledge, how Aboriginal, traditional, knowledge-based cultures and Western, science- based cultures use language can vary significantly, thus making consensus difficult. Although presenters of science take great care in adapting their presentation for use in a public forum some of the grammatical problems in scientific English may lead to confusion for some Aboriginal community members. Conversely, language devices employed by the Aboriginal speakers may not be fully understood or recognized by the others. The results of this research can inform educators, scientists, Indigenous peoples, and lay people on the necessity for using language in a way that can be understood by all.

S8.12.4 Exposing the Impact of Opp(regre)ssive Polices on Teacher Development and on Student Learning

Alberto J. Rodriguez, San Diego State University, arodrigu@mail.sdsu.edu

ABSTRACT: This case study draws attention to Pedro's story--a grade 6, Latino teacher who participated, along with other grade 4-6 teachers, in a three-year professional development research project. By using data analyzed from multiple ethnographic interviews with teachers and students, and by drawing from the quantitative analyzes of concept map unit tests, we illustrate how Pedro's significant professional growth and his students' learning were truncated by top down school district's policies. These policies—in turn—were being implemented due to the punitive nature of the NCLB Act. Simply put, this case study exposes the impact of opp(regre)ssive policies on learning. That is, policies which were oppressive and regressive simultaneously. The critical perspective of the project and its emphasis on assisting teachers in making their pedagogy and curriculum more culturally and socially relevant was informed by sociotransformative constructivism (sTc). This is a theoretical framework that affords equal importance to cross-cultural education (learning about/ acting on socially/culturally relevant and equity issues) and social constructivism (learning to critically produce and consume knowledge). We hope that this case study will provide additional insights into the slow progress we continue to make in science teacher professional development and in closing the achievement gap.

Strand 11: Cultural, Social, and Gender Issues S8.13 Related Paper Set: Place-based Science across Countries and Cultures: In Search of a Model of Universal Design for Learning in Science 4:00pm – 5:30pm, Conference Room 409

S8.13.1 Design Elements and Learning Outcomes of Two Place-Based Education Programs Situated in the Southwest United States

Steven Semken, ASU Deborah Williams, ASU

Janet Ross, Four Corners School of Outdoor Education, Monticello, UT

ABSTRACT: Place-based education is situated and trans-disciplinary, informed by the diverse cognitive meanings and affective attachments that tie people to places (i.e., sense of place). This rich contextualization, coupled with the varied experiential and inquiry learning processes characteristic of authentically place-based teaching, render this pedagogical approach concordant with the principles and guidelines of Universal Design for Learning. This concordance, and the positive cognitive and affective learning outcomes of place-based science education, are demonstrated in two case studies of place-based teacher education programs conducted in the naturally and culturally diverse Southwest United States.

S8.13.2 Raising Navajo Students' Engagement and Achievement with PQRST Lesson Planning and Ss of Lesson Delivery Nancy Kastning, Shonto Preparatory School, AZ

ABSTRACT: Action research in botany, chemistry, earth and ag-science classes from 2007-09 in a Navajo Nation school involved interventions to increase engagement and academic success of students. Instruction shifted from theory and text-based to place, culture, and inquiry-based projects designed to be relevant, service oriented, and team-taught. Field notes, student work, and grades show engagement and academic performance improved. A technology- based, cross-state collaboration, "Science in Culture Exchange Program for Navajos and Native Hawaiian Students and Elders" initiated in spring 2009 supported high student engagement and community interest. Research will continue in 2009-10 to refine the PQRST (Place, Question, Relevance, Service, Team-taught) curriculum model and the instructional Ss of storytelling, slower instructor speech, and student-to-student communication that appear to support increased student engagement, grades, and enrollment in researcher's classes (34% over 2008-09 school year). Research will include colleagues in Hawaii and Navajo Nation schools to examine effectiveness across sites, ages of students, and cultures

S8.13.3 Exploring Culturally Responsive Curriculum for a High-School Science Class in Hawai'i

Lorinda Forster, Kamehameha School

ABSTRACT: This action research seeks to explore the effects of culture and place based curriculum on chemistry students of Hawaiian descent in a private school in Honolulu, Hawaii. Interventions maintained college preparatory goals but integrated technology, Hawaiian culture, and sharing of a place-based assignment with science students in a small school in the Navajo Nation in Arizona. Interventions supported students in incorporating and amplifying a Hawaiian voice. Research methods included interviews of elders, student surveys, field notes, and teacher journals. Results from the 2008-09 school year that indicate higher levels of student engagement and academic achievement inform action research being conducted in 2009-2010. I am honored to work with my students and have been developing my Hawaiian cultural literacy to improve my instructional effectiveness.

S8.13.4 Place-based Science Learning as Universal Design: Increasing Access to Science Learning through Study of Shared Places

Pauline Chinn, University of Hawaii, chinn@hawaii.edu Chiung-Fen Yen, Providence University, Taiwan Li-Hua Ho, Providence University, Taichung, Taiwan Huei Lee, National Dong Hwa University, Hualien, Taiwan Rojjana Sutrabutra, University of Hawaii Pornthip Oatthivech, University of Hawaii Margarita Cholymay, University of Hawaii ABSTRACT: This multi-site, cross-cultural review of place-

ABSTRACT: This multi-site, cross-cultural review of place-based studies conducted by the author, Thai, Chuukese, and Taiwan colleagues explores the question: Does place-based science education meet key criteria of universal design for learning (UDL)? This study of culturally and linguistically different populations provided an opportunity for cross-case, cross-cultural analysis of impacts on student learning with implications for curriculum development and teacher education. Two Thai teachers of hill tribe, rural and urban students, a Chuukese instructor, and three Taiwan colleagues developed curriculum to engage indigenous, underrepresented, rural and mainstream/urban students in collaborative, culturally responsive, inquiry and community-based learning. Field notes, photos and videotapes, student work, and researcher journals indicate outcomes of positive student learning, affect, and school-community partnerships. Instructors recognized the importance of including local and indigenous knowledge in the curriculum. The study suggests place-based science learning addresses principles of UDL by increasing ways for learners to access information, to demonstrate learning, and to engage their interests.

Strand 12: Educational Technology S8.14 SC-Paper Set: Simulations, Design, & Gaming to Support Science Learning and Assessment 4:00pm – 5:30pm, Conference Room 412

S8.14.1 Programming a Simulation to Support 8th Grade Students' Model-based Learning about Natural Selection

Lin Xiang, University of California, Davis, İxiang@ucdavis.edu

Cynthia Passmore, University of California, Davis

ABSTRACT: This study investigated how programming a simulation through an agent-based programmable modeling tool (ABPMT) impacted 8th grade student's understanding about natural selection in a model-based learning (MBL) unit and the affordances and constraints of using ABPMT in a MBL process. Seven low SES students formed small groups and used an ABPMT called NetLogo to build a simulation of adaptation. The comparison between pre- and post-data showed that students made some promising gains in their understanding of natural selection. However, the understandings were fragmented and students had not fully constructed a coherent conceptual model by the end of the unit. In particular, we found students tended to gain better understanding of those conceptions that were visible or directly represented by program codes in NetLogo. By recording and analyzing the students' entire programming process, we found that ABPMT could provide rich opportunities for students to conduct MBL. However, the lack of content knowledge, programming skills, or model-based thinking can impede students as well. This study suggests that agent-based

programming modeling tool can be used to support MBL and a carefully designed instructional process is needed to improve the use of ABPMT in MBL.

S8.14.2 Teaching Animals to Fourth Graders with Lego Engineering-Design

Ismail Marulcu, Boston College, marulcu@bc.edu

Michael Barnett, Boston College

ABSTRACT: In this paper we present a small portion of our work in which we investigate the impact of a LEGO engineering unit about animals on fourth grade students' preconceptions and understanding about animals. The driving questions for our work have been: 1. What is the impact of engineering-design based curricular module on students' learning of animals? 2. What are students' misconceptions on animals? 3. How LEGO-engineering design based instruction help students to overcome their misconceptions? Students' test scores increased from pre-test to post-test. For the sum of the multiple choice questions' scores, students' got a mean score of 2.52 in the pre-test and 3.16 in the post-test. The increase was significant (t= -3.586, p<.001) in the sum of multiple choice item scores. For the sum of the open-ended questions' scores, students' got a mean score of 7.46 in the pre-test and 9.70 in the post-test. The increase was significant (t= -5.084, p<.000) in the sum of open- ended item scores.

S8.14.3 Using Simulations to Assess Complex Science Learning in Middle School Classrooms

Barbara C. Buckley, WestEd, bbuckle@wested.org Edys Quellmalz, WestEd

Matt Silberglitt, WestEd

ABSTRACT: A number of efforts are currently underway to take advantage of technology to develop well-designed classroom assessments that can be used during instruction to monitor and improve progress and following instruction to document learning. This paper will examine a focused, programmatic research and development approach to understanding, assessing, and promoting learning about complex, dynamic systems in science. This paper presents our investigations of the design, feasibility, effectiveness, and quality of simulation-based science assessments. We are developing suites of simulation-based assessments for middle school science that consist of 2-4 online embedded assessments, offline reflection activities for each, a summative benchmark assessment and teacher professional development to support effective formative assessment. We describe the theoretical foundations of model-based reasoning that frame the designs of the simulation assessments as well as the evidence-centered design principles that shape the assessments. We summarize evidence from cognitive laboratories and classroom pilot testing in middle school classrooms to demonstrate feasibility, utility, and technical quality of simulation-based assessments of topics that include ecosystems and force and motion.

S8.14.4 Does The 3D Serious Game Physics Geeks Facilitate Learning In Conceptual Physics Students?

Phillip M. Stewart, Teachers College, Columbia University, pstewart@gmail.com

ABSTRACT: More than 95% of young people 12 to 17 play video games, including 94% of girls, and many of them play often, with the average 8th grader playing about 5 hours a week. Despite the widespread use, educational researchers are just beginning to explore the potential of games facilitating learning in the science classroom. This study reveals what happened when the 3D simulation game Physics Geeks was brought into a classroom to facilitate teaching and learning of conceptual physics. In this quasi-experimental design, two groups received similar instruction about inertia and Newton's First Law, but the experimental group played Physics Geeks before taking the posttest. Additional data sources included a student questionnaire mining prior gaming and science experience, a pretest identical to the posttest, and field notes of student play experiences. Learners in the experimental group had significantly higher assessment gains over those in the control group, F(1,11)=5.14, p<.05. This work provides some encouraging evidence to support the efforts of harnessing the power of games for science learning. By allowing students to visualize invisible phenomena, or interact with concrete physical applications in a safe space, games can provide students new experiences to draw from in their learning.

Strand 13: History, Philosophy, and Sociology of Science

S8.15 SC-Paper Set: Teachers' Knowledge and Practices Related to Nature of Science 4:00pm – 5:30pm, Conference Room 413

S8.15.1 The Effect of a Content-Embedded Explicit-Reflective Instructional Approach on Inservice Teachers' Views and Practices Related to Nature of Science

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

ABSTRACT: This study assessed the influence of an explicit-reflective, metacognitive, content-embedded professional development (PD) intervention undertaken from within a learning-as-conceptual change framework on middle and high school science teachers' understandings and instructional practices related to nature of science (NOS). Nineteen inservice Palestinian teachers were engaged in this pretest, posttest single-group design study. During the first phase, participants were engaged with a six-week NOS PD program. A multiple case-study approach was used in the second phase with a subset of six teachers to examine the impact of the PD program on

their enactment of NOS instruction. Results showed substantial growth and retention in participants' NOS conceptions. The most frequent challenges faced by participants while trying to address NOS in their classrooms were related to the depth and/or situatedness of their NOS conceptions. These challenges mostly could be attributed to participants' lack of the necessary pedagogical content knowledge (PCK) related to NOS. In addition to improving teachers' NOS conceptions, enabling them to successfully address NOS instructionally entails a set of specific scaffolds and supports. The study sheds light on, and provides empirical support for, a number of such scaffolds and supports.

S8.15.2 Chinese Science Teacher Educators' Views about the Values of Teaching Nature of Science

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Siu Ling Wong, The University of Hong Kong

ABSTRACT: Teaching nature of science (NOS) is beginning to find its place in the science education in China. NOS has long been a prominent area of active research in science education in the West, where the science education practitioners' perceptions of NOS education can, to some extent, be informed in the literature. However, little is known on how the teaching of NOS is perceived by practitioners in China, which has very different cultural heritage from the Western world. An exploratory study was conducted to investigate Chinese teacher educators' conceptions of teaching NOS to prospective science teachers. Twenty-four educators took part in two semi-structured interviews. Five dimensions emerged on the conception of teaching NOS, including value of teaching NOS to prospective science teachers, arrangement of NOS instruction in science teacher education courses, learning of NOS, and role of teacher in NOS teaching. This paper only focuses on reporting the value of teaching NOS. Considerable differences between the values of NOS held by Chinese science teacher educators and the corresponding views informed in the Western literature on NOS research. They were attributed to the rather different social, political and historical contexts.

S8.15.3 Year Three, a Replication: Linking Teachers' Understandings of Nature of Science and Scientific Inquiry with Instructional Ability

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Judith S Lederman, Illinois Institute of Technology

Kevin J. White, Illinois Institute of Technology

ABSTRACT: The purpose of this follow-up investigation was to track the relationship between teachers' understandings of NOS and SI and their ability to teach NOS and SI. The sample was 11 science teachers who were enrolled in courses on NOS/SI and Advanced Teaching Strategies. Based on a previous investigation, enrollment in these two courses were during sequential semesters as opposed to concurrently. Data collected included pre and posttests on the Views of Scientific Inquiry survey and the Views of Nature of Science survey. In addition, teachers' book reports and reaction papers related to short readings, were analyzed, along with videotaped lessons, lesson plans, and self-critiques. In a previous investigation limited success in enhancing the connection between knowledge of NOS/SI and instructional ability was noted when courses on NOS/SI and the teaching of NOS/SI were offered concurrently. This investigation clearly documented that the relationship is enhanced when coursework attention is temporally separated. The results indicated a strong relationship between the progression of teachers' understandings and their instructional practice. However, it was also clear that the development of classroom practice lags behind the development of knowledge.

S8.15.4 Teaching Nature of Science in a Third Grade Classroom: An Assessment of Strategies and Student Knowledge

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Khemawadee Pongsanon, Indiana University

Vanashri Nargund, Indiana University

ABSTRACT: This study explored the effectiveness of teaching strategies for improving third grade students' conceptions of Nature of Science (NOS). Using a combination of contextualized explicit reflective instruction, the teacher integrated NOS into her science lessons. Strategies included use of a teacher-designed NOS poster, student science notebooks, class discussions, and embedding NOS aspects throughout the science lessons. Videotapes of all science lessons for the year were used to determine teaching strategies and how they changed throughout the school year, as well as how interactions between teacher and students and students with themselves changed over the year. The Views of Nature of Science version D2 (Lederman & Khishfe, 2002) and Young Children's Views of Science (Lederman, 2009) interview were used pre and post instruction to determine change in third graders' NOS conceptions. Copies of student work were kept to track development of their conceptions over time. It was found that the teacher used more teacher-directed strategies at the beginning of the school year to introduce NOS concepts, and as the year went on the teacher drew more attention to more difficult concepts such as subjectivity. Over time students identified and used NOS concepts appropriately without prompting from the teacher.

Strand 14: Environmental Education

S8.16 Related Paper Set: International Perspectives on Preparing Environmentally Literate Teachers 4:00pm – 5:30pm, Conference Room 414

S8.16.1 An Evaluation of the Implementation of Environmental Education in Two Teacher Training Colleges

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

Peter Van Petegem, University of Antwerp

ABSTRACT: The authors report on the implementation process of environmental education (EE) in two Flemish (Belgian) teacher education colleges. One college had a long history of cross- curricular education, whereas the other college did not. Initially the implementation processes in the two institutions stagnated because of personal and organizational obstructions. After inserting EE in the curriculum for preservice teacher education and in the job descriptions of the participating teachers, the implementation goals were reached. The authors took initiatives and made progress toward the institutionalization of EE. Conflicting priority between mandatory and EE-course time was, however, experienced as a major dilemma in providing EE.

S8.16.2 Preservation and Utilization: An International Study of Pre- And In-Service Teachers' Environmental Attitudes and Values

Franz Bogner, University of Bayreuth, franz.bogner@uni-bayreuth.de

Britta Oerke, University of Zurich

Michael Wiseman, University of Bayreuth

ABSTRACT: The environmental attitudes of 6400 pre-service and in-service teachers across 16 European and neighouring countries were compared. In accordance with the 2-MEV model of Bogner and Wiseman, two orthogonal, robust and independent factors were identified: Preservation and Utilization. We used data from the European BIOHEAD-Citizen project to relate the two independent ecological values to variables such as religion, country pollution and per capita GNI. First we cluster-analyzed the environmental values of pre- and in-service teachers from the 16 countries and identified three European and one Arab and African cluster of similar environmental value scores. Then, the clusters were characterized for affluence, pollution and religiousness. The most dominant relationship was a negative one between Utilization of nature and per capita GNI. Utilization was also related to high pollution and to religiousness within the clusters. On the country level, high Preservation scores were correlated to low ecosystem vitalities but not to environmental health, pointing to the eco-centric character of the measure. The meaning of belief in God and practice of religion within clusters was weak, resulting in a consistent but very low positive correlation between Preservation and belief in God. Further study on cultural impact, including values and norms, seems to be more promising than study on religion. Implications for EE are discussed.

S8.16.3 Student Teachers' Conceptions of Environment and Its Relevance to their Area of Teaching: Are these Influenced by Studies? Implications for Teacher Training Programs

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Bela Yavetz, Kibbutzim College of Education

Sara Pe'er, Oranim College of Education

ABSTRACT: The Israeli Ministry of Education is advancing education for sustainability in the educational system. Teacher-training colleges hold the key to equipping educators to effectively address sustainability in the educational system. As part of a longitudinal research characterizing environment literacy of student teachers in three teacher colleges in Israel, this study explored, in a pretest-posttest design, perceptions of 215 students concerning 'environment' and changes in these during their studies. Content analysis of responses revealed categories reflecting different ways they perceived the environment: romantic, biophysical; environmental quality (man's negative impact, environmental protection); human-nature relationship; value-of-nature; egoistic approach. Quantitative analysis demonstrated that the majority of students, at beginning and towards end of studies, perceive environment in biophysical terms and view the environment as an object and not as a relationship between people and the natural world. The majority of students, including those who didn't major in environmentally-affiliated fields, feel environmental topics are relevant to their area of teaching. Relevance is perceived in two major ways: through a disciplinary lens (subject- matter) and on educational premises. Understanding students' eco-philosophies, including different ways they perceive the relation between environmental topics and their teaching area, can contribute to more meaningful, effective dissemination of EE in teacher-training programs.

S8.16.4 Preservice Teachers' Mental Models of the Environment and Implications for Teaching about the Environment Blanche Desjean-Perrotta, University of Texas at San Antonio, blanche.perrotta@utsa.edu

Christine Moseley, University of Texas at San Antonio

ABSTRACT: This study was designed to understand how preservice teachers define what an environment is through sentence completions and drawings. The NAAEE Guidelines for the Preparation and Professional Development of Environmental Educators (2004) state that preservice teachers should be able to "describe the broad view that environmental education takes of 'environment,' incorporating concepts such as systems, interdependence, and interactions among humans, other living organisms, the physical environment, and the built or designed environment" (p. 9). We used this statement to develop an assessment instrument using each of the four factors - humans, other living organisms (biotic), physical environment (abiotic) and the built or designed environment as

rubric categories for scoring the drawings. Sixty percent of the preservice teachers did not include humans as a factor in their drawings, with only 5 % indicating a systems approach with humans interacting with other factors. Two- thirds of the teachers included items of the built or designed factor in their drawings. For preservice teachers, the word 'environment' produced mental images that did not depict the more naturalistic images of the environment as proposed by the NAAEE Guidelines.

S8.16.5 Ecological Understandings of Teachers in the US: What is Needed to Better Prepare Our Next Generation of Teachers?

Bruce Johnson, University of Arizona, brucej@email.arizona.edu

Constantinos Manoli, University of Arizona

Dennis Rosemartin, University of Arizona

Deborah Barca, University of Arizona

ABSTRACT: Understanding environmental issues at more than a surface level requires an understanding of the ecological processes that underpin the issues. If these processes are to be an important part of student learning, it is essential for teachers to have good understandings of key ecological concepts and how they work both in the natural world and in our society. What do teachers and those preparing to become teachers know about ecological concepts? This paper presents results of surveys of inservice and preservice teachers about four key ecological concepts – energy flow, materials cycling, interrelationships, and change. Interviews were also conducted regarding one of the concepts - the flow of energy through natural systems, how people get and use energy, and the consequences of energy use. While a range of levels of understanding was found, a common lack of understanding in regard to how people get and use energy and the consequences of doing so was apparent. Several important questions are posed for further investigation.

Strand 15: Policy S8.17 SC-Paper Set: Policy Studies Informed by Analyses of Large Data Bases: From International Studies to State Level Studies

4:00pm - 5:30pm, Conference Room 415

S8.17.1 Scientific Literacy, PISA, and Socioscientific Discourse: Assessment for Progressive Aims of Science Education

Troy D. Sadler, University of Florida, tsadler@coe.ufl.edu

Dana L. Zeidler, University of South Florida

ABSTRACT: In this paper, we explore the Programme for International Student Assessment (PISA) with a lens informed by the socioscientific issues (SSI) movement. We consider the PISA definition of scientific literacy and how it is situated with respect to broader discussions of the aims of science education. We also present an overview of the SSI framework that has emerged in the science education community as a guide for research and practice. We then use this framework to support analysis of the PISA approach to assessment. The PISA and SSI approaches are seemingly well-aligned when considering general aims. Both approaches emphasize preparing students for life and citizenship, complex reasoning, reflective practices, and robust understandings of the nature of science particularly as it is practiced in society. However, as the focus of comparison moves from the conceptual to more specific, the connections between PISA and the SSI movement become more tenuous. For instance, many of the PISA test items, at least those that have been released publicly, seem quite removed from the intent of the SSI movement. The paper concludes with a discussion of recent trends in research associated with SSI, which may provide alternative avenues for assessing progressive aims of science education.

S8.17.2 A National Survey of Middle and High School Science Teachers' Responses to Standardized Testing: Is Science Being Devalued in Schools?

Mehmet Aydeniz, The University of Tennessee, Knoxville, maydeniz@utk.edu Sherry A. Southerland, Florida State University

ABSTRACT: This study explored American high school and middle school science teachers' attitudes towards the use of standardized tests for accountability purposes. A total of 161 science teachers participated in the study. Analyses were based on teachers' responses to a questionnaire including nine-item likert-scale questions and two item open-ended questions. The analyses revealed that science teachers have mixed reactions to the administration of standardized tests. However, standardized testing has a significant influence on science teachers' instructional and assessment practices. Our discussion focuses on the implicit and explicit influences of the NCLB Act on science curriculum, teaching and assessment and how the NCLB driven policies may undermine the goals of science education reform. Keywords: science, standardized testing, science teachers.

S8.17.3 Comparison of the Implemented Physics Curriculum and Achievement on of Eighth Grade Students in the United States: A Secondary Analysis of TIMSS 2007

John Murdock, jmurdock@umbc.edu

ABSTRACT: In this study I examined how the implemented curriculum is related to physics achievement of eighth grade students in the US. This study has a three part design, all using data from TIMSS 2007. The first compares the average eighth grade physics achievement of countries that teach general science courses with countries that teach physics courses to middle school students. A t-test showed no statistical difference. The second analysis summarized teachers' responses to a survey where they were asked when 10

physics topics were taught. This analysis showed inconsistency not only nationwide in coverage of topics, but inconsistency between teachers in the same schools. The third analysis of this study examines possible relationships between when the physics topics were taught and student achievement on the TIMSS 2007 assessment. The correlations that were calculated for this analysis were statistically significant due to a large sample (n = 6386), but the effect sizes were very small. In addition, these results cannot be deemed noteworthy because of the inconsistent nature of the teacher survey data. This is yet another example of the lack of focus and cohesion in US science curricula that has been documented since the first TIMSS study.

S8.17.4 Predicting Science Achievement and Science Teacher Retention in Texas High Schools with School- and Teacher-Level Variables

Carol L. Stuessy, Texas A&M University, c-stuessy@tamu.edu Stephanie L. Knight, Pennsylvania State University Dane Bozeman, Texas A&M University Toni A. Ivey, Oklahoma State University Tori Hollas, Texas A&M University Dawoon Yoo, Texas A&M University Caroline Vasquez, Texas A&M University Sara Spikes, Texas A&M University Ra'sheedah Richardson, Texas A&M University

ABSTRACT: Results of a 5-year research project raise questions about policies to alleviate science teacher shortages and demands for highly-qualified teachers. This symposium presents research findings and innovative data collection methods for 50 sample high schools (representing 1,333 high schools and 10,000 science teachers) selected to investigate aspects of the high school science teacher professional continuum in Texas. Data sources included interviews of teachers and principals, questionnaire responses, and school- and state-archived demographic information, used to develop predictors of science teacher retention and high school student science achievement. Multiple regression analyses investigated roles of (a) teacher-level variables (e.g., leadership activities, job satisfaction, educational level) and (b) school-level variables (i.e., professional culture, induction and professional development practices, school size, minority student profile) in predicting (c) teacher retention and student science achievement. None of the variables, however, predicted science teacher retention rates. Research findings are worthy of discussion, but also of interest to the NARST community are the successful methods developed and employed in conducting research in the field. Symposium presenters share their perspectives as original members of the research team as they simultaneously discuss findings and methods.

Presidential Invited Session

S9.1 Symposium: Assessing Youths' Interest in Science: Understanding Motivation and Identity

8:30am – 10:00am, Conference Room 501
Richard A. Duschl, Penn State University, rad19@psu.edu
Jonathan F. Osborne, Stanford University
Leonie Rennie, Curtin University of Technology
Robert H. Tai, University of Virginia
Toni Rogat, Rutgers
Janice Earle, National Science Foundation
ABSTRACT: There is currently no US national baseline on youths' motivations, interests and identity with respect to STEM initiatives. This panel session will discuss issues, practices and policies needed for understanding how the diverse cultural, ling

initiatives. This panel session will discuss issues, practices and policies needed for understanding how the diverse cultural, linguistic and economic backgrounds of students are related to levels of experience and to degrees of comfort with the norms of scientific practices. Understanding how this information relates to patterns of youth motivation and interests in science study would be invaluable for making pedagogical, clinical and policy decisions. The panel members will explore the issues and agendas to consider for the design of assessments examining youths' motivation, interests and identity in STEM-related experiences, courses of study, and careers. The question to the audience is "Should the US consider taking on the design of national assessments to measure youths' motivations, interests and identity in STEM?"

Strand 1: Science Learning, Understanding and Conceptual Change

S9.2 Related Paper Set: Utilizing Writing-to-Learn and Multi-Modal Writing Tasks in Science Classrooms 8:30am – 10:00am, Conference Room 401

S9.2.1 Exploring the Impact of Embedding Multiple Modes of Representing Science Information in Varied Classroom Settings

Mark A. McDermott, Wartburg College, mark.mcdermott@wartburg.edu

Brian Hand, University of Iowa

Andy R. Cavagnetto, Binghamton University-SUNY

ABSTRACT: Emerging research is beginning to explore specific characteristics of writing-to-learn tasks in science. One particular type of task beginning to demonstrate benefit for students is multi- modal writing tasks. In these tasks, student products combine other modes of representing science information (diagrams, graphs, charts, mathematical expressions) with text. Research presented here explored how encouraging students to integrate modes through instruction on "embeddedness strategies" impacted both degree to which students integrated modes and the level of conceptual understanding. The study took place in three phases. The first phase involved chemistry students at four different sites, while the second phase involved four sites with instruction centered on biology or physics topics. In these two phases, treatment classes participated in embeddedness encouraging lessons while control classes did not. Student multi-modal tasks were assessed for degree of embeddedness and student performance on end of unit tests was evaluated. In the third phase, relationships between types of modes utilized in end of unit assessments and student performance by treatment condition was evaluated. Results indicate that level of implementation of the embeddedness encouraging lessons, number of opportunities to create multi-modal tasks, and baseline level of science understanding impact benefit for students from these tasks.

S9.2.2 The Impact of Restricted and Student Choice Embedded Multimodal Representations in a Writing to Learn Approach to the Teaching of Pressure, Bouncy and Heat-Temperature Units

Murat Gunel, Ataturk University, Turkey, mgunel@atauni.edu.tr

Cuneyt Ulu, Marmara University, Turkey

ABSTRACT: Unless the function and shared meaning of the semiotic system of science become apparent for science learners, it is difficult to understand science concepts and to become fluent in communicating them. Modes as essential parts of the semiotic system are critical in physics and gaining importance for teaching physics since students are expected to move between different modes of representation when dealing with a particular concept. Students are often unable to move between these multi-modal representations and thus struggle developing a rich conceptual understanding of the topic. In this study students were asked to explain their understanding through writing and embedding different modes of representation including text and any mode(s), text plus math and any mode, and text plus graph and any mode. A pre-post test design was used to compare performances of groups who used different modes in their writing during consecutive units of pressure, bouncy, and heat-temperature. While students' scores were not statistically different on pre-test scores for all three units, significant mean differences were detected on post-test scores for all units. Students using text plus math and any mode, and text plus graph and any mode scored significantly higher than students using text and any mode(s).

S9.2.3 The Impact of the Science Writing Heuristic Approach on Students' Use and Embedding of Multi-Modal Representations in Summary Writing Tasks

Jeonghee Nam, Pusan National University, Korea

Hyesook Cho, Pusan National University, Korea Aeran Choi, Kent State University Brian Hand, University of Iowa

ABSTRACT: The purpose of this study was to investigate the impact of the Science Writing Heuristic (SWH) approach on students' use and embedding of multi-modal representations in summary writing tasks. One 7th grade science teacher from the second largest city in Korea, taught both treatment (SWH group) and control (traditional teacher-centered group) groups four sub-topics [what are the topics – general area – physics] After eight class periods, summary writing samples were collected from one-hundred and five 7th grade students. Summary writing samples produced by students were examined using an analysis framework for examining the use and embeddedness of multiple modal representations developed as part of this study. Each multi- modal representations used by students in their summary writing was categorized into one of verbal mode, symbolic mode, and visual mode. With regard to the embedding of multi- modal representations, summary writing samples were analyzed in terms of 'constructing understanding,' 'integrating multiple modes,' 'providing valid claims and evidence,' and 'representing multiple modes. Data analysis shows that the students of the SWH group were better at utilizing and embedding multi- modal representations in summary writing as they provided evidence supporting their claims.

S9.2.4 The Impact of Writing for Older Aged Peers

Ying-Chih Chen, University of Iowa

Brian Hand, University of Iowa

Leah McDowell, Seneca valley School District, Pittsburgh, PA

ABSTRACT: Writing for an audience different from teachers facilitates students to focus on translation, in which students explain, elaborate, and integrate their understanding of science concepts using more than just the technical language of the subject. Although much research has been devoted to understanding the effect of writing for different audiences, most studies used "authentic audience" as an approach for writing tasks where students could not interact with their audience. This quasi-experimental and pre/post/delayed posttest study aimed to address this issue in examining if Year 4 students who engage in writing letters for Year 11 perform better than students who do not. The participants included approximately 500 Year 4 students and 150 Year 11 students from four elementary schools and four secondary schools in the USA. Students in treatment groups, including both Year 4 and Year 11, were asked to write three letters for exchanges. Results indicated that students doing letter-writing tasks performed better than students who do not when comparing pretest and posttest. However, for the delayed posttest, no significant main or interaction effects were found between control group and treatment group students' scores. Results also showed that low socio-economic status and gifted students benefited from the letter-writing tasks.

Strand 2: Science Learning: Contexts, Characteristics and Interactions **S9.3 SC-Paper Set: Integrating Technology and Science in Learning**

8:30am – 10:00am, Conference Room 402

S.9.3.1 Building Energy Transformation Conceptions through Design-Based Instruction

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

Yael Bamberger, University of Michigan

Harold B. Short, University of Michigan

James A. Hagerty, University of Michigan

Joseph S Krajcik, University of Michigan

ABSTRACT: The goal of this study was to investigate how the process of design and the deconstruction of real-world phenomena can influence middle-school students' understanding of energy transfers and transformations. In particular, we were interested in assessing how different aspects of the design process could impact students' ability to identify general causal mechanisms, forms of energy, and sequential energy transfers and transformations in everyday phenomena. Thirty-eight middle-school students participated in a two-week summer camp with an energy, design, and engineering focus. Students participated in four design projects related to energy, and in activities focused energy in real-world phenomena. Pre- and post-camp assessments show students improved significantly in each focus area. Thematic analysis of individual and group artifacts, produced before, during, and after the design projects, revealed three main findings: the complete construction or deconstruction of entire systems is particularly important for enabling students to track energy flow, because it elaborates sites where energy transfer or transformation occurs; and that either physical manipulation or student-driven conceptual design of systems and objects can significantly impact students' understanding of mechanisms; and that most middle-school students have the capacity to generate detailed cause-and-effect descriptions of phenomena that can serve as scaffolds for energy transfer and transformation conceptual development.

S9.3.2 Enhancing Students' Classroom Interaction through the use of Personal Digital Assistants (PDAs)

Edgar D. Corpuz, The University of Texas-Pan American, ecorpuz@utpa.edu Ma Aileen A. Corpuz, University of Texas-Pan American Mark Cunningham, University of Texas-Pan American

Rolando Rosalez, University of Texas-Pan American

Liang Zeng, University of Texas-Pan American

ABSTRACT: This study involves the implementation of an interactive teaching approach using personal digital assistants (PDAs) as classroom interaction instruments in various physics and physical science courses in a predominantly Hispanic institution. Using a likert-scale questionnaire, we determined students' attitude towards the teaching approach with PDAs as interaction instruments. Overall, students have positive attitude towards the interactive teaching approach irrespective of their educational background. Moreover, using a quasi-experimental pretest-posttest comparison group research design, the relative effectiveness of the interactive teaching approach with personal digital assistants (PDAs) as interaction instruments (experimental group) was compared with a similar teaching approach with flashcards as the interaction instruments (comparison group). Two introductory algebra- based physics classes were selected as participants of the study. The descriptive analysis showed that the mean gain scores in the Force Concept Inventory (FCI) of the experimental group are significantly higher than that of the comparison group. The calculated Cohen's index of effect size (d=0.6988) indicates that the average gain scores in the experimental group exceeds 76% of the gain scores of the comparison group. Our data suggest that the interactive teaching approach using PDAs as classroom interaction device is more effective in promoting conceptual understanding compared to an interactive teaching approach using flashcards.

S9.3.3 The Youth Engagement with Science and Technology Survey: Informing Practice and Measuring Outcomes

Glenda M. McCarty, University of Missouri, St. Louis, glendamccarty@gmail.com

Jennifer M. Hope, University of Missouri, St. Louis

Joseph L. Polman, University of Missouri, St. Louis

ABSTRACT: Engagement in science and technology is plainly relevant to the development and an important outcome of informal and formal education, but the term "engagement" has had many meanings. In this paper, the authors review uses of the term, and propose a framework for engagement including behavior, interest, and identity. The development process for a survey instrument to measure engagement based on this framework is described. The Youth Engagement in Science and Technology (YEST) Survey should be a more valid measure than is currently available, and will allow researchers to pay attention to how individuals with different engagement profiles learn, and also measure the impacts of in- school and out-of-school programs on engagement. The YEST survey will be piloted within the context of a larger science education reform project engaging high school students in science journalism. Results of the pilot administration will be presented, and the survey's validity and impact examined through case studies of youth engagement. The potential relationship to practice will be discussed.

S9.3.4 Integrating Science, Literacy, Technology and Universal Design for Learning to Enhance Middle School Students' Inquiry-Based Science Learning

LeeAnn M. Sutherland, University of Michigan, lsutherl@umich.edu

Namsoo Shin, University of Michigan

Kasey L. McCall, University of Michigan

ABSTRACT: Active inquiry science learning requires many complex skills: reading, collecting data, analyzing, drawing conclusions, and applying higher-order thinking skills to problem-solving activities. These tasks challenge all students, but especially those with learning disabilities. Principles of Universal Design for Learning (UDL) address a range of students, including those with and without learning disabilities, by removing barriers that impede their learning (Rose & Meyer, 2002). In addition, students who struggle with reading can experience significant difficulties learning science. A well-designed inquiry science curriculum can address these realities just as it addresses important science content, scientific practices, and science literacy, but a digital version can go further, capitalizing on the affordances of technology to support student learning. In the two, intensive qualitative studies addressed herein, we investigated how students interacted with a UDL-enhanced, web-based version of an inquiry chemistry unit designed using best practices in science and literacy education. The paper describes the design-based research process used to create digital materials from original print versions, provides data from student interviews and illustrates how those data were used to shape revisions, and provides design guidelines for others' use as they develop or revise curricula to enhance learning opportunities for a broad range of students.

Strand 2: Science Learning: Contexts, Characteristics and Interactions S9.4 SC-Paper Set: Exploring Sociocultural Factors Influencing Science Learning 8:30am – 10:00am, Salon D

S9.4.1 An Ethnographic Study of Sociocultural Factors Affecting Learning in a High School Environmental Science Course Erica N. Blatt, University of New Hampshire, erica.blatt@unh.edu

ABSTRACT: This qualitative ethnographic study at a public high school in the Northeastern United States investigates the process of change in students' understanding of their relation to the environment and pro-environmental behavior during an Environmental Science course. Specifically, the study uses a sociocultural approach to explore how factors such as students' background, social interactions, and classroom structures impact the environmental learning of students. The participants in this study are an Environmental Science teacher and the 10-12th grade students in her Environmental Science elective course (N=17). The researcher collected data for a period of six months during the spring semester of 2009, attending class on a daily basis. Data was collected

through participant observation, videotaping, interviews, cogenerative dialogues, and an environmental attitude and behavior survey. The results of this study provide new information for educators working with students to help them define their relationship with the environment by illuminating the elements contributing to whether a student is likely to change his/her views towards the environment and pro-environmental behaviors. Additionally, results highlight the classroom structures that affect the environmental learning of students over the course of a semester.

S9.4.2 Transforming the Culture of Undergraduate Organic Chemistry through Performance Enhanced Interactive Learning Karen E. Phillips, Hunter College of the City University of New York, kphil@hunter.cuny.edu

ABSTRACT: This study describes a group learning strategy referred to as Performance Enhanced Interactive Learning (PEIL) and analyzes its effect on the culture associated with the teaching and learning of Organic Chemistry. PEIL activities require students to teach their classmates by acting out or performing some aspect of what they learn before an audience of their peers. The two types of PEIL activities focused on here are problem-solving workshops and group presentation exercises incorporated in Organic Chemistry classes at a large urban public college. In typical Organic Chemistry classrooms, fear associated with this subject can create barriers to comprehension and cause added anxiety during examinations, while also fostering a spirit of ruthless competition between students. Analysis of videotape and testimonials about their learning experiences reveal that, as students engage in PEIL activities while studying Organic Chemistry, they gain greater mastery of concepts, fluency with the language used in the course, and agency as learners. With time, this transforms the culture associated with the subject, replacing fear and competition with signs of positive emotional energy, mutual support and increased solidarity. This also permeates different fields, stimulating further production, reproduction and transformation of the culture related to other subjects and learning environments.

S9.4.3 Exploring the Associations between Social Motivational Factors and Science Achievement among 9th Graders

Fang-Ying Yang, National Taiwan Normal University, fangyang@ntnu.edu.tw

Ju-Shi Tseng, National Taiwan Normal University

Shu-Ching Fu, National Taiwan Normal University

ABSTRACT: This study attempted to explore the association between the social motivational factors including goals and expectations and academic performance in science. More than 200 junior high school students participated in the development of Goal and Social Motivational Questionnaire (GSEQ). And then 277 ninth graders participated in the main study that examined the association among goal, expectation and science achievement. By factor analysis, GSEQ received a satisfactory validity and reliability, and subscales for goal and expectation constructs were extracted. Correlation analysis found that goal and expectation subscales were interacting with each other. The Regression analysis indicated that the social motivational factors that give positive influences on the academic performance include self future expectation, parent expectation, learning goals and student-centered teaching style.

S9.4.4 Connecting a Student-Directed Participant Structure to the Acquisition of Collaborative Skills

Dennis W. Smithenry, Elmhurst College, smithenryd@elmhurst.edu

Joan A. Gallagher-Bolos, Glenbrook North High School

ABSTRACT: This paper examines how students' prior experiences with the student-directed whole-class inquiry (WCI) participant structure impact their acquisition of collaborative skills. The study assessed the extent to which six classes, each of which contained differing ratios of WCI students (those with previous WCI experiences) and non-WCI students (those without), collaborated to collectively solve a problem posed during a researcher-designed assessment. After an initial analysis of video recorded during these assessments, it became clear that there were strong differences in the extent to which each class was able to manage a whole-class discussion as they attempted to accomplish the task. An analysis of the occurrences and duration of whole-class discussions, which were deemed as appropriate metrics for the exhibition of collaborative skills, revealed two main findings. First, as the percentage of WCI students increased in a particular class, the number and duration of whole-class discussions increased. Second, there appeared to be a critical percent of WCI students that had to be present to allow the exhibition of collaborative skills. The results of this study provide a clear path to the ways in which participant structures can be modified to teach the collaborative skills that are essential to conducting scientific inquiry.

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

S9.5 SC-Paper Set: Writing in Science

8:30am – 10:00am, Conference Room 403

S9.5.1 Elementary Teachers' Beliefs about How Scientists Use Writing

Nicole J. Glen, Bridgewater State College, nglen@bridgew.edu

ABSTRACT: Writing is highly valued in science. Therefore, science educators advocate that writing in science should be for communicating and building ideas and knowledge, and understanding content and the discipline. Although studies have investigated the cognitive gains of students who write in science, few have explored how elementary teachers understand scientific writing and how this translates to pedagogical practice. This qualitative case study of four elementary teachers investigated their beliefs about how

scientists use writing in their daily work. The findings describe that the teachers believed scientific writing is for communicating factual information, including observations, procedures, findings, and conclusions. Some of the teachers considered some of the writing their students did in science to be scientific because they wrote for these same purposes. Yet, there are many other ways that scientists use writing. Teachers' understanding that scientific writing is factual is contrary to nature of science views that science is a subjective and creative endeavor. Educating teachers about writing in science should include enhancing their knowledge of the nature of science and scientific inquiry and helping them understand that writing to model what scientists do is important to undertake for reasons that support both science and literacy learning.

S9.5.2 Exploring Primary Teachers' Conceptions and Implementation of Science Notebook Writing

Vicki McQuitty, Davis College, vmcquitty@msn.com

Sharon Dotger, Syracuse University

Uzma Khan, Syracuse University

ABSTRACT: Although many science educators advocate the use of science notebooks in elementary classrooms, little research has investigated how teachers view science notebook writing or how primary grade (K-2) teachers use science notebooks with their students. This study addresses that gap by exploring how first and second grade teachers conceptualized notebook writing and implemented science notebooks in their classrooms. Using qualitative methodology, the researchers collected data by recording a lesson study process in which the teachers planned, implemented, and evaluated an inquiry science lesson that included notebook writing. The researchers then analyzed how teachers' conceptions of science notebook writing influenced their notebook use. Findings indicate that teachers viewed science notebook writing through an ELA lens and assigned narrative, text-driven notebook writing tasks; considered their students struggles with letter formation and spelling as barriers to science notebooks and sought ways to make notebook writing tasks more manageable and time efficient; and conceptualized science notebook writing as a product rather than a thinking process, which stripped the notebooks of their purpose and meaningfulness. Implications include the need for science teacher educators to make the conventions of scientific writing and the purposes of science notebooks explicit for primary teachers.

S9.5.3. Reasoning about Invisible Forces: The Use of Graphics and Written Text to Reveal Elementary Student Sense Making

 $John \ C. \ Bedward, North \ Carolina \ State \ University, johnbedward@yahoo.com$

James Minogue, North Carolina State University

Eric N. Wiebe, North Carolina State University

Lauren P. Madden, North Carolina State University

Michael Carter, North Carolina State University

ABSTRACT: The focus of this study is the "conceptual domain" of student learning. We describe a small scale study (N=24) that was conducted with 4th and 5th grade students the aim of which was to systematically provide these students with "conceptual encounters" with the invisible. The SOLO taxonomy model along with a second level coding scheme was used to identify the level of student sense making both in text and written form. Cumulative results of the SOLO coding for both graphics and text across all the panels has students operating at a unistructural level (level 2). Graphical tools, learned symbol conventions, and scaffolding techniques infused into real time discourse may be useful in helping students' reason through their thoughts. We feel that the work described here makes theoretical and methodological contributions by challenging long held assumptions about children's ability to reason abstractly and dissecting the relationships between graphical representation and textual descriptions of invisible phenomena. The exploratory work presented here begins to highlight the critical connections between the authentic revealing of students' misconceptions, abstract reasoning, and instructional strategies. In this work we document the various ways students use graphical representations and/or text to reason about and describe magnetism.

Strand 4: Science Teaching--Middle and High School (Grades 5-12): Characteristics and Strategies S9.6 Administrative Symposium: Collaborative Study: Improved Pedagogy

8:30am – 10:00am, Conference Room 404 **Presenters:** Helen Meyer, University of Cincinnati, helen.meyer@uc.edu Krista Woods, University of Cincinnati Danielle Dani, Ohio University Amy Jameson, Dater High School Cincinnati Public Schools Maureen Andreadis, School for Creative and Performing Arts Cincinnati Public Schools Megan Urbaitis, Norwood High School Andrea Burrows, University of Cincinnati Anna Hutchinson, Aiken High School Cincinnati Public Schools Kathie Maynard, University of Cincinnati Michelle Marlow, University of Cincinnati

ABSTRACT: This symposium discusses the benefits of engaging in collaborative professional learning communities to improve curriculum and pedagogy in science classrooms. The four case presentations in the symposium span a continuum of collaborative study groups from a, student-faculty collaboration on an in class project through a voluntarily attended reading group focused on history and science. The first presenter worked with a faculty member to guide an action research project focused on implenting an inquiry-based physic unit into her college physics course. The second presentation involved two teacher educators collaborating in the development of a science methods classed focused on authentic inquiry in pre-service classes. The third case is an action research project from a master teacher involved in a summer program that focused on engaging girls in upper level science work. The final presentation involved faculty, doctoral and masters students, teachers and a pre- service teacher as they studied the science history using biographies of scientists as a focal point. Each presentation of collaborative learning resulted in an action research project focused on the development and implementation of new learning experiences for students.

Strand 5: College Science Teaching and Learning (Grades 13-20) S9.7 SC-Paper Set: Preparation of Pre-Service Elementary Science Teachers 8:30am – 10:00am, Conference Room 405

S9.7.1 Preservice Elementary Teachers: Disciplinary Engagement, Knowledge Growth, and Motivation

Anita Roychoudhury, Purdue University, aroychou@purdue.edu

Diana C. Rice, Florida State University

ABSTRACT: This study explores the engagement of students (preservice elementary teachers) in a university physical science course. The study shows the changes in the nature of student participation; it also shows an improvement in student content knowledge and motivation (measured by pre- and post-scales) over the course of time.

S9.7.2 Embedding Scientific Arguments in a Pre-Service Elementary Science Methods Course to Develop NOS

Sharon P. Schleigh, East Carolina University, schleighs@ecu.edu

Katie Nock, East Carolina University

Tammy Lee, East Carolina University

ABSTRACT: This was an empirical study to conduct contextual research in the area of STEM teacher education examining the development of pre-service elementary teachers' skills in argumentation and their changes in the understanding of the nature of science (NOS). Discourse and scientific argumentation has been identified as an important skill when engaging in science and engaging in a scientific argument addresses both explicit and implicit understandings of the NOS. Three cohorts of pre-service elementary teachers participated in this study by engaging in activities that promoted argumentation focusing on the connection between argumentation and the NOS. A mixed methods approach to analyze the participants' understanding of the NOS included questionnaires, surveys, journal entries and classroom observations. The purpose of the study was to determine if developing skills in argumentation would promote a well developed understanding of the NOS. Results indicate that there is a correlation between the ability to engage in a scientific argument and the understanding of the nature of science.

S9.7.3 Reform in Entry-Level Undergraduate Science Coursework: Impacts on Pre- and In-Service K-6 Teachers in a National Sample

Dennis W. Sunal, University of Alabama, dwsunal@bama.ua.edu Cynthia S Sunal, University of Alabama Mason L. Cheryl, San Diego State University Dean Zollman, Kansas State University Corrine Lardy, San Diego State University Erika Steele, University of Alabama Mjogan Matloob-Haghanikar, Kansas State University Donna Turner, University of Alabama Sytil Murphy, Kansas State University **ABSTRACT:** The multi-year NSF supported-National Study of Educational Study S

ABSTRACT: The multi-year NSF supported-National Study of Education in Undergraduate Science is a project on critical needs in teaching undergraduate science to diverse majors with an emphasis on preparation and long-term development of pre-service K-6 teachers of science. The impact of undergraduate standards-based, reformed entry-level science courses as compared to traditional coursework is the focus. Reformed science courses were analyzed in a professional development impact design model with a national sample of 30 reformed and 30 comparison undergraduate science courses from a national population of 103 diverse institutions stratified by institutional type. Quantitative and qualitative data were analyzed using comparative and relational studies of the impact design model. Conclusions relate to: evidence and effects of short-term impacts on all undergraduates and long-term effects on matriculated in-service teachers in science teaching, identification of characteristics of reform courses producing significant impacts, and identification of faculty characteristics. Results are reported from a review and synthesis of the research literature, national survey of 103 reformed undergraduate science courses, and focus group interviews, individual interviews, teaching observations, and multiple instruments.

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

S9.8 Symposium: Mentoring Doctoral Researchers: Stories from the NARST Summer Research Institute

8:30pm – 10:00pm, Conference Room 411

Presenters:

Sandra K Abell, University of Missouri, abells@missouri.edu Deborah Smith, Pennsylvania State University Felicia M. Moore-Mensah, Teachers College--Columbia University Patricia M. Friedrichsen, University of Missouri Valarie L. Akerson, Indiana University Allan Feldman, University of South Florida Danusa Munford, Federal University of Minas Gerais, Brazil Carla Zembal-Saul, Pennsylvania State University

ABSTRACT: In order to create "stewards of the discipline," science education doctoral programs are designed in part to help students develop as researchers. However, there is little research about the nature of the research mentoring relationship in doctoral programs. In such programs, mentoring takes place formally through the doctoral advisor, and informally through relationships with other faculty and student researchers. The inaugural NARST SRI took place in June, 2009, on the University of Missouri campus, with 23 doctoral researchers and 9 faculty mentors. The theme of the SRI was science teacher learning research. The major aim of the SRI was to provide a context beyond the doctoral program for mentoring emerging researchers in science education. The purpose of this symposium is to uncover issues, tensions, and processes in science education research mentoring in the context of this summer research experience for doctoral researchers. The panel consists of SRI faculty mentors, and student researchers will also be on hand to discuss their experiences.

Strand 6: Science Learning in Informal Contexts S9.9 Symposium: OST Science: It's Not What You Think! Variations across Learning Goals and Outcomes and the Implications for Research Methods and Tools

8:30am – 10:00am, Conference Room 406

Presenters:

Bronwyn Bevan, Exploratorium, bronwynb@exploratorium.edu

Susan A Yoon, University of Pennsylvania

Irene Lee, Santa Fe Institute

Kim Sadler, Middle Tennessee State University

Susan Brown, New Mexico State University

ABSTRACT: There is increasing interest in how organized out-of-school-time settings (e.g., afterschool, summer camps, and weekend classes) can support children's engagement with and learning of science. Accordingly, there is growing pressure to evaluate, assess, and document student learning outcomes. Many out-of-school-time (OST) science policies and assessments assume that OST science, while adopting different pedagogical strategies, operates with the same fundamental goals as school science. They thus argue for using school or school-like assessments to evaluate the contributions of OST programs to student learning. In this symposium, we present program strategies and research findings from four different OST science programs to reveal the breadth of ways that science learning goals and outcomes vary within the field of OST, and also are distinct from school science. This variation suggests a pressing need to better characterize and specify the nature of science learning activities in OST settings so that more appropriate ways of assessing program effectiveness and children's learning can be developed. After brief presentations from the four programs, the symposium will actively engage participants in discussion about the range of science learning goals and outcomes found in OST programs, and the implications of this variation for measurement of student science learning.

Strand 7: Pre-service Science Teacher Education S9.10 Symposium: Improving Science Teacher Preparation by Studying How Knowledge & Identity Affect Teaching Practices

8:30am – 10:00am, Conference Room 407 Discussants:

Gail Richmond, Michigan State University, gailr@msu.edu Joyce M. Parker, Michigan State University Hosun Kang, Michigan State University Takumi Sato, Michigan State University Amelia W. Gotwals, Michigan State University Amy Lark, Michigan State University HsingChi von Bergmann, University of Calgary

Charles W. Anderson, Michigan State University

ABSTRACT: The process by which individuals learn to become secondary science teachers is a complex one. Effective science teaching requires not only strong content knowledge but the ability to use formative and summative assessments, respond to diverse students, construct a productive learning environment, respond to the politics and cultures of schools, and respond to distinct, sometimes competing demands made by the university and schools in which they learn about and engage in teaching. We view teaching as the product of knowledge (understanding of content, students, and classroom/school context) and practice (the ability to plan, teach, assess, and reflect/revise. Together, these practices constitute what we refer to as the Teaching Cycle. How knowledge develops and appears in practice is shaped by a candidate's values and positioning relative to multiple communities of practice, i.e., her professional identity. The Teaching Cycle has allowed us to study difficulties TCs have in developing necessary knowledge and practices and to understand better why some candidates succeed and some fail. In the proposed Symposium, we will analyze patterns in TCs' practice, based on their reports and our observations; and examine how evidence about TCs' knowledge bases and identities can be used to understand and improve their practices.

Strand 8: In-service Science Teacher Education S9.11 SC-Paper Set: PCK, PD and Evidence 8:30am – 10:00am, Conference Room 408

S9.11.1 Improving Students' Science Achievement through Long-Term Teacher Professional Development

Yue Li, Miami University, liy@muohio.edu Kathryn Scantlebury, University of Delaware Jane B. Kahle, Miami University

Constance Blasie, University of Pennsylvania

Sarah B. Woodruff, Miami University

ABSTRACT: This study analyzed results from a National Science Foundation funded Mathematics Science Partnership project that focused on providing standards-based, pedagogically appropriate, content-based professional development to middle school science teachers and high school chemistry teachers. Findings reported here focus on student achievement and attitudes as well as on teachers' use of standards-based teaching practices. The analyses of data collected from two teacher cohorts and their students indicated that both teachers and students reported that participating teachers' implemented more standards-based teaching practices reflective of those recommended within the National Science Education Standards (National Research Council, 1996). Moreover, the program's evaluation provided tentative evidence that on-going, sustained professional development in content and pedagogy is critical for improving students' science achievement.

S9.11.2 Exploring Process of Constructing Pedagogical Content Knowledge (PCK) in Science Teaching

Kongju Mun, Ewha Womans University, munkongju@ewhain.net

Sung-Won Kim, Ewha Womans University

ABSTRACT: The purpose of this study was to suggest practical and theoretical framework about science teachers' PCK constructing. The Strauss and Corbin's(1998) grounded theory was adopted to explore the process and structure of science teachers' experiences. Data was collected through in-depth interviews with twenty two secondary school science teachers who have experienced in science teaching for many years. The results of paradigm analysis revealed that constructing PCK was influenced by 87 concepts, 35 subcategories, and 17 categories. In the paradigm model, the phenomena of constructing PCK were 'raising teachability of subject matter knowledge (SMK)', 'understanding students', and 'developing teaching repertory'. These phenomena showed 'teachers' effort for successful science teaching'. The causal conditions of constructing PCK were 'emerging intrinsic motivation', 'being externally influenced'. The contextual conditions related to central phenomenon were 'being aware of science teachers' role', 'being interested in science class'. The intervening conditions were 'social atmosphere', 'school culture', 'class surroundings', and 'personal characteristics'. The identified actions/reactions included 'following and acceding', 'finding one's way of teaching', and 'adjusting through teaching practice'. The result of constructing PCK was 'successful science teaching', 'finding one's satisfaction in teaching', and 'remaining'. The process analysis was also conducted, based on the results of paradigm analysis. The entire process of constructing PCK was divided into four phases over time: (1) awareness of necessity, (2) development, (3) adjustment, and (4) accomplishment. The process of constructing PCK was circular and continuous. To represent the process of constructing PCK, the core category was emerged from selective coding. The core category was 'constructing PCK through teaching practice'. These findings will provide teacher educators deep understanding about science teachers' knowledge and professional which enable them to develop effective teacher education programs that enhance teachers' PCK and teaching ability

S9.11.3 How to Change Science Teachers' Practice? An Evidence-based Approach in a Continuous Professional Development (CPD) Program

Liora Bialer, Kibbutzim College of Education, Israel, liora.bialer@weizmann.ac.il Bat-Sheva Eylon, The Weizmann Insttute of Science, Israel Zahava Scherz, The Weizmann Insttute of Science, Rehovot, Israel

ABSTRACT: The study examined an Evidence-based approach to continuous professional development (CPD) of teachers as a way to promote change in teachers' practice. The program focused on the instruction of high-order learning strategies using the 'Learning Skills for Science' (LSS) program. In the Evidence-based approach teachers collect evidence about their work and carry out self and colaborative reflection on their practice. By the term "evidence", we mean a collection of artifacts that demonstrates both the teacher's instruction and their students' learning, combined with written commentaries. The CPD meetings involved guided evidence preparation about LSS practice combined with collaborative reflection through evidence presentation, discussion and feedback. At the end of the program the teachers organized and submitted their evidence in a portfolio. We developed a diagnostic tool to evaluate teachers' competency levels in six categories of LSS practice and evidence preparation. We present the analysis of several data sources concerning three case studies of teachers that indicate improvment in their competency levels of LSS practice and evidence preparation. Interviews with other teachers suggest changes in their LSS practice in aspects of planning, implementation and assessment. The teachers also reported improvement in their reflective thinking and their influence on the educational system.

S9.11.4 Enhancing Elementary Teachers' Content and Pedagogical Knowledge through Sustained Professional Development

Sarah B. Woodruff, Miami University, woodrusb@muohio.edu

Terry L. McCollum, Miami University

Yue Li, Miami University

Nazan U. Bautista, Miami University

ABSTRACT: This study evaluated the outcomes of a sustained professional development program on elementary grade science teachers and their students. Research suggests that the science achievement of students is directly influenced by the content and pedagogical knowledge of their teachers. Further, teacher attitudes regarding teaching and learning science impact the teacher's ability to teach standards-based science effectively. Findings of this study suggest that the impact of insufficient preparation of elementary teachers to teach science can be mitigated by high-quality, in-service professional development experiences. Study data indicated that science content knowledge, pedagogical content knowledge, and attitudes of elementary teachers to ward teaching standards-based science could be improved significantly. Additionally, the study found that these improvements in teacher outcomes were accompanied by statistically significant improvement in student science content knowledge. Findings of this study are of import and interest as they suggest a relationship between particular characteristics of high-quality professional development, embodied by this project and recommended by the findings of other researchers, and positive outcomes for teachers and their students.

Strand 8: In-service Science Teacher Education

S9.12 SC-Paper Set: Professional Development for the Science Teacher

8:30am - 10:00am, Salon C

S9.12.1 Enhancing Continuing Professional Development: Contribution from Pre-Service Teachers

Karen M. Kerr, St.Marys University College Belfast, k.kerr@qub.ac.uk

Colette Murphy, Queens University Belfast

Jim Beggs, St. Marys University College Belfast

ABSTRACT: This proposal examines a model of coteaching in which student teachers and classroom teachers learn together first, for example, on a continuing professional development (CPD) programme, and then implement that learning together as coteachers in the classroom. The focus was on expanding teacher and student teacher agency by empowering them to involve children more in their own learning. The findings showed that the combination of relevant and exciting workshop activities designed to empower teachers to enable children to 'lead' their science learning, and the coteaching of science in the classroom, changed the way these teachers approached their science teaching. The success of this work was a result of the solidarity built up by group members learning together. A specific strength of this approach lies in its sustainability (one of the main issues with CPD). Very often teachers find it difficult to implement new ideas/approaches and highlight lack of time, existing curricular pressures and lack of support as problems. In the current programme, New Approaches to Primary Science Teaching and Assessment (NAPSTA), we addressed the sustainability issue by incorporating science student teachers in the CPD. The student teachers provided specific support in terms of science expertise for coteaching, co-planning and co-reflection.

S9.12.2 Professional Development as a Change in Teachers' Conceptions of Teaching and Learning Science: A Retrospective Yael Furman Shaharabani, Technion - Israel Institute of Technology; The Weizmann Institute of Science, yaelfsha@gmail.com Tali Tal, Technion - Israel Institute of Technology

ABSTRACT: Teachers are expected to develop professionally during in-service professional development programs (PD). Although studies of programs are widespread, there is limited research of long-term effects of PD on science teachers. While research of science teacher development has mainly focused on beliefs, teacher conceptions were less studied. The purpose of the study was to explore professional development as a change in teachers' conceptions of teaching and learning science, in relation to past in-service extended PD. We employed grounded theory approach to study 27 7-9 grade science teachers who participated in extended PD in Israel in the 1990s. The findings indicate long-term impact on practical and conceptual aspects of teachers' development. The conceptual aspect refers to a change in teacher's views of teaching and learning science, during the PD, which is consciously articulated at the present

and is related to change of practice. This aspect of professional development ranged from no change to comprehensive change in the teacher's conceptions. The conceptual aspect of the teachers' professional development was associated with the practical aspect. Our findings suggest that major changes in science education require change of teacher conceptions regarding science teaching and learning, in order to maintain long term implementation of innovative practice.

S9.12.3 Exploring the Teacher Professional Growth Continuum - Implications for Professional Development

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

Amy L. Moreland, The University of Texas at Austin

ABSTRACT: The NSF-funded Project Instrument Development (I.D.) is a continuation of a study identifying those empowering experiences of career science teachers that have caused them to persist in their careers. Data collection was accomplished through the use of one-on-one interviews in conjunction with the systems dynamics technique of utilizing behavior over time graphing. The current research study uses a larger and more diverse sample of teachers, and improves on the data gathering procedures employed in the preliminary study. Based on teacher input, and in consultation with experts in both instrument development and technology, the researchers developed a survey tool to collect similar kinds of data in more efficient ways. By better understanding the career paths that successful teachers have followed, and in keeping with the 2010 NARST theme of research informing practice, we can infer some implications for professional development programs and educational policies for the future.

S9.12.4 A Longitudinal Evaluation Study of a University Model for Science Teacher Professional Development through Clustered Randomized Design

Dana V. Diaconu, Rice University, ddiaconu@rice.edu

Wallace Dominey, Rice University

Milijana Suskavcevic, Rice University

ABSTRACT: The purpose of this study is to evaluate the Teacher Professional Development model and to describe the impact of the implementation of the model to sustained improvements in science teachers' content knowledge, teaching practices, and boosting students' science learning. Through this work, we address the challenges of how best to enhance the ability of elementary grade level science teachers to provide effective STEM education and how to measure the effectiveness of changes in teaching practices that ultimately resulted in improvement of student learning. The study focuses on a large urban area with more than 1 million K12 students, many of whom are historically underserved minority and economically disadvantaged students. The conference theme, Research into Practice: Practice Informing Research, permeated this program. Scientists and educators worked with elementary teachers during a year-long, one day each week, training program to provide science content and science pedagogy rooted in research. Researchers and evaluators examined the impact of these interventions on multiple stakeholder groups, and informed the practice. The examination of the model's effectiveness provides insights and offers contributions to the professional development literature. Additionally, by extrapolation, the model should be of value for any STEM subject and any K12 grade level.

Strand 10: Curriculum, Evaluation, and Assessment

S9.13 Related Paper Set: Assessing Pedagogical Content Knowledge

8:30am – 10:00am, Conference Room 410

S9.13.1 Assessing Components of Pedagogical Content Knowledge through Observational Methods

William R. Veal, College of Charleston, vealw@cofc.edu

ABSTRACT: Pedagogical content knowledge (PCK) is a concept that has gained in popularity in the last two decades, but there is little agreement on how to assess the construct. This research study uses the PCK Evidence Reporting Table (PCK ERT, Park & Oliver, 2008) to assess inservice teachers' PCK development. The purpose of the study is to determine if the PCK ERT can be used to effectively evaluate the level of PCK of inservice teachers while they learn science content in a professional development setting. Results indicate that PCK is a construct that must be evaluated using multiple methods and that PCK ERT is an effective instrument to quantify many aspects of PCK.

S9.13.2 Understanding and Assessing Primary Science Student Teachers' Pedagogical Content Knowledge

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

John Loughran, Monash University

ABSTRACT: Despite repeated calls for reliable and valid assessments of teachers' pedagogical content knowledge (PCK), tools suitable for assessing teachers' knowledge remain inadequate. Therefore, exploring ways of how to formatively assess student teachers' PCK is important; both for understanding how PCK develops and for the ways in which we might develop strategies in teacher education for enhancing science teaching and student teachers' professional learning. This paper is based on a science teacher education research project that aims to connect what we know from research on [formative] assessment with what we know about student teachers' development of PCK, and, as a consequence, seeks to determine how an articulation of this knowledge might inform meaningful approaches to science teacher education. During one semester, 24 primary science student teachers were provided with tools for assessment (Content Representation (CoRe), self-assessment and reflective activities) in order to examine their approach to

the teaching of a topic and the reasons for that approach in ways that might demonstrate the extent of their PCK development over time. The project highlights the potential to positively focus on formative assessment of student teachers' development of PCK in order to determine how that might contribute to student teachers' professional learning.

S9.13.3 Pedagogical Content Knowledge of Inquiry: An Instrument to Assess It and Its Application to High School In-Service Science Teachers

Andoni Garritz, Universidad Nacional Aut'noma de México, andoni@unam.mx

Diana V. Labastida-Pina, Universidad Nacional Aut'noma de México

Silvia Espinosa-Bueno, Universidad Nacional Aut'noma de México

Kira Padilla, Universidad Nacional Aut'noma de México

ABSTRACT: The research goal of this work is to assess the Pedagogical Content Knowledge (PCK) for in-service teachers involved through inquiry in the science teaching-learning process. An instrument similar to the Content Representation (CoRe) proposed by Loughran et al. has been constructed by identifying a set of activities done during the inquiry process by means of an analysis of the literature on the topic. This tool, that we have named CoReI, was applied to five high school teachers, whose general approaches were classified by their answers as implicit, historical and explicit. We also analyzed if the teachers give to inquiry the importance of a curricular content or if they simply use it as a strategy. If students are expected to develop more adequate conceptions of scientific inquiry then, as any cognitive curriculum objective, this outcome should be planned for, explicitly taught, and systematically assessed. The main importance of this research has to do with the use of CoReI of outstanding Inquiry driven teachers for the training of preservice teachers to develop their initial critical thinking to guide the classroom within inquiry.

S9.13.4 Assessment and Evaluation of Pedagogical Content Knowledge

Jan H. van Driel, ICLON-Leiden University, driel@iclon.leidenuniv.nl

James G. MaKinster, Hobart and William Smith Colleges

ABSTRACT: This paper is part of a set which focuses on the assessment and evaluation of PCK of in-service and pre-service teachers of science, and how assessment of PCK can drive its (further) development. The research literature documents many problems concerning the conceptualization and assessment of PCK. The complex and dynamic nature of PCK make it difficult to capture PCK in a valid way that speaks to teachers and educators. This paper explores the approaches towards evaluating PCK that are reported in the research literature. The paper also compares and comments on the other papers which are part of the set. It is concluded that researchers need to concentrate on the use of multiple methods to assess both the implicit and explicit aspects of PCK. An ideal approach would include instruments that capture teachers' plans and intentions, their actual teaching behaviors, and their post-lesson reflections as a means of documenting a teacher's explicit pedagogical reasoning. The goal would be to reveal the complexity of teacher knowledge in a manner that one can discuss the multiple dimensions of a teacher's PCK individually and collectively.

Strand 12: Educational Technology

S9.14 Symposium: Electrons, Photons & Neurons: Harnessing Virtual Worlds to Redesign Science Assessment 8:30am – 10:00am, Conference Room 412

Presenters:

Diane Jass Ketelhut, Temple University, djk@temple.edu Douglas B. Clark, Vanderbilt University Brian C. Nelson, Arizona State University Catherine C. Schifter, Temple University Cynthia M. DAngelo, Arizona State University Tera Kane, Temple University Muhsin Menekse, Arizona State University Angela Shelton, Temple University Kent Slack, Arizona State University Mark Snyder, Temple University

ABSTRACT: Traditional approaches to learning and assessment that reinforce memorization of scientific content are gravely outdated and mismatched with the national standards for science education. New tools are needed to assess these evolving scientific inquiry-based standards. This symposium will report on research into the use of virtual environments for assessment in science. In particular, design ideas and research findings from three projects: River City, SAVE Science and SURGE will be presented. The goals of this symposium will be to shed light on the following issues: How in-world interactions offer unique insights into student understanding of scientific inquiry; Design issues in embedding assessment validly, reliably, and without interrupting play that promote reflection and make students' thinking explicit and visible; How to develop those embedded assessments and assessments of students' in-game performance to predict performance on formal science outside of the game; and, How different theoretical lenses can help us analyze in-world interactions to illuminate student understanding.

Strand 13: History, Philosophy, and Sociology of Science

S9.15 SC-Paper Set: Curricula and Nature of Science

8:30am – 10:00am, Conference Room 413

S9.15.1 Analysis of Nature of Science Coverage in Egyptian and Lebanese Middle School Science Textbooks

Zoubeida R. Dagher, University of Delaware, zoubeida@udel.edu

BouJaoude Saouma, American University of Beirut

Sahar Alameh, The American University of Beirut

ABSTRACT: The purpose of this study is to analyze the official middle school science textbooks in Egypt and Lebanon relative to the set of nature of science goals identified in each country's curriculum guides. The analytical framework used in this study consists of nature of science goal statements derived from the curriculum guides of Egypt (3 goals) and Lebanon (6 goals). Unlike many textbooks in western countries, none of the reviewed books (total of 15) included an introductory chapter that provides explicit instruction on the nature of science and scientific work. In line with the goal statements, the Lebanese textbooks made clear reference to science and technology and the social dimensions of science in a number of chapters. The Egyptian books rarely addressed the three goals contained in the curriculum document pertaining to history of science, science and technology and role of scientists. Implications of these findings call for re-evaluating nature of science goals in the original curriculum documents, re-aligning those with state textbook orientations, and improving the currently weak links between the personal, historical, social and disciplinary dimensions of scientific knowledge.

S9.15.2 How Secondary Science Textbooks Present Scientific Methodology

Ian C. Binns, Louisiana State University, ianbinns@lsu.edu

Randy L. Bell, University of Virginia

ABSTRACT: This study explored how eight secondary science textbooks introduced scientific methodology and to what degree the examples from the rest of the textbook, the investigations, and the images were consistent with the text's description of scientific methodology, if at all. Data consisted of all student and teacher text that referred to scientific methodology, all investigations, and any images that depicted scientists working. The text and activity analyses used the ethnographic content analysis approach and the image analysis used stereotypes identified in the DAST literature. Results indicated that all eight textbooks presented mixed views of scientific methodology in their initial descriptions. Five textbooks placed more emphasis on the traditional view and three placed more emphasis on the broad view. Results also revealed that the initial descriptions, examples, investigations, and images all emphasized the broad view for Glencoe Biology and the traditional view for Chemistry: Matter and Change. The initial descriptions, examples, investigations, and images in the other six textbooks were not consistent. Overall, Glencoe Biology had the most appropriate depiction of scientific methodology and Physics: Principles and Problems the least appropriate depiction. These findings suggest that compared to earlier investigations, textbooks have begun to improve in how they represent scientific methodology.

S9.15.3 Degrees of Concordance between Scientific Representations of Evolutionary Theory and Contemporaneous High School Biology Textbooks through the 20th Century

Patrick J. Halbig, University of Illinois at Urbana-Champaign, phalbig@illinois.edu

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

ABSTRACT: This study examined the relationship between representations of evolutionary theory by the scientific community and a major United States high school biology textbook series, namely Modern Biology, which spans the 20th century through its continuous editions (1921-present). For each textbook edition of the series, information pertaining to the theories of evolution, inheritance, and human origin was compiled and categorized. A parallel analysis focused on the historical development of evolutionary theory within the scientific community by reference to multiple scientific literature sources, including original sources. Using a qualitative rubric, degrees of conflict and concordance between scientific representations of evolutionary theory and those presented in the series textbooks were assessed for: (1) general definition and parameters of evolutionary theory, (2) the centrality of evolution to biological thought, (3) the primary mechanism(s) by which evolution operates in natural populations, and (4) and the relationship between representations of human origins and evolutionary theory. Qualitative analyses were used to create a timeline, which outlines the accuracy of each textbook edition in relation to contemporary scientific characterizations of evolutionary theory. Analyses indicated that the general theoretical domain and associated mechanistic components of evolutionary theory were, and largely continue to be, not strongly concordant with contemporary scientific consensus.

S9.15.4 Let's Do It Together! A Collaborative Project of Researchers and Practitioners on Implementing History and Philosophy in Science Teaching

Dietmar Hoettecke, University of Kaiserslautern / Germany, postmaster@dietmar-hoettecke.de

Falk Riess, University of Oldenburg / Germany

Andreas Henke, University of Bremen / Germany

ABSTRACT: Despite the fact that many curricula all over the world demand for an inclusion of history and philosophy of science (HPS), the degree of effective implementation is rather low. Central problems are a lack of effective and suitable materials for

teaching and learning, teachers' beliefs that HPS is an add-on of science education, and a lack of didactical knowledge on how to teach HPS. Student-centered methods like inquiry learning, experiments with replicas, open-ended discussions or role-play activities are far from being implemented widely. The European project HIPST (History and Philosophy in Science Teaching) aims at a contribution to close the gap between curricular objectives and actual practice of science teaching. Ten partners from all over Europe collaborate in order to develop and refine case studies for teaching and learning with and about HPS. Project outcomes will provide an enriched basis for an effective implementation of HPS. The developmental process is characterized by a symbiotic strategy where researchers, science teachers or experts from science museums join to several international and national conferences as well as thematic working groups. Each of the groups brings their special expertise, knowledge, and resources into the developmental process. Case studies developed within these groups are tested, evaluated in practice and refined afterwards. The paper describes the framework, developmental methodology and first results of HIPST.

Strand 14: Environmental Education S9.16 Symposium: How to Change University Faculty Members' Attitudes and Behavior in the Context of Education for Sustainable Development

8:30am – 10:00am, Conference Room 414 Presenters:

Ahmad M. Qablan, The Hashemite University, ahmadgablan@hotmail.com Suleiman Al-Qaderi, Al al-Bayt University Jamal H. Abu Al Ruz, The Hashemite University Samer Khasawneh, The Hashemite University

ABSTRACT: It is commonly assumed that attitudes and behaviors need to be modified to secure a sustainable future. This paper examines insights from the social sciences in this extensive field. It first evaluates college faculty attitudes and classroom practices with respect to ESD using a survey designed for that purpose. Results of the study indicate that college faculty exhibited a moderate level of attitudes toward ESD. Although they showed a strong preference for pedagogical approaches that were contrary to the basic tenets of indoctrination, they used teaching practices that hinged on indoctrination. That mismatch between faculty attitudes and behavior was carefully highlighted and discussed by taking account of the personal, physical, social, and institutional contexts that shape and constrain their choices. The study suggested following several safeguards practices against indoctrination when adopting a committed approach to ESD, offering special training courses for college faculty to enhance their pedagogical knowledge, and building learning communities between college faculty to advance their awareness, attitudes, and pedagogical knowledge that relates to ESD.

Strand 15: Policy

S9.17 Symposium: Connecting Research to Policy and Practice: NARST and Its Affiliates

8:30am – 10:00am, Conference Room 415

Presenters:

Francis Erberle, National Science Teachers Association Justin Dillon, King's College London Jon Pedersen, University of Nebraska

Jodi Peterson, National Science Teachers Association

Jo Ellen Roseman, American Association for the Advancement of Science

ABSTRACT: In order to impact policy in science education, NARST members need to know what policy issues are important and how they can engage in these policy issues. In this session, NARST members will have an opportunity to learn about the policy issues which are of interest to NARST, and AAAS, ASTE, ESERA, and NSTA (affiliates). In a panel discussion format, representatives of these Associations will share the current efforts of their Associations in the area of policy; comment about important trends they see in teacher certification, curriculum, assessment, and standards; and suggest important areas of research that can impact policy. They will also offer suggestions about how NARST members can engage with the affiliates and with the NARST organization in order to impact current and future policy decisions.

International Committee Sponsored Session

S10.1 Administrative Symposium: Challenges and Opportunities between Research and Practice --- From International Perspectives

10:30am - 12:00pm, Conference Room 501

ABSTRACT: Putting theories and findings of science education studies into practice has been considered as one of the major challenges of science educators and researchers in the past two decades. In this session, the International Committee selected five papers to discuss this issue from international perspectives. The first presentation is from Liang and Chen who will discuss the current

science education reform promoting scientific literacy for all students via developing students' scientific understanding, creative thinking, scientific attitudes and inquiry skills in China. The second presentation is from Zoller who examined about students' system thinking and decision making in the multi-cultural context in Israel. The third study is conducted by Aufschnaiter who intended to use research on students' learning processes to inform pre-service teacher education in Germany. The fourth presentation by Guo and Lederman was to investigate teachers' conceptions of nature of science (NOS) in Mainland China and in Taiwan. Finally, Nargund's study was to examine the new National Curriculum Framework that aimed at providing a more constructivist approach to learning for all subjects in India. Although the presenters are from different countries, they tend to provide some possibilities for linking the research with the practice in different disciplines. We believe these presentations will provide some inspiring insights and opportunities for linking theories to the practice of science education to the participants. Individual presentations and corresponding presenters are listed below.

S10.1.1 Challenges and Opportunities between Research and Practice in China—An Examination of Exemplary Physics Instruction and Standardized Assessments

Ling L. Liang, La Salle University, PA, USA Xian Chen, Nanjing Normal University, Nanjing, China

S10.1.2 Does Chinese Marxist Education Affect Chinese Science Teachers' Views of Nature of Science? Miancheng Guo, Illinois Institute of Technology

Norman G. Lederman, Illinois Institute of Technology

S10.1.3 Research Into Practice And Feedback: System Thinking-Decision Making In Secondary Science Teaching In The Israeli Multicultural Context

Uri Zoller, Haifa University, Israel

Strand 1: Science Learning, Understanding and Conceptual Change S10.2 Related Paper Set: Evaluating Proposed Learning Progressions: What Can We Learn From Cross-Sectional Data and Longitudinal Studies?

10:30am - 12:00pm, Conference Room 401

S10.2.1 Using a Comparative, Longitudinal Study with Upper Elementary School Students to Test Some Assumptions of a Learning Progression for Matter

Carol L. Smith, University of Massachusetts at Boston, Carol.Smith@umb.edu Marianne Wiser, Clark University David Carraher, TERC

ABSTRACT: A learning progression is a research-based proposal for how ideas about a content domain could coherently evolve over long period of time, given appropriate instruction, to bridge a lower and an upper anchor. Our project is concerned with elaborating on a Learning Progression for Matter for children in grades 3-5 of elementary school. We have been guided by the view that many of the later difficulties students have with the atomic molecular theory stem from limitations in their macroscopic understanding of matter and that developing these macroscopic understandings involves deep and broad reconceptualizations of children's knowledge. We also believe that elementary school students can build these understandings with supportive curricular units, designed from an LP perspective. To test this assumption, we have been designing such curricular units as well as more in depth clinical assessments, and conducting a three-year longitudinal study in which we compare the progress of students within the same school who have our new units with those who do not. This paper discusses the results of first two years of this study regarding the initial conceptual difficulties of students, the steps they take in reconceptualization, and the effectiveness of our new units in fostering this process.

S10.2.2 A Longitudinal Validation Study of a Learning Progression in Genetics

Nicole Shea, Rutgers University, nicoleashea@yahoo.com

Ravit Duncan, Rutgers University

ABSTRACT: The recently released NRC report Taking Science to School has advocated for a new approach to science instruction, termed learning progressions, which addresses learning as it occurs over multiple grades and across grade bands. We have recently developed a learning progression in genetics that spans the 5th to 10th grades (Author et al., 2009). The learning progression fosters the development of students' understanding regarding three conceptual models in the domain: the genetic model pertains to the patterns of inheritance observed when organisms reproduce sexually and the probabilities with which different patterns are likely to occur; the meiotic model pertains to the cellular processes underlying gene recombination, sorting and transfer from one generation to the next; and the molecular model pertains to the mechanisms that link genes to their biological outcomes. In this paper we present a longitudinal validation study of the learning progression across two grades. The study involved the development and implementation of two 8-week units in genetics. Overall we found that students showed the greatest growth in sophistication for the genetic model

and, to some extent, the molecular models. The study provides useful insights regarding the ways in which our learning progression may need to be revised.

S10.2.3 Progress toward the Development of an Empirically Tested Learning Progressions For the Nature of Matter

Shawn Y. Stevens, University of Michigan, sstevens@umich.edu

Namsoo Shin, University of Michigan

Joseph S. Krajcik, University of Michigan

ABSTRACT: Learning progressions (LPs) are a new strategy being used by the science education community to provide a guide for coherent instruction and assessment that enables students to build conceptual understanding of a few core ideas of science over a broad period of time. In addition to a description of a path that students may follow towards developing more expert understanding of an important concept(s), an empirically tested learning progression requires validated assessments that can place students along the progression and instructional materials that support the development of student understanding as described by the LP. In this proposal, we describe efforts toward developing validated assessments for a LP for the nature of matter using an iterative design research approach that follows cycles of definition, development, evaluation and refinement. We collected two sets cross-sectional data from a total of over 550 middle and high school students to characterize students' understanding of the nature of matter and validate assessments to create a scale that characterizes where students lie along the lower levels of the LP. The two cross-sectional studies provided rich information that will ultimately support the empirical validation of the LP by tracking student progress through a three-year longitudinal data collection.

S10.2.4 Using Rasch Modelling on a Large Cross-Sectional Data-Set to Test for a Learning Progression in Chemistry Suggested by a Previous, Small-Scale, Three Year Longitudinal Study

Philip Johnson, Durham University, P.M.Johnson@durham.ac.uk

ABSTRACT: Previously, a small scale, interview-based, three year longitudinal study (ages 11-14) in one school had suggested a learning progression related to the concept of a substance. This paper presents the results of a large-scale, cross-sectional study which used Rasch modelling to test the hypothesis of the learning progression. Data were collected from 4450 students, aged 11-14, across 30 secondary schools using a computer-based assessment instrument. The construction of the items was informed by the research literature on students' understanding in chemistry. One hundred and seventy six fixed response items, in three formats, involving the use of video and animation were developed. Examples of items are given. Scored dichotomously, the data show a good fit to the Rasch model. Item difficulties have a high degree of invariance across ability, schools, gender and year group. Conceptually, when items are placed in order of difficulty, a coherent progression of ideas emerges which matches the expectations from the longitudinal study. This learning progression will be presented. Independent, nationally standardized data allow projection of student performance to the wider population. Significant implications for research and curriculum design are discussed.

Strand 2: Science Learning: Contexts, Characteristics and Interactions S10.3 Related Paper Set: Classroom Interactions Supporting the Development of Modeling Practices In Elementary and Middle School Classrooms

10:30am – 12:00pm, Salon D

S10.3.1 Examining 4th Grade Students' Changing Scientific Modeling Practices: Influence of Time and Content

M. E. Gonzalez, University of Illinois at Urbana-Champaign, megonzalez@illinois.edu

Barbara Hug, University of Illinois at Urbana-Champaign

ABSTRACT: Scientific modeling is an essential part of both the learning and practice of science. However, scientific modeling is rarely taught in elementary science as a way to facilitate inquiry. We are interested in understanding how elementary students' ideas about models, modeling, and metamodeling knowledge change over time and how different science content areas impact students. We developed a series of modeling activities for use in a local district's science curriculum. Data was collected from a 4th grade classroom where the teacher integrated models and modeling practices throughout four science units during the school year. We analyzed students' pre-posttests for each unit. Nine focus students were interviewed following each unit. Analysis focused on the themes "models are generative tools for predicting and explaining," and "models can change as understanding improves." Over a year in which four science units were taught, we observed the majority of students progressively develop more sophisticated ideas about models and modeling. Students shifted from an early emphasis on models as literal depictions of an object to thinking of models as representations of phenomena. Students began to understand the communicative aspect and predictive power of models. Data suggests the unit context influences the students' views of models.

S10.3.2 Supporting 5th Grade Elementary Students' Development of Modeling Practice over Time with Multiple Modeling Experiences in Different Subject Matter Contexts

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

ABSTRACT: Scientific modeling practice consists of elements of modeling (constructing, using, evaluating and revising models), and the associated metamodeling knowledge—the underlying understanding about models and modeling that makes the practice meaningful. This paper reports on our work with 5th grade elementary students and their engagement with the modeling practice. In this paper, we describe our methodology including curriculum context that supports student engagement in the practice. Secondly, we describe our empirical data to investigate what changes in modeling practices occur over time when students engage in multiple modeling experiences in different subject matter contexts? This data is compared to two dimensions of metamodeling knowledge, 'models are generative' and 'models can change' within a learning progression for scientific modeling. Finally, we report on the successes and challenges that emerge from engaging elementary students in scientific modeling with these extensive modeling experiences over an extended period of time.

S10.3.3 The Affordances and Challenges of Scientific Modeling in a 5th Grade Unit on Evaporation and Condensation

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

Jing Chen, Michigan State University

Hamin Baek, Michigan State University

Li Zhan, Michigan State University

Christina Schwarz, Michigan State University

ABSTRACT: Reform efforts in science education have aimed at fostering scientific literacy by helping learners meaningfully engage in understanding the content and nature of science. Scientific modeling is a practice that targets those goals. In this paper, we report on our two year empirical work that has investigated 5th grade student learning of evaporation and condensation through modeling. We discuss the affordances and challenges of this practice using a theoretical lens that combines cognitive and scoio-cultural frameworks. Our results indicate that students made significant progress in constructing models that convey unobservable characteristics and are consistent with empirical evidence. They have also made progress in thinking of models as changeable tools that are consistent with empirical evidence. However we see little evidence of students spontaneously using models as tools to advance their own thinking or to predict other situations. We theorize that some aspects of modeling practice are more aligned with typical school norms and practices than others - enabling some aspects to be more readily appropriated than others. Thinking of ways to capitalize on successes of this practice and to address the challenges constitutes the next steps that could be taken to help improve students' engagement in modeling.

S10.3.4 Middle School Students and Teachers Making Sense of Modeling Practices in Their Classroom

Andres Acher, Northwestern University, a-acher@northwestern.edu

Brian J. Reiser, Northwestern University

Elizabeth A. Davis, University of Michigan

ABSTRACT: The aim of this research is to investigate how teachers and students construct their own meanings of modeling practices in the classroom. We investigate the emerging tasks and criteria to perform these tasks teachers and students negotiate, and examine the roles of teachers and students in contributing to how these develop across time. Our data come from three 6th grade classrooms enacting a project-based chemistry unit ("How can I smell things from the distance?") that involves students in creating and revising models to account for different molecular phenomena. We examine a total of 39 modeling lesson enactments, from one teacher and three of her classrooms. We analyze both how the teacher frames the activity and how students and teacher actively negotiate this frame as the activity unfolds. Analyses demonstrate that modeling tasks are extended from the form originally framed by the teacher, through interactions contributed both by the teacher and students, and become refined over time. Second, we see increasing attention to the tools that help refine the way tasks are carried out. We expect that by identifying patterns of interactions reflecting these negotiations we will offer clues to teachers and curriculum designers to better support students in performing a more sophisticated modeling practice.

Strand 2: Science Learning: Contexts, Characteristics and Interactions

S10.4 SC-Paper Set: Contexts and Factors Influencing Students' Conceptual Development and Achievement 10:30am – 12:00pm, Conference Room 402

S10.4.1 Quality of Instruction in Biology

Stefanie Wuesten, University Duisburg-Essen, stefanie.wuesten@uni-due.de Stephan Schmelzing, University Duisburg-Essen Martin Linsner, University Duisburg-Essen

Angela Sandmann, University Duisburg-Essen

Birgit Neuhaus, University München

ABSTRACT: A huge number of isolated, subject-independent factors influencing students' learning achievement has been identified within the scope of teaching quality research so far (Fraser et al., 1987; Wang et al., 1993). An analysis of the interaction of these factors, as well as the interaction of those with subject-specific factors has been mostly disregarded (compare Helmke, 2004). The aims of this project are to scrutinize the importance of empirically described subject-independent criteria of teaching quality for

biology lessons, to add subject- specific criteria and to check the interaction of both aspects. Therefore the project consists of three different parts: at first general and subject-specific criteria are identified by doing an explorative interview and literature study. Then, the identified criteria are assessed in 50 videotaped biology lessons and correlated to students' achievement data. Thirdly the most important general and subject-specific criteria are varied in a 2*2-intervention study which serves to check the results from video-study experimentally. All results will be presented during the presentation

S10.4.2 Conceptual Metaphors and hidden Analogies in Physics Language: Textbook Analysis and its Relevance for Physics Teacher Education

Lutz Kasper, University of Education Freiburg (Germany), l.kasper@physik.uni-frankfurt.de

ABSTRACT: Why does it make sense to say that light 'travels' or energy 'flows'? And what does it mean 'translated' into physics? Based on Lakoff's theory of conceptual metaphor we see metaphors not as a mere language phenomenon. Rather metaphors unconsciously control our thinking and acting. So called conceptual metaphors are structure transfers from a more or less well-known domain to an unknown domain that we try to understand. In our study we investigate a sample of all levels' physics textbooks written in english and german language. This will allow us to compare science language concerning the use of metaphors and analogies. The research is including both, qualitative and quantitative analytical techniques. Typically qualitative methods, such as Qualitative Content Analysis and Systematic Metaphor Analysis are used to identify and categorize metaphorical and analogical conceptualizations in science language. As results we identified conceptual metaphors in all physics domains. However, we found the more metaphors, the more abstractly the target domains are. We couldn't elicit significant differences in the use of metaphors across both languages. Our textbook analysis furnished a category system of conceptual metaphors. In our presentation we will give an overview to the categories and will show examples.

S10.4.3 High School Science Teachers Supporting Literacy: A Role for Explicit Comprehension Instruction?

Phillip Herman, University of Pittsburgh, pherman@pitt.edu

Kristen Perkins, Northwestern University

Martha Hansen, Evanston Township High School

Louis M. Gomez, University of Pittsburgh

Kimberley Gomez, University of Pittsburgh

ABSTRACT: There is a growing consensus in the adolescent literacy research community that middle and high school science educators need to more explicitly support reading in science classrooms. General reading teachers cannot provide struggling readers with the scientific reading expertise that is necessary to read and learn from science texts. This trend puts pressure on science teachers who need practical and effective ways to support literate practice in science classrooms. We describe our efforts to develop and evaluate a program of tools, practices and professional development designed to put into practice the research that indicates that when students become proficient with comprehension-focused reading strategies they are better able to read and learn from text. Approximately 900 high school biology students learned to use three classes of reading strategies over one school year. We report here on our efforts to assess whether students' proficiency with each of the strategies predicts science achievement. Teachers need practical and effective ways to deepen science learning by better supporting reading-to-learn in science.

S10.4.4 Depth and Breadth: Bridging the Gap between Scientific Inquiry and High-Stakes Testing with Diverse Junior High School Students

Emily J.S Kang, Adelphi University, emilykang2@gmail.com

ABSTRACT: This study explored how inquiry-based teaching and learning processes occurred in two teachers' diverse 8th grade physical science classrooms in a Program Improvement junior high school within the context of high-stakes standardized testing. Research was drawn from inquiry-based instruction in science education, the achievement gap, the high stakes testing movement, as well as situated learning theory. Analysis of class sessions transcripts; student work samples; interviews with teachers and students; and science standardized test scores indicated that the teachers provided structured inquiry in order to support their students in learning about forces and to prepare them for the standardized test. Supports for structured inquiry included teachers' guided questioning, standardized test preparation, literacy support, and home-school connections. Constraints to student learning included students' limited language proficiency, peer counter culture, and limited time. Notwithstanding the constraints, the teachers had students practice the heart of inquiry – to connect evidence with explanations and process with content. Engaging in inquiry-based instruction provided a context for students to demonstrate their knowledge of forces. Students had stronger and more detailed ideas about concepts when they engaged in activities that were tightly connected to the concepts, as well as to their lives and experiences.

Strand 4: Science Teaching--Middle and High School (Grades 5-12): Characteristics and Strategies S10.5 Symposium: The Invisible College for Inquiry Science Study (ICISS): Integrating Teaching and Research in a Professional Community

10:30am - 12:00pm, Conference Room 404

Presenters:

Scott McDonald, The Pennsylvania State University, smcdonald@psu.edu

Brett Criswell, Keenesaw State University

Scott Delone, The Pennsylvania State University

Cecilia Tang, The Pennsylvania State University

ABSTRACT: This symposium address bringing research to teaching by describing a unique community of pre-service and in-service teachers, graduate students and faculty in science education all engaged in developing a theory of inquiry science teaching grounded in practice. All members of the Invisible College for Inquiry Science Teaching (ICISS) are practitioner/researchers engaged in educational research projects. This symposium highlights the projects of two pre-service teachers, one in-service teacher and graduate student and one overarching project by a faculty member designed to understand the impact of engaging in research as a professional learning context. The symposium will discussion the philosophical and theoretical underpinnings of the group, present the projects briefly and allow time for discussion focused on how engagement with research might provide a context for closing the teaching/research gap.

Strand 5: College Science Teaching and Learning (Grades 13-20) S10.6 SC-Paper Set: Discourse and Argumentation in Undergraduate Biology

10:30am – 12:00pm, Conference Room 405

S10.6.1 The Nature of Undergraduate Students' Questions during Inquiry and the Roles of the Teacher in Fostering Question Asking

Iris Alkaher, Virginia Tech, irisal@vt.edu

Erin Dolan, Viriginia Tech

ABSTRACT: In this exploratory study, we characterize undergraduate introductory biology students' questions during open-ended inquiry to explore how their questions indicate their thinking and learning needs and identify how teachers can encourage students to ask meaningful questions during inquiry. Data were collected during classroom observations and students' discussions during different phases of inquiry. We found that students asked confirmation and transformation questions with a variety of intentions, including experimental, procedural, scientific content, and social. Generalization and evaluation features appeared in the students' questions toward the end of the inquiry. Our results indicate that students are seeking science content during the design and interpretation phases, logistical guidance during the design and initiation of data collection, and interpersonal guidance throughout all phases of inquiry. In addition, we found that the instructor enacted a variety of roles with respect to questioning: guide, motivator, modeler, and diagnostician. Instructors can use the types and intentions of students' questions as a tool for instructional decision-making and for evaluating students thinking. In addition, instructors can use the variety of instructional actions and approaches identified in our study to prompt students' question asking as a step in identifying students' needs for scientific content, logistical, interpersonal or experimental support.

S10.6.2 "Not Simply What's the Science, but How Does It Affect People, and Why Is That Important?" Effects of an Interdisciplinary Human Biology Program Focused on Socioscientific Reasoning

Jennifer L. Eastwood, Indiana University, jvanduse@umail.iu.edu

Kristin L. Cook, Indiana University

Robert D. Sherwood, Indiana University

Whitney M. Schlegel

ABSTRACT: Preparing students to take informed positions on complex problems through critical evaluation is a primary goal of university education. Socioscientific issues (SSI) have been established as effective contexts for students to develop this competency, as well as reasoning skills and content knowledge. This study investigates the effects of an interdisciplinary undergraduate human biology program (HUBI) focused on the development of evidence- based reasoning skills and reflective judgment to form personal commitments on SSI. Specifically we investigate how HUBI majors differ from traditional biology majors in how they reason with SSI and their perceptions of and experiences with SSI. We found that although the two groups did not differ in their decisions or factors influencing their decisions. HUBI majors showed higher levels of socioscientific reasoning. Both groups showed high levels of reflective judgment in their approaches to problems, but HUBI majors often referenced cases encountered in class, suggesting that learning contextualized in SSI helped them understand and reason with other problems. While biology majors reported having few opportunities for socioscientific reasoning, HUBI majors felt well-equipped to reason with SSI and more likely to consider alternative perspectives. The study provides an example of a successful long-term, interdisciplinary approach to teaching SSI.

S10.6.3 The Nature of Discourse Throughout 5E Lessons in a Large Enrollment College Biology Course

Aaron J. Sickel, University of Missouri, ajsrhc@mail.missouri.edu

Binaben H. Vanmali, University of Missouri

Stephen B. Witzig, University of Missouri

Sandra K. Abell, University of Missouri

ABSTRACT: Large enrollment science courses play a significant role in educating undergraduate students. The discourse in these classes usually involves an instructor lecturing with little or no student participation, despite guidelines from the U.S. National Science Education Standards for eliciting and utilizing students' ideas in teaching. In this study, the researchers used the 5E instructional model to develop and implement four 5E lessons in a large enrollment college biology course. Multiple opportunities for teacher-student and student-student discussions were embedded in the lessons. Data consisted of transcribed video and audio recordings of whole group and small group discussions that took place throughout the study. The researchers used an analytical framework specific to science classroom discourse to characterize the discursive interactions throughout the lessons, resulting in two major themes. First, the nature of the discourse was unique to each phase of the lesson. Second, the lesson topic influenced the nature of the discourse. The findings help characterize the role of each phase in a 5E college science lesson and provide implications for developing future lessons. Furthermore, this study provides support for using the analytical framework to characterize the discourse in large enrollment science courses.

S10.6.4 Experience with Primary Literature by Undergraduate Life Science Students: A Lesson in Scientific Argumentation

Miriam A. Ossevoort, University of Groningen, the Netherlands, m.a.ossevoort@rug.nl

Edwin B. van Lacum, University of Groningen, the Netherlands

Martin J. Goedhart, University of Groningen, the Netherlands

ABSTRACT: Written communication among scientist uses mainly an argumentative structure, whereby conclusions with supporting evidence are presented. Unlike textbooks used in an educational setting, where scientific information is given as facts. The ability to succesfully read primary literature has to be mastered by every science student in higher education. The best way to teach students how to unravel the argumentative structure in primary literature is not clear. That is why we developed a teaching strategy for undergraduate life science students that aimed to improve their ability to read primary literature. Beside learning content knowledge, students were made familiar with the persuasive nature of primary literature in tutor-led groups. In our design-based research an argumentation based framework was used. In this paper, we show how well these students are able to distil the conclusions and arguments from the scientific text by comparing their answers with experts' answers. Our results suggest that the students did have difficulties with identifying conclusions and give the identified arguments in a structured way compared with the experts' answers. Confusion of the terminology used, is maybe the cause of this result. Our findings are used to refine the teaching strategy to be used in next years' curriculum.

Strand 6: Science Learning in Informal Contexts

S10.7 Symposium: Teacher's Experience in Informal STEM Settings: What Lessons Can We Learn?

10:30am – 12:00pm, Conference Room 406

Presenters:

Vera S Michalchik, SRI International, vera.michalchik@sri.com Bob Coulter, Litzinger Road Ecology Center Tina Cartwright, West Virginia State University Kelly Pirog, University of Massachusetts Amherst Allan Feldman, University of South Florida

ABSTRACT: Researchers have recently begun to document the value of involving classroom teachers in out-of-school informal science programming, finding, for example, that informal programs can provide teachers much-needed opportunities to experience participatory models that emphasize inquiry, leading to critical shifts in teacher identity and pedagogical framings (Luehmann & Markowitz, 2007; Melber & Cox-Petersen, 2005). In recognizing the potential for productive engagement of classroom teachers in informal learning environments, the research community establishes for itself a two-fold challenge: first, to develop a complete view of the benefits to be derived from out-of-school (OST) instructional experiences for professional development, and, second, to identify the conditions under which teachers are most likely to adopt new pedagogical approaches. This symposium is designed to address both of these research issues, focusing on three OST STEM programs (COMETS, LIONS, and STEMRAYS) that are part of a larger initiative, NSF's Academies for Young Scientists. A deeper understanding of how teachers develop professionally from experiences in informal settings provides a fresh analytic perspective on characteristics of informal settings, provides new means of enhancing pedagogical practice across settings, and contributes to the current agenda for creating synergies between in- and out-of-school learning experiences for students (Bransford et al., 2006).

Strand 7: Pre-service Science Teacher Education

S10.8 Symposium: Exploring the Utility of Discipline-Specific Pedagogy Courses in Science Teacher Recruitment and Preparation

10:30am – 12:00pm, Conference Room 407

Presenters:

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

Noah Finkelstein, University of Colorado at Boulder

Jill Marshall, University of Texas at Austin

Michael Klymkowsky, University of Colorado at Boulder

David E. Kanter, Temple University

Angelo Collins, Knowles Science Teaching Foundation

ABSTRACT: Science education research indicates that, in order to teach effectively, teachers need not only in-depth knowledge of the subject they are teaching and an understanding of how that subject is learned. A new paradigm for science teacher preparation is to focus on discipline-specific content preparation in courses specifically designed to challenge teacher candidates' content knowledge, as well as to build their pedagogical content knowledge. Such courses do double duty: they solidify preservice teachers' understanding of the target content while developing their pedagogical content knowledge. This symposium will present four discipline-specific pedagogy courses being implemented at two universities and will provide a forum in which the models of these courses can be shared and contrasted, approaches to evaluation of these models discussed, and the overall importance and efficacy of such courses addressed.

Strand 7: Pre-service Science Teacher Education

S10.9 SC-Paper Set: Pre-Service Teachers' Development of More Sophisticated Knowledge snd Practices 10:30am – 12:00pm, Conference Room 409

S10.9.1 Critical and Contextual Discourses: Explaining the Development of Ambitious Practices Across "Learning-to-Teach" Contexts

Jessica Thompson, University of Washington, jjthomps@u.washington.edu

Mark Windschitl, University of Washington

Melissa Braaten, University of Washington

ABSTRACT: The nascent practice of novice teachers is influenced by interactions among personal, social, instructional, and contextual factors across the various "learning-to-teach" environments. Candidates in science teacher preparation are exposed to a range of instructional theories and pedagogical tools but we have inadequate models that help identify what influences the fate of these ideas. This study takes a step toward developing a theory to explain how and why the interrelationships among critical and contextual discourses shape beginning repertoires of practice and the uptake of ambitious pedagogy. In this study, we tracked the thinking and use of ambitious practices of 11 novice secondary science teachers across four contexts: the coursework of a teacher education program, student teaching, the first year of teaching, and back to a university induction program. Teachers' appropriation of ambitious practice depended upon if, when and to what extent critical discourses aligned with and filtered contextual discourses. Furthermore, revisions of practice and of critical discourses depended on how teachers used tools and routines to address gaps between their curricular visions and beginning repertoires of practice.

S10.9.2 Secondary Science Teacher Candidates' Learning of Formative Assessment: How do they respond to students and why?

Hosun Kang, Michigan State University, kanghosu@msu.edu

Amelia W. Gotwals, Michigan State University

Charles W. Anderson, Michigan State University

ABSTRACT: The purpose of this study is to understand secondary science teacher candidates' learning of a key science teaching practice, formative assessment. We examined teacher candidates' formative assessment practices associated with their knowledge bases and professional identities. Four seniors (4th year) and four interns (5th year) at a large Mid-Western university participated in this study. Data include a) lesson and unit plans, b) reports of teaching, c) candidates' self-made teaching videos, d) a statement of good science teaching, and d) interview transcripts. We found three distinctive patterns of formative assessment practices through analyzing teacher candidates' ways of identifying, interpreting, and responding to students. Only one teacher candidate successfully used formative assessment to modify her lessons. Across eight participants, we found that there was not a big difference between senior and intern groups. However, there appears to be a strong relationship among each candidate' ways of assessing and responding to students, their knowledge regarding students as learners, and their professional identities (i.e., their values and positioning with respect to communities of practice). These results indicate the strong influence of identity and knowledge of students as learners on teacher candidates' practice.
S10.9.3 The Development of Pedagogical Content Knowledge during Teacher Education

Andreas Borowski, University Duisburg-Essen, andreas.borowski@uni-due.de

Hans E. Fischer, University Duisburg

ABSTRACT: Based on a model of professional knowledge of physics teachers the development of pedagogical content knowledge (PCK) of a group of 100 in-service and pre-service physics teachers in the domains 'mechanics' and 'electricity' was investigated. Two previously evaluated paper-and-pencil-tests were used to measure PCK during teacher education in a quasi-longitudinal setting with students in the first and second phase of German teacher education and in service teachers. The tasks of both tests can be distinguished using two aspects: (1) theoretical background knowledge and (2) knowledge of Reflection-On-Action. The analysis of the data showed a significant increase of pedagogical content knowledge as a whole over the phases of teacher education, as expected. Theoretical background knowledge of Reflection-On-Action but later this knowledge domain remains largely constant. In contrast, the knowledge of Reflection-On-Action increases significantly over the entire teacher education. Moreover, pedagogical content knowledge depends on the grade of teaching experience as small scale studies showed already. With our investigation we demonstrate the feasibility of a large scale study on pedagogical content knowledge. Our results also confirm that one of the aims of teacher education, the acquirement of pedagogical content knowledge, is achieved in the present education system.

S10.9.4 Examining Shifts in Preservice Teachers' Practice-Oriented Goals as Indicators of Learning to Teach Toward Science Reform Initiatives

Robert M. Danielowich, Adelphi University, rdanielowich@adelphi.edu

ABSTRACT: Recent research suggests that teachers' tacit beliefs about general teaching play crucial roles in their learning as they attempt to enact science education reform initiatives such as the NOS, inquiry, and STS/SSI. In this multiple case study, six secondary preservice teachers taught, peer-evaluated, and reflected about five short lessons focused on different science reform agendas in a methods course and then taught, reflected about, peer-shared, and reflected again about five videotaped full-length lessons during student teaching. Reflections in each course were open coded into five practice-oriented goal categories, and shifts in each teacher's reflections among categories were interpreted using three interviews and multiple secondary data sources. While shifts in two categories (lesson structure, classroom climate) were similar for all teachers, analyses of shifts in other categories (assessment, lesson content, lesson coordination) revealed most teachers' negotiations with reform practices were best explained by goals they reflected about less, rather than more, in the student teaching term. The results demonstrate the need for a consistent "safe space" for preservice teachers to examine their practice-driven goals both before and during student teaching and reinforce the need to interpret teachers' struggles to enact science-specific reform agendas in light of their broader goals for teaching.

Strand 8: In-service Science Teacher Education S10.10 SC-Paper Set: Mentoring and Science Teacher Retention 10:30am – 12:00pm, Salon C

S10.10.1 A Case Study of Urban Secondary Science Teacher Career Satisfaction and Retention in an Alternative Certification Program

Christina Gonzalez, Lehman College, angela.kelly@lehman.cuny.edu Angela Kelly, Lehman College

ABSTRACT: The purpose of this study is to analyze select professional characteristics of one cohort of New York City Teaching Fellows (NYCTFs) in science disciplines, as well as their respective organizational support structures and issues affecting career satisfaction. Identification and development of such qualities and structures may lead to improved alternative certification programs and increased science teacher retention in urban high schools. The research focused on the self-efficacy, quality of professional life, and various support systems of a select group of second-year secondary science teachers. The study incorporated a mixed methods approach, utilizing survey data and interview responses to determine which factors most influenced job satisfaction and teacher retention. More than 80% of the participating science educators planned on leaving teaching altogether by the end of their third year in the classroom. Findings suggest that several institutional factors impeded science teachers' sense of professionalism, leading to higher attrition rates. The Department of Education, school-based administrators, and graduate schools of education need to work collaboratively to provide sustained mentorship, meaningful coursework and professional development, and opportunities for better time management and professional reflection

S10.10.2 Educative Mentoring: Reframing the Potential for Mentoring in Science Education

Leslie U. Bradbury, Appalachian State University, upsonlk@appstate.edu

ABSTRACT: The purpose of this paper is to introduce science educators to "educative mentoring" (Feiman-Nemser, 2001), a particular type of support described in the general mentoring literature that focuses on the professional growth of novice teachers through their work with a more experienced veteran teacher. Unlike more traditional mentoring relationships which focus on "survival," educative mentoring rests on a broader conception that prioritizes reflection and continued growth. Because of its emphasis on student understanding and inquiry into teaching practice, educative mentoring can be an important tool in achieving reform-based science education. By providing examples of the behaviors and characteristics of educative mentors, with examples from science

education, I hope to draw attention to this framework for the purpose of reframing prevailing notions of mentoring in science education. The paper also describes the type of assistance mentors may need to enact educative mentoring and an agenda for future research on this topic.

S10.10.3 Teacher Thinking Associated with Science-Specific Mentor Preparation

Michael Dias, Kennesaw State University, mdias@kennesaw.edu

Thomas R. Koballa, University of Georgia

Julie M. Kittleson, University of Georgia

Leslie U. Bradbury, Appalachian State University

ABSTRACT: This qualitative study examined teachers' thinking about mentoring as revealed through their discussions and written cases. The participants were 34 experienced teachers enrolled in a federally funded science-specific mentor preparation program. Data took the form of interview transcripts, electronic bulletin board postings, and written cases. The purpose of the study was to understand the sociocultural tools used by science teachers when leaning to mentor and how tool use may lead to the construction of new understandings about mentoring. Program participants were found to use a range of pedagogical tools to construct understandings about mentoring practices. Analysis of data revealed that the participants used practical tools, including classroom observation protocols and conferencing strategies, and cognitive tools to mediate their learning about mentoring. Cognitive tools included images that mediate the participants' responses to specific mentoring challenges and dilemmas that highlight contradictions in their thinking about mentoring. The findings provide insights into the impact of science teachers' participation in a mentor preparation program on their thinking and identity as mentors of science teachers.

S10.10.4 Early Leavers and Vertical Advancers: Sociocultural Factors Influencing Teacher Attrition from a Graduate Program for Middle and High School Science Teachers

Yushaneen Wilson, University of Pennsylvania, wilsony@sas.upenn.edu

Sonya N. Martin, Drexel University

Rachel Ruggirello, Washington University, St. Louis, MO

ABSTRACT: Published works seldom examine the issue of teacher attrition as it relates to in-service teachers enrolled in graduate science-content degree programs. This study addresses this gap in the literature by investigating teacher attrition and retention graduate program for in-service middle school science and high school chemistry teachers. Using sociocultural theory, this study examines attrition data from a multi-year Math Science Partnership (MSP) project for in-service teachers to identify and characterize factors that contribute to teacher attrition and retention in the program. This paper characterizes the experiences of two populations of teachers who dropped out of the program during the last ten years as either "early leavers" or "vertical advancers". Findings suggest that women and minorities, especially those who teach in urban settings, are at the greatest risk for becoming "early leavers". Researchers discuss an unexpected category of teachers identified "vertical advancers", who left the program due to opportunities for advancement to administrative positions as a result of their participation in, but graduation from, the program. Finally, this paper offers insights to teacher educators and program developers about some retention strategies that have been successful for supporting teacher participants who are at-risk for leaving early.

Strand 8: In-service Science Teacher Education

S10.11 SC-Paper Set: Efficacy and Reform

10:30am - 12:00pm, Conference Room 408

S10.11.1 Science Educators Today: Results from the National Science Teachers Association's First Ever State of Science Education Survey

Sissy S Wong, Arizona State University, sissy.wongkavas@asu.edu

Irasema B. Ortega, Arizona State University

Julie A. Luft, Arizona State University

Francis Eberle, National Science Teachers Association

ABSTRACT: There are limited longitudinal studies on science educators, and how they access and implement professional development. It is through this rationale that the National Science Teachers Association conducted their first ever State of Science Education Survey. The development of the survey considered the importance of questioning areas on professional development activities, policy-related matters, and perspectives of the membership on science education. From these topics, questions were constructed in categories titled: Perspectives on Science Education, Status of Science Teaching, and Professional Development. After development, the survey was placed on SurveyMonkey where 3,606 science teachers and other education professionals responded. Through this survey, science educators have explained their views of science education today, the challenges they face, the issues that persist in the field, and what they need to become more actively engaged in research and the science education community. Knowledge into the needs and desires of science educators in the United States will assist NARST in designing and implementing opportunities that foster involvement in professional organizations, research opportunities, and collaboration amongst professionals in

the field. It is critical that NARST members are provided the information of what science educators need today in order to advance the profession and support science educators in the classrooms.

S10.11.2 Content, Self-Efficacy, and the Nature of Science Gains from Immersive Science Courses for K-8 Teachers

 $Margaret \ D. \ Nolan, \ School \ of \ Education, \ Boston \ University, \ noland @mersd.org$

Peter Garik, Boston University Charles Winrich, Boston University Donald DeRosa, Boston University Andrew Duffy, Boston University Russell Faux, Davis Square Research Associates Bennett Goldberg, Boston University Manher Jariwala, Boston University Bristol Konoian, English High School, Boston Public Schools Glenn Stevens, Boston University

ABSTRACT: The School of Education and the Departments of Mathematics and Physics at a major urban research university have teamed to offer K-8 teachers professional development courses in science. One course focuses on sources of alternative energy, and the other on causes of climate variation. The courses engage participants in five preliminary meetings dedicated to content, and then two immersive weeks in the summer during which period the participants generate an investigable question, plan and conduct investigations to collect and organize data about their question, and prepare a report about their research project. The principal objectives of the courses are to improve participants' content knowledge in science, improve their self-efficacy for teaching science, and to improve their understanding of the nature of science. Survey and interview results are consistent with improvements in participants' self-efficacy and understanding of the nature of science. Content gains as measured by standard surveys are small. Nevertheless, participants claim significant content gains probably as a result of the broad range of science concepts and process covered in the courses.

S10.11.3 Collaborative Professional Development and Curriculum Enactment: Teacher Reflection to Inform Classroom

Discussions in Project-Based Science

Nonye M. Alozie, University of Michigan

ABSTRACT: Professional development for practicing science teachers has been a goal in education for the last two decades. However, we have yet to fully understand the structure, characteristics, and content of professional development that produces such results. Because professional development had shown to be linked to student achievement (Fishman, Marx, Best, & Tal, 2003), the need for intense, sustained and focused professional development grows. In this study, practicing teachers will work collaboratively with curriculum developers to understand how the enactment of rich, inquiry-based discussions can be supported through collaborative and sustained professional development workshops. This study used interviews, professional development workshops, and teacher enactment in an iterative process to shed light on collaborative relationships with teachers to bring forth new knowledge in connecting teacher reflection and curriculum enactment. It will also reveal tensions teachers face as they attempt to apply inquiry-based teaching methods in urban high school classrooms. This study contributes to the literature by revealing how professional development and resources for teacher learning, can provide opportunities for reflection on practice and how reflection can lead to changes in practice.

S10.11.4 Assessing Efficacy through an Outdoor Professional Development Experience for Inservice Science Teachers

Molly Holden, Texas Christian University, m.holden@tcu.edu

Judith Groulx, Texas Christian University

Mark A. Bloom, Texas Christian University

Molly H. Weinburgh, Texas Christian University

ABSTRACT: Teachers' self-efficacy and outcome expectancy have been consistently associated with student achievement. This research examines changes in these constructs for K-12 inservice teachers who participated in a year-long professional development (PD) experience designed to promote the use of outdoor spaces for environmental science instruction. The PD consisted of a two-week summer session, followed by monthly half-day workshops throughout the academic year. The researchers used the Science Teaching Efficacy Belief Instrument, version B (STEBI-B) (Riggs & Enochs, 1990), which was modified to include statements about outdoor science teaching. Pre- and post-assessment results are presented for 22 teachers. Outcome expectancy scores for classroom and outdoor science teaching, as well as self-efficacy scores for outdoor science teaching increased significantly from pre- to post-. An unexpected observation was the reported decrease in self-efficacy for traditional science teaching over same period. The results are examined further using supporting data from the PD (assessments on participants' beliefs about outdoor instruction, audio taped small group discussions, reflective journal entries, classroom observations), as well as pre- and post-STEBI-B scores for the summer session of a second year PD, particularly scores for the eight participants who returned from Year 1.

Strand 10: Curriculum, Evaluation, and Assessment

S10.12 Related Paper Set: Toward a Framework for Studying Research-Based Science Curricula 10:30am – 12:00pm, Conference Room 410

S10.12.1 A Framework for Studying Research-Based Science Curricula: Theoretical Foundations

Janet Carlson, BSCS, jcarlson@bscs.org

Joseph Taylor, BSCS

ABSTRACT: This paper describes the theoretical foundations of a framework for studying research-based curriculum materials. Specifically it describes a symbiotic approach to curriculum development and research that covers a continuum of studies. These range from exploratory design studies through rigorous, large-scale effectiveness studies that attempt to make causal inferences about program effectiveness and that generalize to a broad array of student populations.

S10.12.2 Curriculum Field Test Studies - Example One: Focus on Implementation Fidelity

Joseph Taylor, BSCS, jtaylor@bscs.org Janet Carlson. BSCS

ABSTRACT: In this field-test study description, we discuss an approach to assessing program effectiveness that involves disaggregating student achievement data using teachers' implementation fidelity scores. A compelling relationship was observed between high fidelity implementation and high student achievement scores. Recommendations include professional development targeted at science content and instructional models.

S10.12.3 Curriculum Field Test Studies - Example Two: Focus on Acheivement Gaps

Susan Kowalski, BSCS, skowalski@bscs.org

Joseph Taylor, BSCS

ABSTRACT: In this field-test study description, we discuss an approach to exploring the equity of student achievement outcomes associated with a curriculum program. In particular, we examined whether mean student outcomes were equivalent when the outcome data were disaggregated by race, gender, and socioeconomic status. The main finding of this analysis was that student outcomes were comparable even when disaggregated by these factors. Recommendations include embedding into curriculum research-based teaching strategies, especially those suggested in How People Learn.

S10.12.4 Curriculum Efficacy Studies - Example One: Comparisons to Commonplace Curriculum and Teaching

Christopher Wilson, BSCS, cwilson@bscs.org

Joseph Taylor, BSCS Susan Kowalski, BSCS Janet Carlson, BSCS

ABSTRACT: In this efficacy study description, we discuss a randomized control trial study in which students received instruction through inquiry-based materials or via "commonplace" teaching materials/strategies, as defined by Horizon Inc. survey and interview data. Three different outcomes were measured: scientific knowledge; reasoning with scientific models; and construction/critique of scientific explanations. Students in the inquiry-based group scored significantly higher on posttest measuring scientific knowledge and reasoning than students in the commonplace group, and also received significantly higher argumentation scores on posttest interviews. While no achievement gaps were present for race, gender or SES variables in the inquiry-based group, the commonplace teaching led to a significant achievement gap by race on posttests. The findings are discussed in the contexts of accountability and teacher practice, equitable science education, and the role of curriculum materials in reform.

Strand 11: Cultural, Social, and Gender Issues

S10.13 Related Paper Set: Laughing Together, Learning Together: The Role of Laughter in Science Education 10:30am – 12:00pm, Conference Room 411

S10.13.1 Creating and Maintaining Emotional Climates to Afford Success in Science Education

Kenneth G. Tobin, City University of New York, Graduate Center, ktobin@gc.cuny.edu

Llena Reynaldo, City University of New York

Devin Sepulveda, City University of New York

Selenia Abad, City University of New York

ABSTRACT: Laughter can contribute to the practices that sustain positive emotional energy and afford science achievement, participation, and identity development. Also, laughter can serve to create solidarity and cosmopolitanism in science classes where there are high levels of diversity. In this research in urban science classes we note that laughter can also act as a resonance site that switches students away from doing science toward forms of practice that distract and subvert. The ambiguity of laughter in the classroom may lead teachers to shut down instances as they arise. However, the benefits might far outweigh the disadvantages and as

part of a reflexive approach to teaching and learning students and teachers might collaborate to ensure that laughter rarely impacts negatively on the quality of learning environments. This mixed methods study of teaching and learning science was situated in a small high school in New York City. The participants were youth from two living environment classes taught by a teacher researcher. Data resources included digital video, transcripts of conversations and interviews about shared experiences of being in the class.

S10.13.2 Laughter, Perseverance, and Kinship among Minority Students in a Physics Classroom

Konstantinos Alexakos, School of Education, Brooklyn College, CUNY, kalexakos@gmail.com

Victor H. Rodriguez, Brooklyn College, CUNY

Jayson J. Jones, Brooklyn College, CUNY

ABSTRACT: This study looks at laughter in a college physics classroom composed of inner city high school minority students. It investigates emotionally stimulated and driven laughter among friends as they use it to cope with physics, reduce edginess and stress, and facilitate healthy competition among themselves. For these close friends, laughter helps generate a safe and supportive space that they report as favorable to their perseverance and success in a class that they had initially viewed with apprehension. Furthermore, laughter helped to further develop and strengthen friendship bonds among them as well as within many of the new in-class study groups they were part of that were created during the course of the semester.

S10.13.3 The Role of Laughter in Science Teacher Education Courses

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

ABSTRACT: This research explored encounters within a pre-service elementary science methods course that focuses on learning to teach through shared responsibility. In examining these encounters, I explore the role of laughter in the group, and elaborate on the ways in which laughter supported and acknowledged difference within dialogic classroom interactions. This proposed presentation focuses on positive emotions as represented by laughter, and situates laughter as a structural resonance that emerges spontaneously from the social bonds established within the collective.

S10.13.4 Examining the Role of Laughter as Structures for Developing Reflexivities towards Teaching and Learning

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

Correa H. Jennifer, New York Hall of Science

ABSTRACT: In this research, we examine the role of laughter as it becomes a structure for self and others to appropriate in teaching and learning environments and mediates the development of reflexive activities for teaching in a science center setting. Pre-service science teachers who work as floor facilitators in an urban science center participate in cogenerative dialogues with science center supervisors. The outcomes of this study describe the different reasons why laughter emerges during meetings and over time mediates the transformative experiences where supervisors and floor facilitators work together, in solidarity, to support one another in becoming aware of self and others as teachers and learners.

Strand 12: Educational Technology

S10.14 Symposium: Research on Teaching and Learning Science with Geospatial Technologies

10:30am – 12:00pm, Conference Room 412
Presenters:
James G. MaKinster, Hobart and William Smith Colleges, makinster@hws.edu
Cathlyn D. Stylinski, University of Maryland
Carla McAuliffe, TERC
Michael Barnett, Boston College
Nancy M. Trautmann, Cornell Lab of Ornithology
Alec M. Bodzin, Lehigh University
Louise Yarnall, SRI International
Shey Conover, Island Institute
ABSTRACT: This symposium will describe the current state of research on teach

ABSTRACT: This symposium will describe the current state of research on teaching and learning science with geospatial technologies and develop a vision for future research. While research on the use of these tools for teaching and learning has been productive in the fields of geography and educational technology, comparatively few studies have focused on the use of geospatial technology in science education. This symposium will discuss the state of relevant research in terms of student learning, teacher practice, and teacher professional development. It will then develop a vision for research needs and discuss potential collaborations for science education research within and across existing projects. The panel includes scholars who focus on each of the three research areas. All seven panelists are authors in two upcoming books focused on the design of teacher professional development and the design of student learning environments using geospatial technologies in K-12 science.

Strand 13: History, Philosophy, and Sociology of Science

S10.15 Symposium: NOS between Subject-Specific and Subject-Comprehensive Science Education Approaches 10:30am – 12:00pm, Conference Room 413

Presenters:

Nicola Mittelsten Scheid, Queens University, Canada, nicola.mittelsten.scheid@uni-oldenburg.de

Renee Schwartz, Western Michigan University

Kerstin Kremer, Institut für Biologiedidaktik Karl

Juergen Mayer, Justus-Liebig-Universität Gießen

Pinar Cetin, Middle East Technical University

Sibel Erduran, University of Bristol

Ebru Kaya, Middle East Technical University

ABSTRACT: There is broad consensus within the science education community for the incorporation of the notion of "nature of science" (NOS) into science curricula. However, there is an area of tension: On the one hand, a comprehensive model contributes to homogeneous research, assessment and education regarding NOS. On the other hand, there is an increasing awareness of individual characteristics of sciences. Accordingly, the question arises whether an NOS-model for science education should consider individual characteristics of the sciences or should be a general one and it is to be discussed which advantages and disadvantages come along with both approaches. This symposium aims at facilitating discussions between the poles of a science subject-specific and a comprehensive approach within (1) research, (2) assessment, and (3) education. Each panelist refers to at least one of these three fields and, in addition, takes a specific position on the continuum between the poles of subject-specifity and subject-generality either from an analytical or empirical point of view. Subsequently, educational implications will be discussed within group discussions and within a final plenum discussion. The symposium is considered not to give final answers to the topic at issue but to initiate discussions both for NARST 2010 as well as for future science education approaches.

Strand 14: Environmental Education

S10.16 SC-Paper Set: Fostering Collective Responsibility in Environmental Education

10:30am – 12:00pm, Conference Room 414

S10.16.1 A Sociocultural Model for Motivation of Indigenous Students to Learn Science

Eleanor D. Abrams, University of New Hampshire, eleanor.abrams@unh.edu

Michael J. Middleton, Morrill Hall University of New Hampshire

Chiung-Fen Yen, Providence University Taichung, Taiwan

Juliann Benson, Morrill Hall University of New Hampshire

Judy Tang, Morrill Hall University of New Hampshire

ABSTRACT: This study of Indigenous adolescents in rural communities broadens our understanding of the development of motivation and identity for environmental science learning for the purpose of enhancing student achievement in science. Environmental science was selected because these students live their lives in close contact with the environment and have extensive life experiences with ecology, geoscience and atmospheric concepts but often underachieve in science and are underrepresented in science-related careers. We collected in-depth data over several years on a group of students to determine what contextual features are salient as they identify or dis-identify as science learners. Our data suggest that our notion of academic support needs to go beyond cognitive scaffolding to include student-centered instruction by incorporating the use of local knowledge and examples, the use of local language and dialect for explanations, and teacher interest and understanding in bridging science content and process with the students' emerging identities. We will offer examples that show teachers who have an intimate understanding of the community in which the students are more likely to tailor their academic support for their students by integrating content that is of interest and of value to their students' lives. This supports students' identities as science learners.

S10.16.2 Environmentalism in the Science Classroom: Complex Issues, Complex Understandings?

Michael L. Tan, University of Toronto, m1ket4n@gmail.com

Erminia G. Pedretti, University of Toronto

ABSTRACT: In this paper, we study the beliefs and practices of teachers in [location], where there has been a Ministry-level resurgence of attention paid to environmentalism, accompanied by the introduction of new curricula in science and technology, where the document now strongly suggests that all topics be taught through an environmental application or issue. We were interested in (i) what constituted environmentalism in the classroom; and (ii) what were teacher attitudes and orientations toward environmentalism in the classroom. We used an online questionnaire to cope with the expanse of the province, and obtained 377 respondents, and 24 interviewees. A major theme to emerge was that teachers possessed a strong sense of imperative toward environmental issues, in some cases expressing what can be described as moral outrage at the lack of concern the rest of the educational establishment seemed to portray. Our respondents typically used environmental issues as a 'hook', creating an interesting context around which to discuss content. Action is limited to the propagation of environmental messages; measures meant to change personal behaviour; and what

amounted to, in the words of one of our interviewees, "garbage collection". We believe science can do better, and we discuss some issues relating environmentalism in the science classroom.

S10.16.3 How Different Populations of College Students Write and Learn About Ecology

Meena M. Balgopal, Colorado State University, Meena.Balgopal@colostate.edu

Alison M. Wallace, Minnesota State University Moorhead

Steve Dahlberg, White Earth Tribal Community College

ABSTRACT: An ecologically literate citizen is able to identify and discuss how to resolve ecological dilemmas. We developed a model grounded in the premise that when students are guided through iterative writing assignments around an ecological concept (such as hypoxia), they will be able to articulate their ecological knowledge and understanding through explanation of their dilemmas. We compared and contrasted how undergraduate students (42 Biology and 47 Elementary Education Majors at a 4-year college and 8 Native Studies Majors at a tribal community college) identified their ecological dilemmas after participating in a writing-to-learn activity. In a prior study students received much in-class guidance and improved their ecological literacy score by 67%. In this study we gave minimal guidance in order to determine how the writing activities alone affected students' ecological literacy. About 30% of the 4-year college students' essays demonstrated a more ecologically literate understanding of hypoxia by the end of the study. The tribal college students improved their ecological literacy by 50%, albeit with a small sample size. Biology majors were more Human-Centered than the Education majors. The Native American students discussed trade-offs between quality of life and ecological consequences, and were both Human-Centered and Ecosystem-Centered.

S10.16.4 Incorporating the Ocean into Diverse Contexts: A Collective Case Study

Meghan E. Marrero, U.S Satellite Laboratory, Inc., mmarrero@us-satellite.net

ABSTRACT: The ocean is critical to the functioning of the earth system, yet it is conspicuously absent from most state science standards (Hoffman & Barstow, 2007). In a culture of accountability, it is a challenge for any teacher to include anything not explicitly tied to standards. This collective case study follows a group of diverse New York City teachers as they integrate ocean-based lessons into their classrooms based on lessons learned from a semester-long ocean literacy-focused professional development course. Emergent themes demonstrate that teachers incorporated the ocean in order to increase student engagement, promote inquiry, and to integrate multiple subject areas including English Language Arts, Art, and Social Studies. This study shows promise for the ocean sciences to be implemented in virtually any formal education context, and suggests that short-term professional development may help teachers to incorporate the ocean science into diverse curricula.

Strand 15: Policy S10.17 Symposium: The Role of Public Policy in K-12 Science Education 10:30am – 12:00pm, Conference Room 415

Presenters:

George E. DeBoer, AAAS Project 2061, gdeboer@aaas.org Janice Earle, National Science Foundation Dennis W. Cheek, Ewing Marion Kauffman Foundaiton Jodi Peterson, National Science Teachers Association Sarah B. Woodruff, Ohio's Evaluation & Assessment Center for Mathematics and Science Education Noah R. Feinstein, University of Wisconsin-Madison Linda De Lucchi, University of California at Berkeley Sharon J. Lynch, National Science Foundation Rodger W. Bybee, BSCS Jonathan F. Osborne, Stanford University

ABSTRACT: This policy symposium involves discussions of key issues around the role of public policy in K-12 science education. Each topic that will be presented is the result of research done by the presenters for an upcoming edited volume on science education policy. The goal of that volume is to examine the relationship between science education policy and practice and the special role that science education researchers play in influencing policy. It has been suggested that the science education research community is isolated from the political process and does not influence policy, but to influence policy it is important to understand what constitutes the policy terrain, how policy is made, and how it is implemented. This symposium will shed light on the intersection between policy and practice through both theoretical discussions and practical examples. After a brief description of their research by each presenter, time will be allotted to questioning of the presenters by the audience.

International Committee Sponsored Session

S11.1 Administrative Symposium: ESERA at NARST: Research into Practice: Practice Informing Research: European Dimensions

1:15pm – 2:45pm, Salon D

ABSTRACT: How can researchers react to and influence policy in science education? In this invited session, sponsored by NARST's International Committee, members of the European Science Education Research Association (ESERA) examine issues revolving around the policy/practice interface. Four contributions, from a diverse set of contexts address issues of citizenship, science inquiry and practical work, and language and learning. Developing, implementing, and researching the chemistry inquiry laboratory: 12 years experience. Individual presentation names and corresponding presenters are listed below.

S11.1.1 Developing, Implementing, and Researching the Chemistry Inquiry Laboratory: 12 Years Experience

Avi Hofstein, The Weizmann Institute of Science, Israel Rachel Mamlok-Naaman, The Weizmann Institute of Science, Israel Mira Kipnis, The Weizmann Institute of Science, Israel

S11.1.2 Science for Citizenship?

Anna Jobér, Malmö University, Sweden

S11.1.3 Getting Practical: A Case Study of the Research-Practice-Policy Interface

Robin Millar, University of York, UK

S11.1.4 Exploring interlanguage - Supporting students' talk as an arena for learning

Clas Olander, University of Gothenburg, Sweden Åke Ingerman, University of Gothenburg, Sweden

Strand 1: Science Learning, Understanding and Conceptual Change S11.2 Related Paper Set: Learning Progression for Carbon Cycling in Socio-ecological Systems 1:15pm – 2:45pm, Conference Room 401

S11.2.1 Promoting Students' Causal Reasoning about Carbon Cycling Processes

Hui Jin, Michigan State University, jinhui@msu.edu

Charles W. Anderson, Michigan State University

ABSTRACT: We investigated the causal reasoning patterns students use to account for carbon cycling processes. Scientific modelbased reasoning describes carbon cycling processes linked across scales with matter and energy conservation as constraints. In contrast, students may rely on their intuitive ways of reasoning to account for processes. We conducted teaching experiments targeting students' intuitive reasoning, using interview and written assessments before and after the teaching intervention. Our research has two products. First, based on the interview data analysis, we developed a learning progression with two progress variables—naming and explaining. The naming progress variable focuses on the specific terms and sentences in students' accounts, while the explaining progress variable describes the qualitatively different reasoning patterns students use for their explanations. Second, the comparison of pre-interview and post-interview data indicates the existence of two different learning trajectories. The pre-interview data indicate that although students may be able to recite terms and sentences from a higher level, they still tend to rely on lower level reasoning to make accounts. The post-interview data indicate that, under a teaching approach targeting intuitive causal reasoning patterns, it is possible for students to progress more effectively toward scientific causal reasoning.

S11.2.2 Students' Learning Trajectories of Carbon Cycling in US and China

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

Hui Jin, Michigan State University

Jing Chen, Michigan State University

Charles W. Anderson, Michigan State University

ABSTRACT: We studied the different learning trajectories American and Chinese students for carbon-transforming processes in socio-ecological systems. We conducted both interview and written assessments with American and Chinese students. We analyzed the data using a learning progression with two dimensions—naming and explaining. We found evidence that different educational practices rather than linguistic and cultural differences lead to the differences of the learning trajectories. This finding is supported by data showing that elementary school students in both countries show similar patterns of force-dynamic (informal) reasoning. As students' progress into middle and high schools, their learning trajectories become different. Although Chinese secondary students are more capable in reciting some scientific terms, formula, and statements, both Chinese and American students still tend to rely on force-dynamic reasoning to explain events. Finally, Chinese students demonstrated the ability to apply energy principles to explain

events in chemical and physical contexts, while failed to use the same principles to account for events in biological contexts. American students' accounts tended to show the same reasoning patterns across different contexts.

S11.2.3 Assessing K-12 Students' Learning Progression of Carbon Cycling With Items in Different Formats

Jing Chen, Michigan State University, jingchen@msu.edu

Charles W. Anderson, Michigan State University

Choi Jinnie, University of California, Berkeley

Yong-sang Lee, University of California, Berkeley

Karen L. Draney, University of California, Berkeley

ABSTRACT: In our previous studies, we investigated and validated a multi year learning progression that describes how K-12 students' understanding of carbon transforming processes changes over years (Authors, 2009a). We used both written assessments and clinical interviews to collect our data. The written assessment items are in 3 formats: ordered multiple-choice (OMC) (Briggs, Alonzo, Schwab, & Wilson, 2006), multiple true/false (MTF) and open-ended (OE). In this study, we compare the use of these types of assessments. In particular, we analyze the validity and reliability of the OMC and MTF items by comparing students' responses to the OMC and MTF items to their responses to similar problems in the OE format or in clinical interviews. We analyze whether the options in OMC and MTF items can successfully differentiate students among levels. We find that students' responses to the OMC, MTF items are significantly correlated to their responses to the OE items or interview questions. However, some options in the OMC or MTF items are not associated with a particular achievement level or they are associated with more than one level. The implications for how to design OMC and MTF items to measure students' learning progression levels more reliably are discussed.

S11.2.4 Secondary Students' Arguments about Carbon-transforming Processes Before and After Instruction

Kennedy M. Onyancha, Michigan State University, onyancha@msu.edu

Charles W. Anderson, Michigan State University

ABSTRACT: Arguments are important to both the construction of scientific knowledge and development of skills and tools to assess this knowledge. In this paper, we use a modified version of Toulmin's (1958) model of argument analysis to examine the extent to which more targeted instruction using instructional tools we designed is helpful in supporting learners move toward using data and warrants to defend claims that they make about matter and energy in interviews about carbon-transforming processes. Students who had more sophisticated accounts (claims in Toulmin's system) were also more likely to support those claims with empirically verifiable data and with warrants that used general principles to connect data to claims. Our preliminary findings suggest that more targeted instruction holds promise in supporting students in constructing arguments that are both based on empirically verifiable data and connected to the claims made.

S11.2.5 College Student Understanding of Carbon Transformation and Cycling Processes

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

Wilke Brooke, Michigan State University

Hartley Laurel, University of Colorado, Denver

Charles W. Anderson, Michigan State University

ABSTRACT: Full participation in dialogue about environmental issues often requires an understanding of fundamental science concepts. The sustainability of various biofuel production systems is one such issue, as it necessitates discussion of carbon cycling and various transformation processes (e.g. – photosynthesis, combustion, sequestration), among other concepts. This paper presents data from assessments of college students enrolled in general biology and ecology courses, both pre- and post-instruction. College students often possessed many of the same problematic understandings as younger students, although they also demonstrated stronger learning gains after instruction, particularly with regard to photosynthesis and respiration. Understanding of carbon cycling at landscape and global scales, however, often lagged behind understanding of its constituent processes, thus making it more difficult for students to completely describe differences between biofuels and fossil fuels. Further, students often conflated the concepts of global warming and stratospheric ozone depletion, leading to an emphasis on the relative pollution production of these fuels, rather than their different timescales of carbon sequestration and oxidation.

Strand 1: Science Learning, Understanding and Conceptual Change S11.3 Related Paper Set: Narrative and Textual Analysis 1:15pm – 2:45pm, Conference Room 413

S11.3.1 Exploring Narrative Scaffolding in the use of Multimedia Simulations for the Teaching and Learning of Chemistry Catherine E. Milne, NYU, cem4@nyu.edu Jan Plass, NYU

Jan Plass, NYU Bruce Homer, CUNY Graduate Center Trace Jordan, NYU Ruth Schwartz, NYU

Yan Wang, American Institutes for Research Yoo Chang, NYU Florrie Ng, CUNY Graduate Center & NYU Elizabeth Hayward, NYU

ABSTRACT: In science instruction, which commonly focuses on developing argumentation skills, narrative is often understood to have no place. However, this study reports some intriguing results for multimedia chemistry simulations embedded in narrative scaffolds. Participants used either narrative, proto-narrative, or no narrative (control) texts. Process and outcome data were utilized to explore simulation use, recall, comprehension, and transfer of knowledge. Results showed that students in narrative and proto-narrative conditions explored the simulation longer and more purposefully. For the narrative group, recall was significantly better than for either of the other groups, suggesting that narrative has the potential to positively affect learning. The role of narrative in making connections between everyday and domain specific knowledge could account for the results observed.

S11.3.2 Perceived VS Actual Knowledge of Students in Chemical Education

Shirly Avargil, Technion- Israel Institute of Technology, shirly.avargil@gmail.com

Orit Herscovitz, Technion- Israel Institute of Technology

Yehudit Judy Dori, Technion- Israel Institute of Technology and Massachusetts Institute of Technology

ABSTRACT: As part of a national reform for high school chemistry students, we developed the Taste of Chemistry learning unit which focuses on meaningful learning and self-regulation in the context of food chemistry. The study investigates the students' perceived and actual knowledge of food-related chemistry concepts. Research participants include 370 students; two experimental groups (271) who studied the unit and two comparison groups (99). Experimental students were exposed to a metacognitive tool that builds on four chemistry understanding levels for monitoring their reasoning processes while solving problems. The research tools were pre-post questionnaires. We found that the post-metacognitive gap perceived knowledge score minus actual knowledge score of the experimental students, was significantly smaller than that of the comparison groups. This indicates that using a metacognitive tool improves students' ability to self-regulate their knowledge and perceive their knowledge levels more precisely. Teachers play an important role in promoting efficient application of metacognitive thinking. The research contributes to the understanding of structuring the metacognitive knowledge in general and the perceived vs. actual metacognitive knowledge in particular. The metacognitive tool we have developed can serve as a scaffold for constructing and improving teachers and students knowledge. Similar tools can be constructed for other domains.

S11.3.3 A Study of Students' Reading Strategies in Different Science Argumentative Text

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Fu-Pei Hsieh, Kuang-Hua Primary School, Taiwan

Yen-Wen Lin, An-Chao Primary School, Kaohsiung, Taiwan

Pei-Jun Chen, Chung-Sang Primary School, Kaohsiung, Taiwan

ABSTRACT: The purpose of this study was to explore elementary students' reading strategies toward different science argumentative texts. Several copies of text were developed and validated for students' reading tasks. Nine 5th graders from three elementary schools participated in this study. After the training of thinking aloud method for two to three weeks, the protocols of these students' reading strategies were collected and analyzed. The results indicated that students' reading strategies can be divided into five progressive categories with total of thirteen codes. However, the expected specific strategies needed in reading science argumentative texts did not appear. In addition, it is found that the more advanced reading strategies are easier to be found in high level students' protocols compared to low and medium level students and it is inferred that low and medium reading level students need instructional assistances in learning how to read science texts. Finally, when the forms of science argumentative texts are taken into considerations, the analysis reveals that the two- sided non-refutational text can probably bring about more cognitive operations in students' reading processes and this can be seen as a useful feedback to the principles of science reading materials designing.

S11.3.4 Sharing Knowledge Using Text-Based Structured Dialogue Environment In Understanding And Promoting The Conceptual Change Of Science Teachers' Thinking Of The Nature Of Science

Nasser Mansour, University of Exeter, n.mansour@ex.ac.uk Rupert Wegerif, University of Exeter Nigel Skinner, University of Exeter Keith Postlethwaite, University of Exeter Azza A. Hashem, University of Exeter Mriga Williams, University of Exeter

Lindsay Hetherington, University of Exeter

ABSTRACT: The purpose of this study is to document how prospective science teachers describe and comprehend the ways in which participating in a digitally mediated discussion promotes sharing knowledge, critical thinking and conceptual change in thinking about the Nature of Science. While the discussion software used (InterLoc) is a linear text based tool, it is purposely developed to support structured argumentation. Within a design based research project, the researchers conducted multiple sessions using InterLoc with 65 postgraduate teachers, Data were collected through formal and informal interviews, online-focus group interviews using Interloc as a

medium for discussion and 'pre-and post test' usage of a nature of science scale. This revealed some participants who had changed their view of the Nature of Science and these were followed up with interviews to explore the extent to which the structured support for argumentation provided had been a factor in this change of view. The findings suggest that structured support for argumentation can be effective in promoting reflection and cases of conceptual change. (For more details about InterLoc visit http://www.interloc.org/).

Strand 2: Science Learning: Contexts, Characteristics and Interactions

S11.4 Related Paper Set: Children's Development of Science Expertise across Everyday Settings: Documenting Learning Pathways Amidst Cultural Diversity

1:15pm – 2:45pm, Conference Room 402

S11.4.1 The Development of Everyday Expertise: A Framework for Understanding the Social Foundations of Youth Science Learning Across Pursuits and Contexts

Philip Bell, University of Washington, pbell@u.washington.edu Leah A. Bricker, Loyola University Chicago Suzanne Reeve, University of Washington Heather T. Zimmerman, Pennsylvania State University

ABSTRACT: Learners navigate a range of diverse social, material, and discursive contexts every day--from the classroom to home, afterschool programs, informal education institutions, and out into their communities--with a variety of purposes and value systems in place. Learning is accomplished across these diverse pathways of participation in activity and affiliation with cultural groups in ways we barely understand. In this paper we describe a theoretical framework and a team ethnography that engages the driving question: How do everyday moments-- experienced across settings, pursuits, and social groups--result in expertise, sophisticated understanding, and expert identification? The Everyday Expertise theoretical framework seeks to account for the social and material dimensions of sophisticated science learning as it relates to the interests and practices of specific cultural groups. The ultimate explanatory goal is to better understand the extended learning pathways that are culturally architected through complex sequences of contingent interaction and activity that occur across the breadth of everyday life. We pay heightened attention to the social processes that shape learning, the affordances and constraints of material resources that help us understand the accomplishment and evaluation of situated performance, and linguistic features of multimodal discourse that shape and inform learning pathways.

S11.4.3 Playing With Narrative: Developing Expertise in Story-Telling as Connected to Biology and Personal Interests

Heather T. Zimmerman, Pennsylvania State University, haz2@psu.edu

Suzanne Reeve, University of Washington

ABSTRACT: This paper is an inquiry into the development of expertise with narrative, defined here as the creation, reading, and use of story-telling in its various oral, playacting, digital, and written forms. This case focuses on one youth, Johnny Misterio, with high interest in certain aspects of the domain of biology when related to and expressed through narrative forms but who often did not connect with the biological content or practices in his elementary classroom. Johnny's case study shows how his expertise is connected identity as a performer, developer, and consumer of creative arts. His experiences with narrative provide Johnny with both a science-related future (through his interest in creating animal documentaries and a rich exploration of biology-related constructs at home) and at the same time did not allow for him to be successful in school science as enacted through hands- on curriculum units. This analysis used data from videotaped observations, fieldnotes, and student created narrative forms collected over a fifteen-month period.

S11.4.4 "God Mode Is His Video Game Name": Expertise Development in Technology Domains

Leah A. Bricker, Loyola University Chicago, lbricker@luc.edu

Philip Bell, University of Washington

ABSTRACT: In this paper, we use a case of expertise development in technology-related gaming (e.g., video gaming, on line gaming, game design), to explicate the associated learning processes and practices and learning pathway dynamics. The following research questions guide our analysis: (a) what specific learning processes and practices are associated with specific instances of youth expertise development; and (b) how are learning pathways constructed in order to foster and then further youth expertise development? We utilize data from a cross setting, longitudinal ethnography of youth learning and expertise development related to science and technology. Data sources include video and audio-recordings of observations and interviews, as well as digital photographs, documents, and surveys. Findings indicate that resource acquisition and repurposing, identity construction, and interdiscursive practices are important aspects of the development of expertise. Implications for STEM education are discussed.

S11.4.5 Developing Expertise In "Doing School": Tracing One Family's Pathway towards Academic Success

Suzanne Reeve, University of Washington, sreeve@u.washington.edu Heather T. Zimmerman, Pennsylvania State University

ABSTRACT: In order to advance successfully through high school, college, and other career training, students must learn the "values and beliefs, expectations, actions, and emotional responses" (Phelan, Davidson & Cao, 1991, p. 225) that are expected in the classroom. Learning to crack this code, however, is not easy for many students, and schools and teachers are not always oriented towards increasing access to it (cf. Delpit, 1988). The case study described in this proposal analyzes how one adolescent girl and her family created a home culture that encouraged and even replicated the practices of formal schooling, and of how this culture facilitated the achievement of children's goals for academic success. We draw from observations and interviews with this family in home, school, and community settings over a period of fourteen months in order to show how expertise in cultivating school skills developed across time and space, focusing on the domain of science.

Strand 4: Science Teaching--Middle and High School (Grades 5-12): Characteristics and Strategies S11.5 Symposium: Teacher Knowledge(s) and Teacher Change: Reflections on Conceptualizations that Inform Research and Teacher Education Practices

1:15pm – 2:45pm, Conference Room 404

Presenters:

Sara Salloum, Long Island University – Brooklyn Saouma BouJaoude, American University of Beirut, Lebanon Sherry A. Southerland, Florida State University Julie Gess-Newsome, Northern Arizona University Jan H. van Driel, Leiden University, The Netherlands

ABSTRACT: The complexity inherent in teaching and instructional practices/decisions deems teacher knowledge as multilayered with varying dimensions. Such complexity causes the nature of teacher knowledge to remain a rich area for discussion and exploration by teacher educators and researchers. This symposium aims to present various conceptualizations of science teacher knowledge. Experienced teacher educators and researchers present and discuss their conceptualizations of teacher knowledge and change. They also discuss the development of such conceptualizations and how these guide their work. As reflective practitioners, the presenters share how their frameworks have developed in the "rough and tumble" of their practice, which is particularly important for novice researchers and teacher educators. A major aim of the symposium is to promote a sustainable and critical professional conversation about these conceptualizations and how they influence our practices as teacher educators and researchers. Presentations of the multiple frameworks will open them up for critical reflection by both the participants and the attending NARST members. Strengths, limitations, and situational aspects of different perspectives will be delineated and discussed. Both participants and attendees will play an active role in extending our thinking about teacher knowledge and issues pertaining to its development and change.

Strand 5: College Science Teaching and Learning (Grades 13-20) S11.6 SC-Paper Set: Understanding and Visualization in the Life Sciences

1:15pm – 2:45pm, Conference Room 405

S11.6.1 Exploring the Link between Mental Rotation and College Student Learning with Phylogenetic Tree

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

ABSTRACT: Mental rotation has been strongly linked with learning in chemistry. However, no studies have explored connections between mental rotation and tree thinking in biology. Phylogenetic trees are mobile in nature. Branches can rotate around nodes without altering relationships. This study investigated the role of mental rotation in tree reading and how an instructional intervention influenced 39 undergraduates tree reading in an upperlevel plant systematics course. Data sources included student responses on a pretest, posttest, mental rotation test, instructional intervention, and weekly reflections. I identified a significant correlation between mental rotation and improvements when students compared phylogenetic trees. I also found that using tree manipulatives improved students understanding of branch rotation regardless of mental rotation ability. Mental rotation was not a limiting factor for students opportunities to externally visualize branch rotation rather than rely upon mental rotation. This study provides insight into connections between spatial reasoning and learning evolutionary biology using phylogenetic trees. Also, it offers an example of transforming education research into practice through the development and assessment of a research based instructional intervention.

S11.6.2 Undergraduate Students' Conceptions of Learning Biology and Their Approaches to Learning Biology

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Jyh-Chong Liang, National Taiwan University

Chin-Chung Tsai, National Taiwan University of Science and Technology

ABSTRACT: This study aims to first investigate the relationship between students' conceptions of learning biology and their approaches to learning biology, and then examine whether gender difference exists within these two aspects. Two instruments, Conceptions of Learning Biology survey (COLB) and Approaches to Learning Biology survey (ALB), were developed and

administrated to 681 undergraduate biology students (360 males and 321 females) to investigate their conceptions of learning biology and approaches to learning biology, respectively. The results confirmed two hypothetical relationships that higher-level conceptions of learning biology (such as 'applying,' 'understanding,' and 'seeing in a new way') were positively related to the deep approaches to learning biology, and that lower-level conceptions of learning biology (such as 'memorizing,' 'testing,' and 'calculating and practicing') were positively correlated with the surface approaches to learning biology. However, higher-level conceptions of learning biology also showed a positive relationship with the surface motive for learning biology. The results also revealed significant gender differences; the female students were more likely to possess higher-level conceptions of learning biology and to express deep approaches to learning biology than the male students. However, female students showed more orientations toward surface motive for learning biology.

S11.6.3 Decoding of Visual Narratives used in University Biology

Phyllis Griffard, Weill Cornell Medical College in Qatar, pbg2002@qatar-med.cornell.edu

ABSTRACT: The aim of this study was to understand how one type of graphic representation, the visual narrative, is used in science textbooks and how they are decoded during learning. Visual narratives are defined here as rich images that employ graphic elements (shapes, colors and arrows) to 'tell a story' of a process that involves multiple structures and conditions interacting at multiple levels of organization in a temporal sequence. An analysis of randomly selected pages in two biology textbooks, one chemistry textbook and one physics textbook indicate that graphic representations occupy a similar amount of page space, but the types employed differed greatly between the disciplines and only the biology textbook exploited the visual narrative. Five first-year pre-medical students participated in clinical interviews in which they were to think aloud as they decoded two visual narratives representing topics they had not yet been taught: one depicting viral replication and one depicting muscle contraction. Participants readily interpreted the elements representing familiar phenomena (receptors, protein synthesis, calcium flow) but failed to decode the novel aspects (action potential, sliding filaments). Debriefing readily bridged these gaps. These findings contribute to our understanding of visualization in science education.

S11.6.4 Pharmacy Students' Analysis of Medical Advertisements: A Method to Improve Instructional Practice based on Research on Learning

Paula A. Witt-Enderby, Duquesne University, wittp@duq.edu

Eva E. Toth, West Virginia University Jordan Espenshade, Duquesne University

ABSTRACT: Improving instructional practice based on research on learning is at the center of science education thus it is the timely focus of the 2010 NARST annual convention. Accordingly, this study reports results on an innovative practice in a large, lecture-based pharmacy classroom: the evaluation of pharmaceutical advertisements. Using a problem-based learning approach, the instructional method tasked students to evaluate a self-selected pharmaceutical advertisement for scientific content and for themes that aimed to influence consumer behavior. The results indicated that students were able to apply their newly constructed scientific knowledge to evaluate the claims made by pharmaceutical advertisements. Students also recognized four themes related to consumer behavior including: (1) highlighting the positive medial characteristics of pharmaceuticals, (2) emphasizing the health benefits and the (3) convenience of using these pharmaceuticals as well as (4) appealing to the social norms and values of consumers. Students' evaluation illustrated that claims made in the advertisements had significant deviations from currently accepted scientific knowledge within all four themes. The significance of the results is that they support the formulation of innovative classroom pedagogies for pharmacy student education.

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

S11.7 Related Paper Set: Teaching Into Research-Research into Teaching: Examining the Ties That Bind 1:15pm – 2:45pm, Conference Room 414

S11.7.1 Factors That Facilitate Inquiry-Based Teaching

Cindy Stiegelmeyer, University of South Carolina, cindystieg@gmail.com

Michelle Maher, University of South Carolina

David Feldon, University of Virginia

Briana Timmerman, University of South Carolina

ABSTRACT: Inquiry-based teaching is an important strategy for all levels of education, kindergarten through university. This crosscase analysis explores the experiences of graduate level scientists as they engage in inquiry-based teaching in a K-12 science classroom. Findings suggest that a solid base of support structures facilitate the development of inquiry-based teaching skills, including tailored coursework and a strong relationship between university advisors and/or K12 teacher mentors. Additionally, those who successfully engaged in inquiry-based teaching noted that it begins with interest and wonderment by the students, and that the students themselves must drive the formation of the questions under investigation. Graduate level scientists felt that this new perspective assisted in their development of teaching skills and positive self identities as teachers.

S11.7.2 Crossing the Threshold Concept: A Transformative View of Research Skill Development

Briana Timmerman, University of South Carolina, briana.timmerman@gmail.com

Michelle Maher, University of South Carolina Denise Strickland, University of South Carolina David Feldon, University of Virginia

ABSTRACT: The development of scientific reasoning is a common core goal of most science education. While extensive literature exists on how to encourage such thinking in K-12 and undergraduate students, comparatively few researchers have investigated how graduate students develop scientific reasoning during the transformative years of graduate school. Using Kiley and Wisker's (2009) work on "threshold concepts" to identify critical developmental breakthroughs in graduate students' scientific reasoning skills, this study seeks to validate the threshold concept theory using a large sample of research proposals written by STEM graduate students at multiple time points in their graduate careers. Results suggest that the perspective of threshold concepts is a valid one with which to consider the developmental trajectory of graduate student research skills.

S11.7.3 Exploring the Goal Commitment of Teachers and Researchers in Science, Technology, Engineering, Math, and Education

Melissa Hurst, University of South Carolina, mhurst@mailbox.sc.edu

ABSTRACT: This study examined the stability of goals across an academic year and explored factors that shaped the level of goal commitment of graduate students in science, technology, engineering, math and education disciplines. Using a qualitative approach, the study identified academic and professional goals of graduate students and attempted to place students on a continuum of goal commitment by identifying factors and early teaching and research experiences that impacted students' initial and final levels of goal commitment. The ability to predict goal commitment and ultimately goal completion will allow institutions to identify experiences that increase graduate students' persistence to the smaller academic goals that define their degree progress, and ultimately, equate to their degree completion. Study results suggest that, overall, graduate students' early teaching experiences do increase their personal agency beliefs and ultimately their levels of commitment to their primary academic and professional goals. Implications of these findings as they pertain to doctoral education across academic disciplines are advanced.

S11.7.4 An Exploratory Study of Factors Influencing the Development of STEM Graduate Students' Teaching Skills

Joanna Gilmore, University of South Carolina, jagilmor@mailbox.sc.edu

Melissa Hurst, University of South Carolina

ABSTRACT: The science education community has come to advocate for a new vision of science instruction emphasizing inquirybased teaching (National Research Council 1996). However, Graduate Teaching Assistants (GTAs), who represent an important link in current science reforms, rarely receive training on how to teach (Prieto & Meyers, 1999) and less frequently on inquiry-based teaching methods. Thus this study explored how GTAs in the sciences, technology, engineering, and mathematics fields learn to be effective teachers and the factors that facilitate their skill development. GTAs whose inquiry-related teaching skills increased generally had a moderate level of prior teaching experience, reported frequently interacting with others regarding their teaching, had advisors who were knowledgeable about the participants and were often involved in their teaching, and were more likely to hold beliefs about inquiry teaching that are consistent with current reforms including that students should develop their own research questions and that students should be encouraged to develop their own hypothesis that explain unexpected results that arise during inquiry. Overall this study contributes to knowledge about how GTAs learn to use inquiry-based teaching methods. This information can be used to develop and improve training and support programs that address GTA's experiences and beliefs.

Strand 6: Science Learning in Informal Contexts

S11.8 Symposium: Using Informal Learning Environments to Support Future Science Teachers

1:15pm – 2:45pm, Conference Room 406

Presenters:

James Kisiel, California State University, Long Beach, jkisiel@csulb.edu Melissa Mercer-Tachick, Albion College Janette Griffin, University of Technology, Sydney Shawn Rowe, Oregon State University Jennifer DeWitt, King's College London

ABSTRACT: This session presents a variety of unique approaches for utilizing informal science education settings to support the development of future teachers, along with evidence for program impacts and suggestions for improving ILE collaboration projects. Each of the panelists, affiliated with a university-based teacher preparation program, will briefly report on how different experiences in ILEs were used to enhance future teacher understanding of their students, their practice, and the potential role of ILEs to support their efforts in the classroom. Both quantitative and qualitative data is used to demonstrate strengths and weaknesses of these different approaches. Discussion will then focus on both the affordances and constraints when considering such collaborative efforts, as well as the importance of using a broad lens when considering how best to support the teaching and learning of science across settings.

Strand 7: Pre-service Science Teacher Education

S11.9 Symposium: From University Students to Teachers of Science: Researching Preservice K-8 Teachers' Development of Pedagogical Context Knowledge within a Reform-Based Curriculum

1:15pm – 2:45pm, Conference Room 407 **Presenters:** Steve Fifield, University of Delaware John Madsen, University of Delaware Danielle Ford, University of Delaware, djford@udel.edu Linda Grusenmeyer, University of Delaware Ratna Nandakumar, University of Delaware Eric Pizzini, University of Delaware

Xiaoyu Qian, University of Delaware

ABSTRACT: In this symposium we examine the conceptions, experiences, and identities of prospective K-8 teachers enrolled in reform-based science and science education courses in our teacher education program. Using the model of Pedagogical Context Knowledge (Barnett & Hodson, 2001), we examine prospective teachers' (1) beliefs about science teaching and learning and their evaluation of what they need from our program to become good science teachers, (2) longitudinal development of understandings of content and pedagogical content in the area of earth systems science teaching, (3) self-efficacy and the validity of the Science Teaching Efficacy Beliefs Instrument (STEBI-B), and (4) reactions and resistance to inquiry through the frameworks of loss and generative transformation. We examine longitudinal and cross-sectional data across our reform-based continuum to gain insights into a critical dimension of teacher education – the ways in which preservice teachers accept, resist, and modify dimensions of the undergraduate teacher preparation experience to align with their goals for their own college experience as well as their future teaching careers.

Strand 7: Pre-service Science Teacher Education

S11.10 SC-Paper Set: Impact of Lab Work and Inquiry Experiences in Pre-Service Teacher Education 1:15pm – 2:45pm, Conference Room 409

S11.10.1 Level of Inquiry as Motivator in an Inquiry Methods Course

Mizrap Bulunuz, Uludag University, mbulunuz@gmail.com

Olga S Jarrett, Georgia State University

Lisa Martin-Hansen, Georgia State University

ABSTRACT: Abstract Of great importance for achieving science education reform may be teachers' interest in science and enjoyment of science. This study explores the relationship between level of inquiry of class activities and their motivational qualities (interesting, fun, and learning value). Subjects were 53 preservice teachers in two sections of a science methods course with hands-on activities taught at four levels of inquiry, varying in how much choice was given for posing questions and designing investigations. Daily ratings of each hands-on activity indicated that participants found activities of higher levels of inquiry to be more fun, to be more interesting, and to promote more learning. These findings suggest that choice of research question and involvement in designing experiments may be important in the development of interest in science. A focus on hands-on learning especially at higher levels of inquiry may serve both to capture the interest of the teachers and to model how they can make science more authentic and engaging for the children.

S11.10.2 The Impact of an Inquiry-Based Science Education Program for Pre-Service Elementary Teachers

Susan A. Everett, University of Michigan-Dearborn, everetts@umd.umich.edu

Charlotte A. Otto, University of Michigan-Dearborn

Richard H. Moyer, University of Michigan-Dearborn

Paul W. Zitzewitz, University of Michigan-Dearborn

ABSTRACT: In this study, we looked at the impact of our specially designed inquiry-based science courses for pre-service elementary teachers. The new courses focus on science content that K-7 teachers need to know and be able to teach based on state and national science standards. In addition, the courses use an inquiry-pedagogy as recommended by both sets of standards. Overall test scores and subscores from the six subject areas of the Elementary Education Test (#083) of the Michigan Test for Teacher Certification (MTTC) were analyzed from over 1,000 pre-service elementary teachers at our institution. Results showed that approximately 70% received the highest score on the science subtest portion which was significantly higher than the five other content areas, that students who took three of the science courses vs. none of them scored higher on the science subtest (p=.08), and that there is a negative correlation between the number of science courses transferred from other institutions and the science subtest score (r = -.141, p<0.01). We conclude that our pre-service elementary teachers can and do learn science using inquiry as recommended by the National Science Education Standards.

S11.10.3 Research into Practice - Practice Informing Research: A Case from the Physical Science Laboratory for Elementary Teachers

Milijana Suskavcevic, Rice University, milijana@rice.edu

Eric Hagedorn, University of Texas at El Paso

ABSTRACT: The guided inquiry approach rooted in the Powerful Ideas in Physics (PIPS) curriculum offers many innovative activities and creative approaches in learning and teaching science that are used in teacher preparation courses at the undergraduate level. However, not every unit developed in this curriculum has equal clarity. As an alternative to PIPS's unit on composite density, we developed a unit treating the same concept with a somewhat simplified approach using an orange to illustrate the concept of system's density. Teachers involved in the study tested whether they could average the densities of these components to find the value for the density of the system. The unit is flexible enough to be introduced in inquiry based classrooms at several grade bands and at different levels of sophistication, from basic qualitative description of the behavior of the orange in different liquids to quantitative calculations of the buoyant force which selected liquids exert on an orange. The study has been carried out among several populations of pre-service teachers (n=484) through physical science courses, with statistically significant differences in favor of the newly developed approach over the existing PIPS activities for densities of systems.

S11.10.4 Understanding the Nature of Pre-Service Science Teachers' Argumentation during Laboratory Work

Yasemin Özdem, Gaziosmanpasa University, yasemin.ozdem@hotmail.com

Hamide Ertepinar, Middle East Technical University

Çakýroðlu Jale, Middle East Technical University

ABSTRACT: This study aimed at investigating the argumentation practices of pre-service science teachers while they are engaged in a laboratory work. In a science-related activity developed by the researchers, PSTs were asked to describe the relationship between force applied to a spring and spring's elongation. According to the argumentative inquiry model (Kim, & Song, 2006), the enquiry of the scientific topic was employed by groups of PSTs through two sessions. In the experimentation session, PSTs planned and carried out an experiment and in the critical discussion session, one of the research groups presented their experimentation and this presentation was followed by a class discussion. A total of 33 PSTs participated in this study. Data were collected through video records during the participants' investigation. The analysis of the PSTs' discourse was done through the categorization of argumentative dialogues according to the argumentation schemes proposed by Walton (1996). As a result, a wide range of argumentation schemes, 17 out of 25, was found to be employed by PSTs. The critical discussions engaged learners in the evaluation of claims in the light of the evidence. The nature of resulting argumentation schemes also give idea about how PSTs construct and evaluate scientific knowledge claims.

Strand 8: In-service Science Teacher Education S11.11 SC-Paper Set: Science Education and the Elementary Context

1:15pm – 2:45pm, Conference Room 408

S11.11.1 The Development, Implementation and Evaluation of an Intensive System-Wide Professional Learning Program for Elementary Science Teachers

Deborah J. Corrigan, Monash University, Debbie.Corrigan@Education.monash.edu.au

Richard F. Gunstone, Monash University

Rebecca Cooper, Monash University

ABSTRACT: An intensive 3 day professional leaning program for primary (elementary) teachers of science was designed, implemented and evaluated. Design foci included concerns with increasing both teacher confidence in and knowledge of science, recognition and appropriate use of the pedagogical expertise of primary teachers, and 6 specific areas of practice (How students learn science, Teaching for understanding in science, Understanding and teaching the nature of science, Engaging students in contemporary science, Planning the science curriculum, Assessing understanding in science). In the 2-4 week gap between days 2 and 3 of the program participants undertook some form of change in their science classrooms and reported on this to day 3 of the program. A range of forms of evaluation data were collected. Examples are: pre- and post-program on-line surveys, a set of open questions used as part of the learning experiences in day 3, the nature of the change projects undertaken and reported by participants, reflections by those teaching the professional learning program, open-ended evaluation questions given in differing forms to different cohorts in the program. The paper considers these data and the ways the data relate to the design and delivery of the program.

S11.11.2 Advancing Science and Engineering in Elementary Schools: Fostering Teachers' Knowledge and Scientific Inquiry

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Elisabeth McGrath, Stevens Institute of Technology

ABSTRACT: Teachers' disciplinary content knowledge influences instructional practice. Inequalities in instruction, qualifications of teachers and resources result in widely different learning opportunities for students. To address these challenges, this Math and Science Partnership project provided 43 grade 3-5 teachers with high quality science and engineering curricula, classroom-focused professional development, and mentoring designed to address key topics in earth systems science and engineering education. The study examined whether the project's instructional activities enhanced teachers' content knowledge and whether these activities improved teachers' notions of scientific inquiry. Results showed that the treatment group of teachers significantly increased their content knowledge in science and engineering compared to teachers in the comparison group. Moreover, their notions of scientific inquiry also improved after attending a year of intensive professional development.

S11.11.3 Developing a Hybrid Online/On Site Community of Practice to Support K-8 Teachers' Improvement in Inquiry and Nature of Science Conceptions

Jeffery S Townsend, Eastern Kentucky University, scott.townsend@eku.edu

Valarie L. Akerson, Indiana University

Ingrid S Weiland, Indiana University

ABSTRACT: Professional development programs that use a community of practice strategy have been found to improve teachers' views of NOS and inquiry as well as their teaching practice. However, these communities can be hard to develop for many reasons including time constraints, schedules, work/family commitments, and distances to universities, especially for teachers from rural areas. An online community helps resolve these issues of inconvenience, but creates difficulties in emphasizing important aspects of science education such as NOS or inquiry because participants cannot physically participate in lessons and interactions. We created a hybrid onsite/online MA-level course in which we developed a community of learners with K-8 teachers emphasizing the reciprocity of NOS and inquiry. The summer course met once a week for five weeks. The online component of the course included professional development videos, reflection questions, readings, and discussion board prompts. Teachers' NOS and inquiry conceptions were assessed using pre/post VNOS- B, VOSI-E instruments, and interviews. Additional data for analysis included supplemental online instructional materials and onsite interactions. Teachers' understanding of both NOS and inquiry improved. Researchers also found the hybrid course model to be popular with participants. Presenters will share both course design and research results.

S11.11.4 Conceptions of Sound: A Lesson Model to Promote Accommodation in Elementary Teachers

Barbara A. Austin, Northern Arizona University, barbara.a.austin@nau.edu

ABSTRACT: Promoting accommodation of correct scientific explanations for natural phenomenon is a major challenge for teaching science. This project describes a lesson model that addresses common misconceptions of sound that was implemented in a professional development workshop for elementary teachers. Two different interventions using the same general model were tested. Both groups rotated through six stations in which they experimented with sound making objects. The purpose of experimentation was to identify which statements, out of a set of twelve statements about sound, were true. The statements were based on common misconceptions about sound from the research literature. Both groups were required to illustrate what was happening at each station at a particle (air molecule) level. Group A (n = 25) used a structured writing approach to record observations. Both groups had statistically significant score increases on post-tests taken one month later. Pretest A = -1.08 ± 4.16; posttest A = 6.60 ± 2.97. Pretest B (n = 14) = 1.07 ± 3.29; posttest B = 3.57 ± 5.37. The effect size pre to post test was large for group A (Cohen's d = 2.12) and moderate for group B (Cohen's d = 0.51) indicating that this lesson model shows promise for promoting accommodation of accurate conceptions of sound in elementary teachers.

Strand 8: In-service Science Teacher Education

S11.12 SC-Paper Set: Technology, Distance Learning and Science Education

1:15pm – 2:45pm, Salon C

S11.12.1 Virtual Professional Learning Communities: Video-Conferencing as a Tool to Facilitate Teacher Learning

Tom J. McConnell, Ball State University, tjmcconnell@bsu.edu

Joyce M. Parker, Michigan State University

Jan Eberhardt, Michigan State University

Matthew J. Koehler, Michigan State University

Mary A. Lundeberg, Michigan State University

ABSTRACT: Research suggests that professional development that engages teachers in instructional inquiry over an extended time through collaborative professional learning communities (PLCs) is effective in improving instruction and student achievement. Still, most professional development is offered as short-duration workshops that are not effective in changing practice. Barriers to the implementation of PLCs include lack of shared meeting time and a shortage of teachers who share the same subject areas or common goals and interests. Convening teachers from multiple districts can alleviate this problem, but teachers are reluctant to travel for meetings due to time and cost restraints. Video-conferencing software offers a solution to these barriers while serving to foster the sense of cohort needed for PLCs to be effective. This presentation describes the use of virtual PLCs in which two groups of teachers met monthly for one school year to collaboratively analyze evidence collected as part of their teacher inquiry plans. With help from a

facilitator, these groups developed a relationship similar to other groups meeting face-to-face as part of the same professional development program. The presentation will share the reflections of teacher-participants and facilitators about the virtual PLC experience, along with videotaped excerpts of virtual meetings.

S11.12.2 Investigating the Role of Pedagogical Discontentment in Teachers' Changes in Practice: An Exploration of 23 Rural Science and Mathematics Teachers Following Technology-Infused Teacher Professional Development

Margaret R. Blanchard, North Carolina State University, Meg_Blanchard@ncsu.edu

Jason W. Osborne, North Carolina State University

Jennifer Sharp, North Carolina State University

ABSTRACT: Many teachers are resistant to take up the messages of reform if these messages require them to substantially shift their teaching practices. One well-established explanation is that the teacher lacks the self-efficacy required to attempt something new in their teaching. However, a host of studies describe teachers with high self-efficacy who remain resistant to change. Another possible explanation relates to teachers' pedagogical discontentment, in which teachers who are discontent with their classroom practices problematize their teaching, and become more receptive to reform messages. In this study, we followed 23 middle school science and mathematics teachers who were involved in technology-infused teacher professional development to see if teachers' levels of self-efficacy and pedagogical discontentment impacted their changes in classroom practices. Quantitative and qualitative analyses using pre and post classroom videotapes (RTOP) and surveys (attitudes toward technology, pedagogical discontentment, STEBI) indicate that the odds that teachers would change their practice toward more reform-based practice was nearly eight times higher in teachers with higher pedagogical discontentment than teachers who were more content. When we controlled for initial familiarity with technology, the effect increased substantially. This study implies that those conducting professional development should find ways to foster pedagogical discontentment in teacher participants.

S11.12.3 Effecting Change in the Teaching of Temperature and Heat through Distance Learning

Rebecca M. Krall, University of Kentucky, rebecca.krall@coe.uky.edu

Amber M. Sullivan, University of Kentucky

Ashlie M. Beals, University of Kentucky

Joseph P. Straley, University of Kentucky

Sally A. Shafer, University of Kentucky

Jeffrey L. Osborn, University of Kentucky

ABSTRACT: Findings from a multicase study on four middle school teachers' instructional practice after participating in a temperature and heat distance learning course are reported in this presentation. The study occurred across two years in which teachers served as the control group in Year 1 and a treatment group in Year 2. Structured classroom observations, pre and post observation conference notes, end of year interviews (in 2009), and pre and post survey responses were used to explore changes in teachers' instructional practice across the two years. Data analyzed through the constant comparative method (Strauss & Corbin, 1998) revealed dramatic changes in teachers' use of student investigations to teach temperature and heat concepts. Teachers placed particular emphasis on using essential questions to guide student investigations, facilitating student interpretation of data and formulation of explanations, and making connections to real world applications. Implications for professional development programs also are discussed.

S11.12.4 Inquiry Practices and Identities of Beginning Secondary Science Teachers in Online and Offline Contexts

EunJin Bang, Iowa State University, ejbang@iastate.edu

Julie A. Luft, Arizona State University

ABSTRACT: This two-year study explored changes in practices and the emerging identities of beginning secondary science teachers who participated in an online science specific mentoring program. Fourteen beginning secondary science teachers and six experienced secondary science teachers were selected for the study. As a mixed methods study, data were analyzed quantitatively and qualitatively. A hierarchical linear model was used in order to depict the changes in inquiry-based practices (IBP) as well as time-ordered displays for exploring emerging identities of three cases, respectively. Qualitative data were collected via monthly semi-structured interviews, pre, post, and follow-up yearly semi-structured interviews, and finally online written dialogues of beginning secondary science teachers; however, three groups were detected: increasing use, no change, and decreasing use in inquiry-based practices. This study provides not only an in-depth picture of the contemporary community of practice in science education but also suggest a roadmap to design an effective induction program.

Strand 10: Curriculum, Evaluation, and Assessment S11.13 Related Paper Set: Teaching and Learning Engineering

1:15pm – 2:45pm, Conference Room 410

S11.13.1 A Place for Engineering in Science Education

Dale R. Baker, Arizona State University, dale.baker@asu.edu

Senay Purzer, Purdue University

Mehmet Aydeniz, University of Tennessee

ABSTRACT: While the reciprocal relationships between science and engineering education are important, the researchers in these two fields rarely come together in an organized manner. This collaborative paper set aims to open a dialogue between science and engineering education researchers and discuss the following questions: (1) Where is the place of engineering in science education research? (2) What perceptions do students have about engineering? (3) What do K-12 students know about engineering? and (4) What are K-12 teachers' concerns about teaching engineering? The paper set is composed of five papers. This paper, the first one in the set, provides a detailed review of articles published in the Journal of Research in Science Teaching in the last two decades addressing engineering education and an overview of the other papers in this paper set. The paper set provides evidence that JRST emphasizes the importance of engineering education and presents various research methods used to study perceptions and understanding of engineering. However, there is still a significant need for future research that focus on teacher learning and contemporary curriculum development. The paper set aims to address this gap and promote discussion on how to infuse engineering into the K-12 curriculum.

S11.13.2 Survey of the Nature of Engineering: Views of First-year Science and Engineering Students

George M. Bodner, Purdue University

Faik Karatas, Purdue University

ABSTRACT: Building on prior work on similarities and differences in individual's views of the nature of science (VNOS), a study was conducted of the views of the nature of engineering (VNOE) held by 35 first-year science and engineering majors. Student responses to the VNOE questionnaire were grouped into five general categories: definitions of engineering as a field and comments on the purpose of engineering; factors that influence engineering work; characteristics of a good engineer; the role of creativity in engineering; and differences and similarities between science and engineering. Each of these categories was then subdivided into three and six subcategories that were analyzed in terms of the percentages of engineering students, of science students, and of the total sample population offering comments of this nature. The results suggest that engineering students' views of NOE are more sophisticated than science students. They recognized that engineering work is shaped by the needs of society; requires teamwork; and has its own ethical values. However, many aspects of nature of engineering were either not evident in students' responses or naively held. The distinction between engineering and science in students' responses was found vague. Main aspects of NOE should be considered in teaching NOS.

S11.13.3 Middle School Students Perceptions of Engineering

Tirupalavanam G. Ganesh, Arizona State University

ABSTRACT: This paper presents an analysis of 7th and 8th grade students' drawings of an engineer at work. The Draw an Engineer (DAE) assessment was administered pre- and post- participation to (n=103) participants and their (n=611) nonparticipant peers in a National Science Foundation (NSF) sponsored year-round, inquiry-based, hands-on afterschool engineering education project. Participants took part in the project over two years. The project was designed to enhance traditionally underrepresented youths' interest in Science, Technology, Engineering, and Mathematics (STEM) subjects and career pathways. Participants were engaged in learning activities that used the engineering design process as a conceptual framework. Participants also learned about engineers by working with engineers, undergraduate engineering students, and by engaging in industry-university internships.

S11.13.4 Elementary Students' Learning Progressions and Prior Knowledge on Engineering Design Process

Ming-Chien Hsu, Purdue University Monica Cardella, Purdue University Senay Purzer, Purdue University

ABSTRACT: In order to examine elementary students' understanding about engineering design processes, we conducted interviews with 76 students in 2nd through 4th grade using an adapted version of a validated engineering design process knowledge instrument. We elicited students' comments on a fabricated design task using photos and open-ended questions. Students' responses were analyzed using a mixed-methods approach. Qualitative data were first coded with design concepts introduced in the "Engineering is Elementary" units developed by the Boston Museum of Science. ANOVA revealed that the number of design concepts mentioned by 4th graders was significantly higher than the number of concepts mentioned by 2nd graders. Examination of the qualitative data showed that there were different levels of understanding based on how students reasoned each concept. Engineering activities such as asking and planning appeared to be more difficult for students to recognize. Based on the differences found between different grade levels and differences in the depth of reasoning, this study guide science educators in laying out learning progressions of engineering design processes for elementary students.

S11.13.5 Stages of Teachers' Concerns on Integrating Engineering into Elementary Classrooms

JeongMin Lee, Purdue University

Johannes Strobel, Purdue University

ABSTRACT: Engineering education is emerging as a new discipline for p-12 schools. To increase the presence of engineering in p-12 schools, professional development for in-service teachers in engineering is required, because teachers are the ones who play a key role in implementing any change in their classroom. However, despite what teachers know about or are able to implement engineering, affective factors such as concerns may interfere with their attempts to integrate engineering. Teachers are not likely to adopt innovation or change their teaching practice unless they are confident to implement it. Therefore, capturing the level of teachers' confidence with dealing engineering issues is needed. In this regard, the purpose of this quantitative survey study was to identify patterns of specific concerns teachers express about integration of engineering into their classrooms. This research project utilized the theoretical framework of a concern-based adoption model to capture concerns on a new class of innovation (a mix of subject and pedagogy innovation. The study used a pre- post- test design around a week-long teacher professional development workshop for P-6 teachers. Results indicate that stages of concerns dealing with the new innovation are addressed and significantly lowered, while other more complex concerns are significantly raised.

Strand 10: Curriculum, Evaluation, and Assessment

S11.14 SC-Paper Set: Developing and Assessing Higher-Order Thinking and Nature of Science 1:15pm – 2:45pm, Conference Room 412

S11.14.1 Designing for Argument: Developing a Rich Learning Environment for the Teaching of Scientific Argumentation Harold B. Short, University of Michigan, hbshort@umich.edu

Morten Lundsgaard, University of Illinois at Urbana-Champaign

ABSTRACT: Scientific argumentation offers students pathways into the discourse and norms of science as well avenues for the use and elaboration of content knowledge. Yet, learning environments that foster competence in scientific argumentation have remained rare. This study details a design experiment involving a curriculum in which advanced science content was combined with scientific argumentation and explores how revisions to this curriculum were associated with changes in student argumentation and content knowledge. To describe student learning, we administered pre/post tests, conducted pre/post interviews, and collected written argumentation artifacts. We found that our revised curriculum led to dramatic gains (p<.001, ES = 3.3) in knowledge of intermolecular forces, while at the same time supporting students' ability to generate claims and marshal evidence to support these claims. However, improvements in argumentation were nuanced with students still struggling to provide scientific warrants in their reasoning. We propose expanding beyond the common focus on content and argumentation to consider the role of genre, audience, stance, and epistemic commitments in the design of argumentation learning environments. We will also discuss the affordances and limitations of our curricular revisions and offer insights to those seeking to develop problem-based instruction that seeks to develop and elicit scientific argumentation.

S11.14.2 Assessing Evaluative Thinking Capability of High-School Science Students in the Multicultural Israeli Context

Tami Nahum, University of Haifa-Oranim, Israel, ntami@weizmann.ac.il

Ibtesam Azaiza, University of Haifa-Oranim, Israel

Naji Kortam, University of Haifa-Oranim, Israel

David Ben-Chaim, University of Haifa-Oranim, Israel

Uri Zoller, University of Haifa-Israel

ABSTRACT: Our coping with complex issues in the Science-Technology-Environment-Society (STES) context, requires the development of students' higher-order cognitive skills (HOCS), such as question-asking, critical system thinking, evaluative thinking, decision-making and problem solving capabilities within science education. This research concern is the establishing of the evaluative thinking capability baseline of 10th-grade high-school students in the Arab (N=219) and the Jewish (N=175) sectors within the Israeli multicultural society. Our main research tool was a specially developed and validated evaluative thinking questionnaire which was administered to the research student population. The responses were analyzed both qualitatively and qualitatively. The results indicated a large significant difference between the evaluative thinking and related HOCS capabilities (in the STES context), of these two sectors. Yet, overall, the basis for the development of the evaluative thinking capability "is there" for both sectors, suggesting that persistent application of evaluative thinking-promoting science teaching strategies and assessment methodologies, have the potential to develop students' HOCS capabilities in the cultural context.

S11.14.3 A Competence Test in the Field of Nature of Science and Nature of Scientific Inquiry

Irene Neuman, University Duisburg-Essen, irene.zilker@uni-due.de Gary M. Holliday, Illinois Institute of Technology, Chicago Hans E. Fischer, University Duisburg-Essen Alexander Kauertz, University Duisburg-Essen

Judith S Lederman, Illinois Institute of Technology, Chicago

Norman G. Lederman, Illinois Institute of Technology, Chicago

ABSTRACT: Within science education research, Nature of Science (NOS) and Nature of Scientific Inquiry (SI) are agreed on as important topics for science education. Accordingly, these topics are men-tioned in science education standards, too. Mainly due to international large-scale assessments, e.g., Programme for International Student Assessment (PISA), science education research focused on teaching and testing for competences. Standards formulate competences to describe levels of students' achievement. While various valuable questionnaires do exist that investigate students' understandings and views on NOS and NOSI, there is no test instrument for students' competence in that field. A test for students' competence was developed based on a model for physics competence described by Kauertz and Fischer (2006). 107 test items were developed providing examples from physics history and focusing on aspects of NOS and NOSI. These items were administered to 1080 10th graders using a multi-matrix design. Based on Rasch and correlation analyses, items were investigated with respect to fitting the model. Results show, that these items can be a first step to providing a workable competence test for NOS and NOSI.

S11.14.4 Looking Forward: Teaching the Nature of Science of Today and Tomorrow

Y. Debbie Liu, Harvard, yul826@mail.harvard.edu

Tina A. Grotzer, Harvard

ABSTRACT: The "nature of science" (NOS) refers to the epistemology, or the values and beliefs inherent to scientific knowledge and its development. It has been argued by numerous science education literature and organizations that teaching NOS in K-12 settings should be a major goal in science education, as it is of equal, if not greater, importance than traditional subject matter. Understanding NOS is believed to be crucial for scientific literacy and critical in preparing students to participate in a discovery-oriented field. However, it would be easy to fall into the trap of teaching the nature of yesterday's science. We examine key shifts occurring in the epistemology of science—from approaches that are reductionist to integrative/systems-based, from biological to mechanistic, and from hypothesis-driven to data-driven—by identifying emerging trends in current-day scientific practice from interviews with scientists working at the cutting edge of experimental research. The identified trends portray forms of thinking relevant to 21st century science—systems thinking, mechanistic (engineering) thinking, interdisciplinary thinking, quantitative thinking, and distributed thinking. We consider the implications of these particular thinking patterns and argue for the necessity of a general stance of epistemological flexibility for educating the next generation of scientists.

Strand 11: Cultural, Social, and Gender Issues

S11.15 Symposium: Theoretical and Methodological Coherence in Conceptualizing Identity in Science Education 1:15pm – 2:45pm, Conference Room 411

Discussants:

Gale Seiler, McGill University, gale.seiler@mcgill.ca Anjali Abraham, McGill University Allison Gonsalves, McGill University Phoebe Jackson, McGill University Janine Metallic, McGill University Stephen Peters, McGill University Lilian Pozzer-Ardenghi, McGill University

ABSTRACT: This symposium proposes to identify methodological issues that arise when the concept of identity is used in science education research. While identity is a valuable concept in advo-cating for equity in education in general and science education in particular, it has not yet been clearly conceptualized within the field. This has resulted in methodological inconsis-tencies and contradictions that limit the use of identity to mobilize change in science edu-cation research and practice. To investigate these issues, we have conducted a review of re-search articles on the topic of identity in science education published in the last ten years. Our symposium will discuss the various theoretical frameworks to identity that research-ers have used, and elaborate on their epistemological approaches present in relation to different types of data and analytical frameworks. We will also explore what type of methodological approaches can or cannot be undertaken when research questions on identity are generated from certain ways of conceptualizing identity. This symposium will contribute to the conversation on the usefulness of identity in sociocultural research in science education.

Strand 15: Policy

S11.16 Symposium: A Pathway to College Readiness: Science College Board Standards for College Success

1:15pm – 2:45pm, Conference Room 415
Christopher C Lazzaro, The College Board, clazzaro@collegeboard.org
Danielle Luisier, The College Board
Cynthia Hamen Farrar, The College Board
Melanie M. Cooper, Clemson University
Robert W. Ridky, National Education Coordinator U.S Geological Survey
George E. DeBoer, AAAS Project 2061
Nancy B. Songer, University of Michigan
ABSTRACT: With the increasing demands of global competition in science and technology, it is clear that students must be better
prepared for future success in STEM careers. In response, the College Board has devoted three years to the research and development of college and career readiness standards in science that explicitly outline the essential knowledge and skills students need in order to

of college and career readiness standards in science that explicitly outline the essential knowledge and skills students need in order to be prepared for success in an introductory college-level science course. In this symposium, an expert panel will examine the evolution of science standards over the past fifty years and link this research to the clear, vertical articulation, beginning in middle school and leading to college, of the competencies necessary for engaging in appropriate scientific discourse in a high school science class. The panel will also examine how all students can develop these competencies and be prepared for college level science courses. The panel will then explore how the Science College Board Standards for College Success add to this research and offer valuable insight and guidance to curriculum developers and teachers by describing how students are expected to use and build their science knowledge, while at the same time allowing for curriculum to be tailored to the specific needs of students at the local or district level.

Strand 1: Science Learning, Understanding and Conceptual Change S12.1 SC-Paper Set: Technological Innovations to Support Learning

3:00pm – 4:30pm, Conference Room 413

S12.1.1 Comparing Students' Performance and Reasoning with Physical and Virtual Manipulatives to Learn about Pulleys Jacquelyn J. Chini, Kansas State University, jackiehaynicz@gmail.com

Amy Rouinfar, Florida State University

Adrian Carmichael, Kansas State University

Sadhana Puntambekar, University of Wisconsin - Madison

N. Sanjay Rebello, Kansas State University

ABSTRACT: In this study, we examine the benefits of physical and virtual manipulatives in assisting student learning about pulleys. Using real pulleys and a pulley simulation, students in a conceptual physics laboratory performed experiments, answered worksheet questions, and completed conceptual tests. While no overall difference was found in the post-test performance of the students who used physical manipulatives (PM) and the students who used virtual manipulatives (VM), question-by-question analysis revealed some interesting differences. The following semester, students from an algebra-based physics class performed the same experiments in an interview setting, which allowed us to probe the reasoning students used when answering the post-test questions. In this paper, we discuss one question where the PM students outperformed the VM students, one question where the VM students outperformed the PM students, and one question where the groups had similar performance. Our qualitative analysis of the interview transcripts reveals that even within a single context -- pulleys -- learning about specific concepts, such as force and work, may be better supported by either physical or virtual manipulatives.

S12.1.2 Computer-Supported Collaborative Scientific Conceptual Change: Learning Sciences in CSCL Learning Environments

Lei Liu, University of Pennsylvania, leil@gse.upenn.edu

Cindy E. Hmelo-Silver, Rutgers University

ABSTRACT: A myriad of studies on conceptual change have investigated the nature and process of conceptual change, pedagogical strategies to foster conceptual change and improve higher-level thinking. Instead of focusing on the effects of cognitive conflicts, which is widely accepted to be essential for conceptual change (Posner, Strike, Hewson, & Gertzog, 1982), we apply a theoretical framework - the collaborative scientific conceptual change (CSCC) - to investigate middle school students' conceptual change processes. The CSCC framework proposes that conceptual change is a gradual process and stress the influence of peer interactions and engagement in the epistemic practices of science on conceptual change. The goal of this study was to support middle school science curriculum instruction and to promote deep scientific understanding of aquarium ecosystems through the use of computer simulations. The MLA analyses found that predicting and coordinating theory and evidence were key practices that predicted students' individual posttest performance. The qualitative analyses compared the high and low-achievement groups and found that the features of group discourse and the epistemic practices were related to the group understanding. These results are consistent with the CSCC framework.

S12.1.3 Qualitative Analysis of the Effects of Sequence of Physical and Virtual Activities on Student Conceptual Understanding in Mechanics

Adrian Carmichael, Kansas State University, carmichaelam@gmail.com

Jacquelyn J. Chini, Kansas State University

Sadhana Puntambekar, University of Wisconsin-Madison

N. Sanjay Rebello, Kansas State University

ABSTRACT: This study investigates the effects of the sequence of virtual and physical activities on student learning of physics concepts related to pulleys. We analyzed open-ended student responses to worksheet questions and compare these to pre, mid and post test data. We examined student progression of understanding as they worked through the different sequences of activities. On the open-ended questions, students who completed the physical experiment first showed signs of cognitive dissonance in concepts related to work and potential energy. This was then resolved through the virtual experiment, resulting in large gains in understanding. Students who completed the virtual experiments first acquired a stronger understanding after the virtual but appeared to be confused after they completed the physical activity. Both sequences showed stable understanding of force and distance concepts based though students in the physical then virtual sequence showed greater conceptual understanding compared to the virtual then physical sequence but not for the virtual then physical sequence on the questions about work and potential energy.

S12.1.4 Connecting Tacit Understanding from Video Games to Formalized Vector Concepts

Cynthia M. DAngelo, Arizona State University, cynthia.dangelo@asu.edu

Douglas B. Clark

Brian C. Nelson, Arizona State University

Kent Slack, Arizona State University

Muhsin Menekse, Arizona State University

ABSTRACT: Student learning through playing video games many times stays within the context of the video game. SURGE (Scaffolding Understanding by Redesigning Games for Education), an online game, has been developed to help students build on their tacit intuitive understanding of motion gained through gameplay and translate that into the formalized explicit language and ideas used in school-based contexts. Students in introductory physics have difficulties in many areas of physics, and a lack of understanding of concepts relating to vectors (including vector components, addition, and subtraction) underlies many of their difficulties. Pilot study evidence suggests that some students are able to make gains on vector concept test items after playing the game for a short period of time without any out-of-game supports. Interview data reveals that their tacit understandings in the game are being utilized in out-of-game contexts. However, many students are not able to correctly apply their tacit understanding in a formalized context. Out-of-game supports will help students make the connections between these two contexts and further improve learning through playing games.

Strand 2: Science Learning: Contexts, Characteristics and Interactions

S12.2 Symposium: Incorporating Social Foundations of Learning into Design: Cases and Design Principles from Two Efforts to Re-design Existing Curriculum Kits

3:00pm – 4:30pm, Salon D **Presenters:** Carrie T. Tzou, University of Washington Bothell, tzouct@u.washington.edu Philip Bell, University of Washington John Bransford, University of Washington Nancy Vye, University of Washington Giovanna Scalone, University of Washington Kari Shutt, University of Washington Katie Van Horne, University of Washington Amy Winstanley, Bellevue School District, WA Tiffany Lee, University of Washington

ABSTRACT: The aim of this special symposium is to explore the "social" in design. Our overarching hypothesis is that by leveraging social practices that students engage in when given the choice (e.g., with their families and peer groups), we can make science instruction more engaging and personally consequential for students and, therefore, improve learning. We label this as introducing integral social consequentiality. We draw from two design-based research efforts to incorporate social foundations of learning into formal classroom instruction. Both efforts aim to re-design existing fifth grade science curricula; however, they each take a different theoretical stance on incorporation of "social" practices into their designs. One effort takes a sociocultural perspective on "social", aiming to bridge informal and formal learning environments by leveraging students' culturally-based repertoires of practice (Gutierrez & Rogoff, 2003) into formal science instruction. The second effort takes a socio-cognitive approach to science instruction, leveraging authentic science practices and questions, student choice, and communication of ideas into a challenge-based (Schwartz, Lin, Brophy, & Bransford, 1999) design. After looking at example work from each project, we will synthesize across the two and pull out general design principles for incorporating social foundations of learning into the design of inquiry-based science curricula.

Strand 2: Science Learning: Contexts, Characteristics and Interactions

S12.3 Related Paper Set: Argumentation in Different Science Classrooms Learning Environment Based on Reserach Experience from Four Countries

3:00pm – 4:30pm, Conference Room 402

S12.3.1 Stimulating Peer Argumentation in the School Science Laboratory – Exploring the Effect of Laboratory Task Formats Per Kind, Durham University, England, p.m.kind@durham.ac.uk

Janine Wilson, Durham University, England

Avi Hofstein. The Weizmann Institute of Science. Isreal

Venessa Kind, Durham University, England

ABSTRACT: The aim of the research was to understand the types of discourse occurring in laboratory tasks and what factors that hinder and/or stimulate scientific argumentation. Three tasks were developed: two including data gathering and a third (non-practical) using hypothetical data. Four groups of 12-14 year-old students were video recorded while conducting all three tasks. Two more groups did the non-practical task only. The design gave an opportunity to see how conducting practical work (data gathering) affects discourse between students. Each task lasted 20-50 minutes and resulted in nearly 8 hours video recordings. Data were analysed, firstly, by breaking each group's work into units according to the type of discourse occurring. Eight types of discourse were identified, with talks about equipment and the data recordings being most common followed by task-clarification and social talk. Students avoided evidence evaluation even if the tasks asked explicitly about this. Next, units including scientific argumentation, but generally it was found that data gathering hinder rather than stimulates argumentation. Students seem to operate with an epistemic belief that data gives final answer and make no need for further discussions.

S12.3.2 Argumentation in the Chemistry Laboratory: Inquiry and Confirmatory Experiments

Dvora Katchevich, The WeizmannInstitute of Science, Israel, dvora.katchevich@weizmann.ac.il

Rachel Mamlok-Naaman, The WeizmannInstitute of Science, Israel

Avi Hofstein, The WeizmannInstitute of Science, Israel

ABSTRACT: One of the goals of science education is to impart students with the ability to construct arguments – reasoning and critiquing in a scientific context. Over the past decade, many studies have been conducted on constructing arguments in science teaching, but only few of them deal with studying argumentation in the laboratory. Our research focuses on the process in which the student constructs arguments in the laboratory in various types of experiments. We found out, that inquiry experiments can be a platform for formulating arguments, due to the features of the learning environment. The discourse during the inquiry experiments was found to be rich in arguments, whereas the one during confirmatory experiments does not include argumentation components. The arguments developed during a discourse in an open inquiry experiment, focus on some of the inquiry-type skills, such as: (1) defining an assumption, (2) analyzing the results, and (3) writing the conclusions. Based research findings, it is recommended to provide teachers with the skills of formulating arguments so that they will be able to integrate this topic in their work with students during the laboratory activities.

S12.3.3 Assessing Understanding of Argument: Investigating High School Students' Arguments and Implications for Classroom Practice

Ebru Kaya, Middle East Technical University, Turkey, ekaya@metu.edu.tr

Sibel Erduran, University of Bristol, United Kingdom

Pinar Cetin, Middle east Technical University, Turkey

ABSTRACT: Since the mid-1990s, science education researchers have placed strong emphasis on the role of argumentation in science teaching and learning. Argumentation, the processes of justification of claims with evidence, has become a significant goal also promoted in international educational policies and professional communities. However, there is insufficient knowledge on preservice science teachers' (student teachers') understanding of argument. This paper reports on a study conducted in England with 53 students in a teacher training programme. The participants were given two questionnaires developed by Sampson & Clark (2006). The first questionnaire assessed understanding of the nature of science and its relation to argument whilst the secont assessed understanding of argument. Numerous findings will be reported including the trainees' difficulties in distinguishing between data and warrants. The test items were useful in exposing such difficulties and provided a tool for assessment of understanding argument. Overall the results are not surprising considering students have difficulties with argumentation even after explicit support and instruction at advanced levels in the sciences and applied fields such as engineering. Implications for teachers' professional development in argumentation are discussed.

S12.3.4 Model-Based School Scientific Argumentation with Prospective Science Teachers

Agustin Aduriz-Bravo, University of Buenos Aires, Argentina, adurizbravo@yahoo.com.ar

ABSTRACT: In the intervention reported in this presentation, my aims are both to foster and to assess what I label as 'school scientific argumentation' in secondary science teachers during their pre-service education. For these purposes, I use the meta-scientific construct of 'theoretical model' (proposed by the so-called semantic view of scientific theories from contemporary philosophy of

science) in three different and complementary conceptual levels. Firstly, I suggest teachers to argue using theoretical models (as opposed to propositional items) from science as a key component of their arguments. Secondly, I try to scaffold teachers' argumentation practices modelling them with paradigmatic exemplars ('epitomes'). And thirdly, I use a four-component model of school scientific argumentation as an analytical tool to inspect how science teachers argue. Teachers' argumentative texts that I discuss here arise from their participation in teaching-learning sequences designed to improve their argumentation skills via three synergic model-based operations: analysing epitomes of arguments, (co-)constructing new arguments, and meta-theoretically reflecting upon them.

S12.3.5 Fostering Constructive Criticism in a High School Biology Classroom: Understanding the Social Dynamics of Argumentation

Ellice Ann Forman, University of Pittsburgh, ellice@pitt.edu

ABSTRACT: A major challenge for science education is to foster the practice of authentic scientific activities, such as argumentation. Unfortunately, the enactment of this instructional reform has not always been successful. The aim of our presentation is to present an analysis of a grant proposal activity that occurred at the end of the nine-week high school evolutionary biology course (part of Modeling for Understanding in Science Education or MUSE Project). Our overall analytic aim was to integrate tools from sociolinguistics (e.g. participant structures) and argument analysis. Our research questions focused on student counter- arguments and replies to their classmates' and teacher's questions. We also examined the teacher's instructional support. We found that the enacted curriculum during the final two days of this course offered many opportunities for students to constructively critique each other's arguments and required the presenters to defend, modify, or withdraw their proposals. The teacher's use of a range of participation structures (from monitor or mentor to partner) in the two day event afforded her students the opportunity to humorously engage their classmates during their presentations and offer serious evaluations of their peers' proposals. Thus, this study provided a detailed picture of constructive critiques and collaborative responses during classroom argumentation.

Strand 3: Science Teaching--Primary School (Grades preK-6): Characteristics and Strategies S12.4 Symposium: Teacher Knowledge and Science Teaching—Effects on Students' Learning in Elementary and Secondary School Science

3:00pm – 4:30pm, Conference Room 403
Thilo Kleickmann, Max-Planck-Institute for Human Development Lentzeallee, Germany, kleickmann@mpib-berlin.mpg.de
Alexander Kauertz, University of Education, Germany
Anne Ewerhardy, University of Muenster
Katharina Fricke, University of Duisburg-Germany
Kim Lange, University of Muenster, Germany
Annika Ohle, University of Duisburg-Essen Department of Physics Schützenbahn 70 D-45127 Essen Germany
Kathleen Roth, BSCS
Hans E. Fischer, University of Duisburg-Germany
Kornelia Möller, University of Muenster Seminar, Germany
ABSTRACT: Especially since Shulman's critique in the 1980s, educational research considered domain- specific measures of

Abstruction and teachers' knowledge. Among studies on teachers' domain-specific knowledge investigations preponderate that use distal measures such as certification status and the number of in-service courses. Studies using direct measures of domain-specific teacher knowledge in the domain of science are rare. Nevertheless, the highlighting of domain-specific aspects of the quality of teaching may not lead to a negligence of more domain-general aspects of instruction. Assuming that domain-specific characteristics of teachers' knowledge and instruction have an impact on students' science content learning the question raises of how to modify these relevant variables through science teacher education programs. The research reported in the symposium at hand tries to deliver insights into the assessment and the impact of domain-specific teacher knowledge and science instruction. The interplay of more domain-general characteristics of instruction and students' domain-specific learning will be discussed as well. Based on the findings of a study on a teacher training program that aims at modifying domain-specific teacher knowledge and instruction implications for science teacher education will be discussed.

Strand 4: Science Teaching--Middle and High School (Grades 5-12): Characteristics and Strategies S12.5 Symposium: Peer-Enhanced Classrooms: A Field Trial Experiment Leading to a Successful Model for the Urban Classroom

3:00pm – 4:30pm, Conference Room 404 Pamela Mills, Hunter College, pmills@hunter.cuny.edu William Sweeney, Hunter College Jeanne Weiler, Hunter College Leslie Keiler, York College

Linda Gerena, York College

James A. Zimmerman, Montclair State University

ABSTRACT: The problem of educating students in urban public high schools is well known, endemic, and persistent. In response to this, an experimental field trial has been conducted in four New York City public high schools using a novel implementation of peer tutoring -- the Peer-Enhanced Classroom model. The model uses cross-age peer teaching, and integrates aspects of group learning and workshop pedagogies. Significant student gains on the Regents exams (20% improvement) were observed in the experimental classroom as compared to the control classrooms. The Peer-Enhanced Classroom model is a restructuring of the role of the teacher. It supports and empowers the peer teachers in their academic life. The model, the methodology of the field trial, quantitative results, and the research conducted to ascertain the impact of the model on the teachers, students, and tutors will be the subject of the symposium. There will be numerous opportunities for interaction including discussion with a panel of participating teachers, tutors, and students.

Strand 5: College Science Teaching and Learning (Grades 13-20) S12.6 SC-Paper Set: Learning and Understanding in Undergraduate Geology 3:00pm – 4:30pm, Conference Room 405

S12.6.1 Through Their Eyes: Tracking the Gaze of Students in a Geology Field Course

Adam V. Maltese, Indiana University, amaltese@indiana.edu

Eric M. Riggs, Purdue University

ABSTRACT: The focus of this research was to investigate how students understand science through observation. This study addressed the following questions: 1) To which features do students attend during observation of natural phenomena in particular contexts, such as demonstrations, laboratories and field exercises? 2) Do students make observations of the important features that their instructors intend? To accomplish this, we collected eye tracking video from students completing a geology field course. Data were collected from nine students (primarily undergraduates) participating in two different independent exercises where they were asked to create geological maps of an area based on their field observations. Through iterative review of the videos, substantive features of students' observational habits were exposed. Initial findings reveal that while instructors were passing along valuable information students neglecting key observational information because it did not fit with their preconceived models of the geologic structure in the study area. We believe these findings provide data for science educators to use in thinking about how to develop the observational skills of their students and how to structure field courses.

S12.6.2 Developing a Field Trip to a Science Museum for a College-Level Geology Course

Molly E. Phipps, Science Museum of Minnesota, mphipps@smm.org

Kent Kirkby, University of Minnesota

Connie Tzengis, University of Minnesota

ABSTRACT: This proposal details an effort to develop a self-guided module for students in an introductory college-level geology class to visit a local science museum. This module takes advantage of the museum's extensive paleontology collection to help students explore dinosaur anatomy and what it implies for dinosaur life styles. In this study we evaluate students' experience using the module and compare changes in students' conceptual understanding of geological concepts using a pre/post administration of a geologic concepts inventory. Students who completed the optional module showed higher gains on the geologic concepts inventory. Additionally minority and women students participated in the module in higher numbers than their enrollment in class would suggest. This pilot test of the module produced promising results for expanding the selection of modules geared toward college students for museum settings.

Strand 5: College Science Teaching and Learning (Grades 13-20) S12.7 Symposium: Science Faculty with Education Specialties

3:00pm – 4:30pm, Conference Room 414

Presenters:

Michael T. Stevens, California State University, Stanislaus, mstevens@biology.csustan.edu

Seth D. Bush, California Polytechnic State University, San Luis Obispo

Nancy J. Pelaez, Purdue University

James A. Rudd, California State University, Los Angeles

Kimberly D. Tanner, San Francisco State University

Kathy S Williams, San Diego State University

ABSTRACT: Efforts to improve science education include university science departments hiring Science Faculty with Education Specialties (SFES), scientists who take on specialized roles in science education in their discipline to improve K-12 teacher preparation, reform undergraduate science education, and/or build discipline-specific science education research. Speakers will present

results of the first cross-disciplinary research study on SFES. Two SFES subpopulations were identified, those hired as SFES and those who transitioned into these roles. SFES reported more training in basic science than in science education, spending more time on service responsibilities than do non-SFES science faculty, and having less institutional support for their scholarly activities than their non-SFES department colleagues. Almost 40% of SFES were seriously considering leaving their positions. Findings indicate key barriers to SFES success and call for leadership to articulate expectations for SFES positions, establish pathways to train future SFES, and build expertise about science education in the sciences. We will present and discuss aims to create a registry of SFES, which could serve as a nucleus for developing greater professional activities and connections for this emerging type of position.

Strand 7: Pre-service Science Teacher Education

S12.8 Symposium: Science Teacher Recruitment and the Robert Noyce Teacher Scholarship Program: Promising Strategies and Possible Connections

3:00pm – 4:30pm, Conference Room 407

Presenters:

Steven S Fletcher, St. Edward's University, stevenf@stedwards.edu Julie A. Luft, Arizona State University Michael Beeth, University of Wisconsin Oshkosh Ann Cavallo, University of Texas at Arlington Juanita Jo Matkins, College of William and Mary Jacqueline T. McDonnough, Virginia Commonwealth University Laura Henriques, California State University - Long Beach Lorelei Wood, Arizona State University

ABSTRACT: This special symposium revolves around research related to science teacher recruitment and retention through the NSF Robert Noyce Teacher Scholarship program. Presenters from a wide range of higher education settings will share innovative recruitment strategies, will share findings from successful and challenging recruitment and retention efforts, and will compare specific situational and programmatic factors that led to successful numbers of Noyce Scholars being recruited and prepared in the highlighted programs. This session will be useful for those starting or attempting to build student numbers in existing science teacher preparation programs as well as those intrigued by the breadth of projects supported by this NSF-funded program.

Strand 7: Pre-service Science Teacher Education S12.9 SC-Paper Set: Ethical and Socio-Scientific Instruction and Parental Involvement in Pre-Service Teacher Education

3:00pm – 4:30pm, Conference Room 409

S12.9.1 Turkish Preservice Science Teachers' Perceptions and Adaptation of Socio-scientific Issues into the Science Curriculum

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

Mustafa S Topcu, Yuzuncuyil University

ABSTRACT: The work presented here represents a preliminary effort undertaken to address the role of teachers in supporting students' learning about socioscientific issues (SSI) by characterizing preservice science teachers' critique and adaptation of Turkish science curriculum and identifying factors that serve to mediate this process. Twenty three undergraduate preservice science teachers were studied over the course of one semester. Participants (52% female) completed a questionnaire comprising open-ended questions. Results indicated that participants perceived a need to address SSI positively. Participants had low personal science teaching efficacy beliefs related to teaching about SSI. They perceived the lack of instructional time and the unavailability of relevant materials as the primary obstacles that hindered the teaching of SSI. Implications for science teacher education and the design of curriculum materials in respect to SSI are discussed. Keywords: Middle school science; Socioscientific issues; Science teacher education.

S12.9.2 Preservice Science Teachers' (PST) Argumentation Skills: Impact of Socioscientific-Based Instruction

Mustafa S Topcu, Yuzuncu Yil University, msamitopcu@gmail.com

Yilmaz Kara, Karadeniz Technical University

ABSTRACT: Our research interests in the present study were twofold. First, we explored to what extent do students' views regarding the role of SSI-based instruction in argumentation change during the SSI-based instruction. Second, we examined how instruction driven by SSI over a five-week period influences students' argumentation skills. One-group pretest-posttest research design guided the study (Fraenkel & Wallen, 2003). The participants were 23 Preservice Science Teachers (PST) from a university in Turkey. They were volunteers from one classroom whose population was 30. While 11 participants were male, 12 participants were female. In order to examine PST's argumentation skills, one instrument was developed. The instrument included the written questions exploring students' views about the role of SSI-based instruction in argumentation and the effectiveness of SSI-based instruction in the development of

participants' argumentation skills. The instrument was applied before and after the implementation of SSI-based instruction as the preand post-tests. In conclusion, this study has provided new evidences related to students' views regarding the role of SSI-teaching in argumentation and the effectiveness of SSI-based instruction on argumentation. Students perceived SSI-based instructions as a pedagogical strategy for achieving improved argumentation and informed decision-making skills. In addition, five- week SSI-based instruction improved students' argumentation skills.

S12.9.3 The Use of Parent Involved Take-Home Science Activities during Student Teaching: Understanding the Challenges of Implementation

Jill Zarazinski, State University of New York College at Brockport, jzarazin@brockport.edu

ABSTRACT: Providing continual support of parent involvement practices by pre-service teachers throughout student teaching is a critical step in sustaining parent involvement initiatives once candidates have graduated from teacher preparation programs and are employed by school districts. Various take-home kits, such as the present Science in a Bag, have helped parents become directly involved in their child's education by providing science activities which strictly utilize household materials, extend on the taught classroom science lesson, and can be completed over an extended time frame. These learning opportunities allow scheduling flexibility among parents who have little time during the week to volunteer in the classroom or sit down and work with their child on daily homework assignments. This paper expands on previously conducted research of childhood education pre-service teachers who utilized Science in a Bag and focuses on needed support when implementing parent involvement programs during their student teaching practicum.

Strand 8: In-service Science Teacher Education

S12.10 SC-Paper Set: Innovative Science Content and Professional Development

3:00pm – 4:30pm, Salon C

S12.10.1 Correlated Science and Mathematics: A Model for Professional Development of Grades 5-8 Science and Mathematics Teachers

Sandra S West, Texas State, sw04@txstate.edu

Sandra T. Browning, University of Houston - Clear Lake

ABSTRACT: A new professional development model of linking science and mathematics instruction called Correlated Science and Mathematics (CSM) for science and mathematics teachers is described. Integrating science and mathematics typically means science teachers

S12.10.2 The Role of Teachers' Barriers in Integrating New Ideas into the Curriculum: The Case of Nanscale Science and Technology

Bamberger M. Yael, University of Michigan, yaelbamb@umich.edu

Joseph S Krajcik, University of Michigan

ABSTRACT: The purpose of this study was to understand what types of barriers teachers face as they start to incorporate new materials into their classrooms, particularly in the case of nanoscale science and technology (NST). In addition, we aimed to understand how a one-day workshop can help teachers overcome those barriers. Fifteen teachers participated in the workshop, which provided them with instructional materials, resources and activities of the emerging science topics that could be incorporated into classes. Pre- and post-surveys were conducted at the beginning and at the end of the workshop, and interviews were conducted three months after the workshop. Our findings address intrinsic and extrinsic barriers in implementing the new ideas into their curriculum, as indicated by the teachers. The workshop helped teachers overcome some intrinsic barriers, such as lack of knowledge. However, three main extrinsic barriers were found in this study: time constraints, standards, and instructional materials. These barriers decreased during the workshop, but increased three months later. The conclusions of this study pointed out the importance of dealing with external barriers in professional development. Ignoring these barriers will prevent curriculum change and renewal of teaching.

S12.10.3 The Impact of Professional Development: Teaching an Enhanced Multimodal Grade 6 Science Unit on Extreme Environments

Christine D. Tippett, University of Victoria, ctippett@uvic.ca

Larry D. Yore, University of Victoria

ABSTRACT: This case study documents the planning and delivery of a multimodal science unit (Grade 6 – Extreme Environments) by Penny, a teacher who joined an established professional development community in Year 4 of an on-going community-based project. Penny's planning integrated a number of oral, print, and visual discipline-specific literacy strategies into a textbook-oriented curriculum, moving her instruction from information dissemination toward knowledge construction. After teaching the unit, Penny reflected upon how her professional development experiences as a participant in the project had influenced her practice. The on-going nature of the project meant that she could revisit strategies and she could implement a strategy, share the results of the implementation with members of her learning community, and reflect both publically and privately on her practice. Penny would not have known about some of the strategies that she successfully incorporated and that have become part of her teaching repertoire. In addition, Penny

felt supported by her colleagues and more able to take risks in her teaching. The study provides insights about the implementation of discipline specific literacy strategies and provides an indication of the possibilities afforded by the incorporation of multimodal representations to demonstrate student understanding of science concepts.

S12.10.4 Teachers Learn about Biological Energy Transfer at the SUN Project Workshop

Ann Batiza, Milwaukee School of Engineering, batiza@msoe.edu Mary Gruhl, Milwaukee School of Engineering Tim Herman, Milwaukee School of Engineering Dave Nelson, UW-Madison Tom Harrington, Bacon Academy Marisa Roberts, Whitefish Bay High School Donna LaFlamme, St. Dominic's School Mary Anne Haasch, Wauwatosa West High School Jonathan Knopp, IB International Gina Vogt, Brown Deer High School

ABSTRACT: Preliminary data suggests that the SUN (Students Understanding eNergy) Project workshop enhances teacher understanding of energy transfer in biology and provides new instructional tools that teachers value for use in the classroom. This project has developed a new conceptual framework that uses energy principles derived from the hydrogen fuel cell to make the "how" and "why" of energy flow in biology accessible to teachers and their students. These data also suggest that the Intervention and Control Groups have equivalent understanding of energy transfer in biology and equivalent confidence in the level of their understanding. Therefore this randomized, controlled trial is poised to deliver meaningful data regarding student achievement in energy transfer as a result of teacher participation in the SUN Workshop and use of these new instructional tools and the new conceptual framework.

Strand 8: In-service Science Teacher Education S12.11 SC-Paper Set: Nature of Science and Inquiry 3:00pm – 4:30pm, Conference Room 408

S12.11.1 Teachers Translating Inquiry-Based Curriculum to the Classroom Following Professional Development: A Pilot Study

Daniel K. Capps, Cornell University, dkc39@cornell.edu

Barbara A. Crawford, Cornell University

ABSTRACT: This study examined the impact of a professional development program centered on authentic science inquiry, evolutionary and geological concepts, and nature of science. We developed cases of experienced teachers, upper elementary and secondary, as they participated in the professional development program and tracked how teachers enacted an innovative curriculum centered on an authentic investigation. We used a range of data sources to determine the following: 1) the influence of the professional development on teachers' knowledge and their classroom practice with respect to inquiry; 2) the extent to which teachers enacted the curriculum in their classrooms, and 3) the adaptations and changes they made to the curriculum in teaching the authentic investigation to their students. During the year we visited each teachers' classroom and had numerous conversations. Since the curriculum was in its first year pilot phase, we had expected the pilot teachers to encounter many challenges and need additional help from the professional development. Findings indicated that experienced teachers held more informed views on inquiry teaching and enacted inquiry-based instruction as a result of participating in professional development. These experienced teachers also adapted instruction to better suit their local contexts, in part due to engaging them in reflection and metacognition.

S12.11.2 Teachers' Pedagogical Use of Inquiry Related Words - Conflating Means and Ends

Jakob Gyllenpalm, Stockholm University, jakob.gyllenpalm@mnd.su.se

Per-Olof Wickman, Stockholm University

Sven-Olof Holmgren, Stockholm University

ABSTRACT: This paper explores how 12 secondary school science teachers describe instances of students' practical work in their own science classes. The objective is to better understand the culture and traditions of secondary school science teaching related to inquiry as expressed in the use of language. Data consisted of semi-structured interviews about actual inquiry units used by the teachers. These examples brought by the teachers were used to situate the discussion of their teaching in a real context. The theoretical background is socio-cultural and pragmatist views on the role of language in science learning. In the analysis we focus on three concepts of scientific inquiry: hypothesis, experiment and laboratory work. The teachers tended to use these terms with a pedagogical function with an emphasis on teaching the children the correct explanation, resulting in a conflation between methods of teaching and methods of inquiry. Learning about scientific inquiry as a way of knowing was thus not a prioritized educational goal. We discuss how learners' possibilities to learn about the characteristics of scientific inquiry and the nature of science are affected by an unreflective use of everyday discourse.

S12.11.3 Comparison between Chinese and United States Science Teachers' Views of Nature of Science and Scientific Inquiry Jingving Wang, Capital Normal University (Beijing, China), wangjingying8018@126.com

Norman G. Lederman, Illiois Institute of Technology

ABSTRACT: The purpose of this study was to compare Chinese and United States in-service secondary science teachers' views of NOS and SI. This mixed methods study involved 90 secondary science teachers, 45 from mainland China and 45 from United States, and they were asked to fill out a paper or online version of the Views of Nature of Science Form C (VNOS-D) and Views of Scientific Inquiry Form S (VOSI-S) questionnaires, along with their interview responses. A paired-sample t-test was performed on the quantitative data, followed by analysis of different stages and Granger causality test. Although the original questionnaire was designed to address aspects of NOS and SI, the qualitative analysis looked for patterns and culture differences between Chinese and United States. This investigation indicated that United States science teachers' views of NOS and SI was statistically significantly higher than Chinese teachers (p<.05), and their views was at different stages. Also, the teachers from two different countries had different results of Granger causality test for VNOS and VOSI. Additionally, Chinese and United States science teachers' views of NOS and SI was several patterns and different proportion. Finally, reflections on possible reasons of their NOS and SI views were discussed.

S12.11.4 Frameworks for an Inquiry-focused, Early-Career, Science Teacher Professional Development Program: Developing a Teaching-Through-Inquiry Learning Progression

Bruce E. Herbert, Texas A&M University, herbert@geo.tamu.edu

Hye-Jeong Kim, Texas A&M University

Cathleen C. Loving, Texas A&M University

Susan Pedersen, Texas A&M University

ABSTRACT: PLC-METS, a professional development for early career science teachers, seeks to develop a research-based professional learning community (PLC) that supports intern and induction teachers in their efforts to introduce inquiry-based learning into their classrooms. Our research is focused on the development of proto-theories through design-based research. In particular, we seek to define a teaching-through-inquiry learning progression that guides the PLCMETS program which scaffolds early-career teachers in overcoming the intrinsic and extrinsic barriers that limit teachers implementing a standards-based science curriculum the incorporates inquiry lessons. Our research design used a partially mixed, concurrent, quasi-control research design with qualitative and quantitative data sources, including quantitative pre-post surveys, interviews, lesson plans developed by early-career teachers, and classroom observations of inquiry lesson implementing inquiry lessons in their classroom. Our inquiry learning progression focuses on three strands: (1) scientific knowledge (content knowledge, nature of science, research skills focused on experimental design, data analysis and representation, and modeling), classroom practice (pedagogical content knowledge and classroom management), and reflective practice (lesson design, learning objectives, learning assessment).

Strand 10: Curriculum, Evaluation, and Assessment

S12.12 SC-Paper Set: Assessing Student Conceptual Understanding

3:00pm – 4:30pm, Conference Room 410

S12.12.1 Optimizing Force Concept Inventory Data Collection and Analysis through Innovative Data Cleaning, Data Plotting and Utilization of Rasch ZSTD and MNSQ Fit Statistics: Implications for the Collection and Analysis of Science Education Test and Survey Data

William J. Boone, Miami University, boonewj@muohio.edu Lynn Bryan, Purdue University Melissa S Yale, Purdue University Mark P. Haugan, Purdue University Deborah Bennett, Purdue University Gregory Applegate, Purdue University **ABSTRACT:** In this paper, we describe how we employed view

ABSTRACT: In this paper, we describe how we employed varied analytical techniques to monitor data quality and prepare Force Concept Inventory (Hestenes, Wells, & Swackhamer, 1992; Halloun, Hake, & Mosca, 1995) data for statistical analysis. The type of analysis described in this study is essential for those using online administration of tests and surveys in the field of science education. This technique provides a means of identifying respondents who may not provide quality data. Specifically, Rasch techniques (Rasch, 1960) used in this study are the same Rasch tools now utilized for the development and analysis of high stakes American statewide K-12 multiple choice and constructed response tests (e.g. Illinois, Ohio, California, Texas, Pennsylvania) as well as PISA data (Baldi, Jin, Skemer, Green, & Herget, 2007).

S12.12.2 Evaluation of Students' Thermal Conceptual Understanding in Everyday Contexts

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Shelley Yeo, Curtin University of Technology

Marjan Zadnik, Curtin University of Technology

ABSTRACT: The 26-item Thermal Concept Questionnaire (TCQ) on heat, temperature, and heat transfer concepts previously developed in Australia was administered to 515 Korean students from Grades 10 – 12 in order to investigate their conceptual understanding of these concepts. The items related to students' experiences in everyday contexts. Analysis of students' responses to ascertain the underlying conceptual structure of the instrument revealed four conceptual groups namely, (1) heat transfer & temperature changes, (2) boiling, (3) heat conductivity & equilibrium, and (4) freezing & melting. Depending on the year group, about 25 - 55 % of students experienced difficulties in applying scientific concepts in everyday contexts. Years of schooling, the science subjects currently studied and physics topics previously studied correlated with the development of the students' conceptual understanding, especially in relation to the heat transfer & temperature changes, and heat conductivity & equilibrium conceptual groups. Although the research results indicated that students improved their conceptual understandings when they had more opportunities to learn about scientific concepts, they still had difficulties in relating the scientific concepts to their experiences in everyday contexts.

S12.12.3 Addressing Misconceptions in Evolution at the High School Level

Laura J. Lenz, University of California, Berkeley, lalenz@berkeley.edu

Kristin Catz, University of California, Berkeley

ABSTRACT: The paper examines student learning, shown by pretest/posttest change, in the Science Education for Public Understanding Program (SEPUP) Science and Global Issues ninth grade evolution curriculum. The unit is part of a two year sequence made up of one year of biology and a semester each of chemistry and physics. The biology year is made up of four units-ecology, cell biology, genetics, and evolution. Specific items were examined that show student learning around documented misconceptions about evolution concepts and processes. The results of this analysis found statistically significant gains in total pre to post scores for the entire population as well as on three sample items. These findings are important because they address several misconceptions and areas where students lack the conceptual understanding about evolutionary concepts or processes. Also, small effect sizes between three populations-Caucasian, underrepresented STEM, and English Language Learners indicate little difference between the three groups.

S12.12.4 Engineering Design and Conceptual Change in Science: Addressing Thermal Energy and Heat Transfer in Eighth Grade

Christine G. Schnittka, University of Kentucky, christine.schnittka@uky.edu

Randy L. Bell, University of Virginia

ABSTRACT: The purpose of this research was to investigate the impact of engineering design classroom activities on middle school students' conceptions of heat transfer and thermal energy. One eighth-grade physical science teacher and the students in three of her classes participated in this mixed-methods investigation. One class served as the control receiving typical instruction. Students in a second class had the same learning objectives, but were taught science through an engineering design curriculum that included demonstrations that targeted specific alternative conceptions about heat transfer and thermal energy. A third class also used the engineering design curriculum, but students experienced typical demonstrations instead of targeted ones. Conceptual understandings of heat transfer and thermal energy were assessed prior to and after the interventions through interviews, observations, artifact analysis, and a multiple choice assessment. Results indicated that the engineering design curriculum with targeted demonstrations was significantly more effective in eliciting desired conceptual change than the typical instruction and significantly more effective than the engineering curriculum without targeted demonstrations. Implications from this study can inform how teachers should be prepared to use engineering design activities in science classrooms for conceptual change.

Strand 10: Curriculum, Evaluation, and Assessment S12.13 SC-Paper Set: Developing Technology-based Science Assessment 3:00pm – 4:30pm, Conference Room 412

3:00 pm - 4:30 pm, Conference Room 412

S12.13.1 Human VS Computer Diagnosis of Student Knowledge of Natural Selection: Testing the Efficacy of Lexical Analyses of Open Response Text

Ross H. Nehm, The Ohio State University, nehm.1@osu.edu

Hendrik Haertig, NWU-Essen, Germany

Judith S Ridgway, The Ohio State University

ABSTRACT: Our study empirically tests the efficacy of computerized Lexical Analyses (LA) of open-response text relative to expert human scoring. Specifically, we explored whether LA can diagnose the explanatory elements (or key concepts) that comprise students' explanatory models of natural selection with equal fidelity as expert human scorers in a sample of > 800 essays produced by undergraduate biology students. We used SPSS Text Analysis (TA) 3.0 to perform our LA and measure Kappa values (inter-rater reliability) of KC detection (i.e., computer- human rating correspondence). Our first analysis indicated that the LA functions (or extraction rules) developed and deployed in TA matched or exceeded the inter-rater reliability benchmark of 0.80 in the vast majority of cases for individual Key Concepts (KCs) for all three item prompts. The second analysis explored the measurement of human-

computer correspondence in the combined sample of all 827 essays. Here we found outstanding correspondence, and that the extraction rules that we generated in TA are broadly applicable to different evolutionary scenarios (e.g., bacterial resistance, cheetah running speed, etc.). This result is encouraging, as it suggests that the development of new item sets may not necessitate the development of new Lexical Analysis (LA) rules.

S12.13.2 A Characterization of Rich Formative Assessment Practice in Secondary Science Classrooms Equipped with an Audience Response System

Melissa L. Shirley, University of Louisville, melissa.shirley@louisville.edu

Karen E. Irving, The Ohio State University

ABSTRACT: Formative assessment (FA) involves probing students' ideas to determine levels of understanding during the instructional sequence. Despite having been shown to increase student achievement in a variety of classroom settings, FA remains a relatively weak area of teacher practice. Methods that enhance FA strategies may therefore have a positive effect on student achievement. Audience response systems (ARS) comprise a broad category of technologies that support richer classroom interaction and have the potential to facilitate FA. Results from a large national research study show that students in algebra classrooms using ARS experience significantly higher achievement gains compared to a control group, suggesting a role for ARS in promoting FA. In this paper, teacher interviews and classroom observations are used to develop a fine-grained descriptive model of FA in secondary science classrooms employing an ARS. This model can be used to characterize components of FA practice in classrooms. In particular, the assessment episode is defined to characterize extended cycles of teacher-student interactions. Further, the use of the assessment episode presents a new methodology to describe the use of questioning and subsequent classroom discourse to uncover student learning. Additional components focus on the teacher's recognition of student learning and changes in instructional practice.

S12.13.3 Using Rasch Modeling to Develop a Computer Modeling-based Measurement Instrument on High School Students' Conceptual Understanding of Matter

Silin Wei, East China Normal University, silinwei@163.com

Xiufeng Liu, State University of New York at Buffalo

Gail Zichitella, State University of New York at Buffalo

ABSTRACT: Research has suggested that difficulty in making connections among three levels of chemical representation, i.e. macroscopic, submicroscopic, and symbolic, is a primary reason for student alternative conceptions of chemistry concepts and computer modeling is promising to help students make the connections. However, no computer modeling based assessment tools are current available. This study used Rasch modeling to develop a measurement instrument to assess students' conceptual understanding on the structure of matter. The draft version of the instrument contained 18 items, 15 in multiple-choice and 3 constructed response formats. The instrument was given to 57 high school students. Rasch modeling was conducted to help examine the item and test properties. The various Rasch modeling statistics suggested that some items need to be removed, while some other items need to revised, and additional items need to be added. A revised measurement instrument has been created and scheduled to be given to a new sample of high school and upper middle school students in the fall 2010. This study has shown that the iterative process of developing a measurement instrument based on Rasch modeling is promising in establishing the validity and reliability of the measurement instrument.

S12.13.4 Insight into Student Thinking in STEM: Lessons Learned from Lexical Analysis of Student Writing

Mark Urban-Lurain, Michigan State University, urban@msu.edu

Kevin C. Haudek, Michigan State University

Rosa A. Moscarella, Michigan State University

John E. Merrill, Michigan State University

ABSTRACT: Constructed response assessments, in which students have to use their own language to demonstrate their knowledge, can provide good insight into student thinking. We have successfully used computerized lexical analysis in studies of students' conceptual understanding in biology, chemistry and geology. We are taking a two-stage approach to analyzing constructed responses. First, we use lexical analysis to extract key terms and concepts from student writing. We then use these terms and concepts as variables for statistical classification techniques to predict expert ratings of student responses. Based on our analysis of constructed response items, we have: 1) learned how to structure questions so that responses are better suited for lexical analyses; 2) learned effective ways to build custom discipline-specific lexical libraries; 3) gained insights into optimal numbers and specificity of categories; and 4) learned about optimizing the granularity of the classification rubrics used to rate student responses. In this paper, we summarize our work to date and describe some of the lessons we have learned in the hope that others can benefit from our work and adopt these techniques.

Strand 11: Cultural, Social, and Gender Issues

S12.14 Symposium: Teaching Science for Social Justice: Models and Evidence

3:00pm – 4:30pm, Conference Room 411

Presenters:

Edna Tan, University of North Carolina at Greensboro, tane@msu.edu Angela Calabrese Barton, Michigan State University Bhaskar Upadhyay, University of Minnesota Tara B. O'Neill, University of Hawai'i at Mānoa Melissa S Cook, University of California, Los Angeles Vandana Thadani, Loyola Marymount University Christopher Emdin, Teachers College, Columbia University **ABSTRACT:** This interactive symposium draws from multiple conceptual models, methodological approaches, and research contexts

Abstract: This interactive symposium draws from multiple conceptual models, methodological approaches, and research contexts to unpack the contested meaning and purpose of social justice in science education. The guiding questions of this symposium include: (1) What are the multiple meanings of teaching science for social justice, specifically in settings that serve racially, ethnically, and linguistically diverse populations?; (2) What are the conceptual models that have been brought to social justice research and science education and how do these models inform our developing knowledge base?; and (3) What are the processes and challenges involved in building socially just teaching and learning environments across perspectives? The focus is cross perspective dialog as informed by the work reflected in the five papers. We focus on conceptual models and empirical data to move beyond surface level claims of what teaching science for social justice is or should be. We desire to see how the research base for work in this area is connected to the broader scope of work in science education, teacher education, and the learning sciences. We also desire to see concretely if and how "social justice research efforts" have made a difference, how, in what contexts and to whom.

S12.15 Administrative Symposium: Creating an Electronic Presence for NARST

This session serves as a call for an Ad-Hoc Committee and Members.

3:00pm – 4:30pm, Conference Room 501

Presider: Charlene M. Czerniak, The University of Toledo

ABSTRACT: This new ad hoc committee is charged with exploring and providing the NARST board with recommendations for technology use within the organization that would facilitate communication, collaboration, and research. Technologies exist that would enable NARST members worldwide to communicate throughout the year as well as in different ways during the annual conference. For example, technology could enhance the annual conference experience and share important aspects of the conference via video technology to members worldwide who could not attend the conference. New and existing technologies could be used for creating learning communities, sharing research databases and research instruments, and publication of manuscripts and other materials. This NARST electronic presence committee is just forming and beginning its task of making a recommendation to the board. All interested NARST members are encouraged to attend this brainstorming session.